External Scientific Report

APPROVED: 2 October 2024

Generating wildlife density data across Europe in the framework of the European Observatory of Wildlife (EOW)

Enetwild Consortium, Guerrasio T, Carniato D, Acevedo P, Apollonio M, Arakelyan M, Arnon A, Beatham S, Belova O, Berde L, Berdión O, Blanco-Aguiar JA, Bleier N, Burgui Oltra JM, Bužan E, Carvalho J, Casaer J, Del Frate M, Dijkhuis L, Duniš L, Ertürk A, Dal Mas M, Ferroglio E, Forti A, Gačić D, Gavashelishvili A, Hillström L, Jenječić M, Ježek M, Keuling O, Licoppe A, Liefting Y, Martinez-Carrasco C, Olano I, Palencia P, Plis K, Podgorski T, Pokorny B, Rowcliffe M, Santos J, Smith GC, Sola de la Torre J, Šprem N, Stoyanov S, Zanet S, Vicente J, and Scandura M

Abstract

The European Observatory of Wildlife EOW, as part of the ENETWILD project, represents a collaborative network that has been operating since 2021 to develop and implement standardized protocols to obtain harmonized data on distribution and density of target mammal species. In so doing, the EOW aims at contributing to improving the quality of data that are available for wildlife management and risk assessment on a European scale. This report describes the activities carried out during the 2023 EOW campaign, which was joined by a total of 30 organizations who committed to collect data in 44 sites across 22 different countries. We present data on the distribution and density of three species – wild boar (*Sus scrofa*), European roe deer (*Capreolus capreolus*), and red fox (*Vulpes vulpes*) – obtained by implementing a camera trapping protocol and by fitting the random encounter model (REM) for density estimation. Camera-trap images were processed using the Agouti platform and some of its tools specifically designed for the management of camera trapping projects. This includes the use of photogrammetry to obtain parameters for the REM directly from the sequences of images. A total of 24 EOW sites were monitored in past years as well, providing multiannual density estimates and population trends and highlighting an improvement in the precision of the estimates, related to the improved study design and protocol implementation. We also describe the activities of the 2024 campaign, carried out as part of ENETWILD 2.0, where big efforts were made to expand the network, focusing on sites at risk of African Swine Fever, with wild boar/pig interactions and containing wetlands, as potential hubs for Avian Influenza. This effort resulted in the engagement of 40 participants monitoring 64 study sites (27 countries), including 28 study sites located either in infected areas or <100km from the ASF frontline, and 25 sites with wetland habitats. Furthermore, in at least 20 sites pig farming is practised either intensively, extensively or as backyard farming. Finally, synergies were established with other international initiatives related to wildlife monitoring and disease prevention, with the aim of sharing experiences and sustaining a transnational data collection and harmonization.

Key words: ungulates, carnivores, wild boar, camera trapping, density estimation, harmonized protocol, random encounter model

Question number: EFSA-Q-2024-00028
Correspondence: biohaw@efsa.europa.eu

Disclaimer: The present document has been produced and adopted by the bodies identified above as author(s). This task has been carried out exclusively by the author(s) in the context of a contract between the European Food Safety Authority and the author(s), awarded following a tender procedure. The present document is published complying with the transparency principle to which the Authority is subject. It may not be considered as an output adopted by the Authority. The European Food Safety Authority reserves its rights, view and position as regards the issues addressed and the conclusions reached in the present document, without prejudice to the rights of the authors.

Acknowledgements: We are grateful to all people who have contributed to the EOW activities and, in particular, to all the hunting associations involved, Bijl H, Csányi S, Della Libera F, De Waele V, Fodor I, Gutiérrez I, István F, Karan G, Kashyap B, Mastura SM, Pissarro F, Platovšek Z, Severino P, Školnik Škrabe K, Soyumert A, Thomas E, Tinoco Torres R, and Watthez Q.

Suggested citation: Enetwild Consortium, Guerrasio T, Carniato D, Acevedo P, Apollonio M, Arakelyan M, Arnon A, Beatham S, Belova O, Berde L, Berdión O, Blanco-Aguiar JA, Bleier N, Burgui Oltra JM, Bužan E, Carvalho J, Casaer J, Del Frate M, Dijkhuis L, Duniš L, Ertürk A, Dal Mas M, Ferroglio E, Forti A, Gačić D, Gavashelishvili A, Hillström L, Jenječić M, Ježek M, Keuling O, Licoppe A, Liefting Y, Martinez-Carrasco C, Olano I, Palencia P, Plis K, Podgorski T, Pokorny B, Rowcliffe M, Santos J, Smith GC, Sola de la Torre J, Šprem N, Stoyanov S, Zanet S, Vicente J, and Scandura M, 2024. Generating wildlife density data across Europe in the framework of the European Observatory of Wildlife (EOW) EFSA supporting publication 2024:EN-NNNN. 69 pp. 72 doi:10.2903/sp.efsa.2024.EN-NNNN

ISSN: 2397-8325

Summary

Background: The European Observatory of Wildlife (EOW), as part of the ENETWILD project, aims at improving the European capacity for monitoring wildlife populations, implementing international standards for data collection, providing guidance on wildlife density estimation and, finally, promoting collaborative, open data networks to enhance wildlife monitoring. The EOW team has developed a protocol for the estimation of wild mammal density through the implementation of the random encounter model (REM), based on the use of camera traps (CTs). The protocol also implies the use of photogrammetry, that, through a calibration process, allows the creation of a three-dimensional digital representation of the scene captured by the camera. Such process enables the direct estimation of key parameters for REM, like day range and camera detection values from the obtained sequences. Image processing and parameter estimation benefit from the use of a common platform (Agouti), which has been enhanced to automate and simplify the workflow. Since 2021 several ENETWILD partners and stakeholders have been engaged in the EOW activities and have implemented this protocol estimating population density values for multiple species in a growing number of 'observatory' sites throughout Europe.

Objectives: This report summarizes the activities in relation to the generation of reliable density data of wildlife (selected species of wild ungulates and carnivores) using the EOW protocol in a network of areas in Europe. Main aim was the extension of the network of monitored sites and the increase in their representativeness, especially in relation to the environments and the species involved in the management of African Swine Fever (ASF) and Avian Influenza.

First, an update on CT campaign 2023 and data generated in the period 2021-2023 is provided, with results summarized for wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*) and red fox (*Vulpes vulpes*). Second, activities to extend the network of areas where CT surveys are taking place in 2024 are reported.

EOW campaign 2023: A total of 30 institutions joined the campaign 2023 covering 44 study sites distributed over 22 different countries and resulting in a global effort of 79,092 CT activity days produced by 1,722 CT deployments. Wild boar was the most detected species with 40 study sites reporting its presence, followed by the badger (37), red fox (36) and roe deer (35). Density estimates were obtained for wild boar from 40 study sites in 22 different countries, for roe deer from 35 study sites in 20 countries, and for red fox from 30 study sites in 15 countries. In a multi-year analysis on data collected in sites monitored over the years 2021-2023, mostly slight density variations were observed together with an increase in the precision of the estimates.

EOW campaign 2024: A total of 40 institutions, including EOW members having contributed to previous data collections and new ones, have joined the campaign 2024. They are cumulatively monitoring 64 study sites, encompassing 27 different countries. New sites were added in ASF infected areas or in areas close to the ASF infection. Out of a total of 64 sites, 33 fall in a country where ASF is present and 28 are in infected areas or at less than 100km from the ASF frontline. According to the information provided by EOW participants, pig farming is practised in at least 20 study sites.

Networking initiatives: In 2023 and 2024 several initiatives have been taking place to establish synergies with other ongoing international initiatives with a focus on wildlife monitoring and disease prevention. This activity took the form of a direct participation in international partnerships or of a liaison activity with related international projects.

Conclusions: The present report highlights the importance of the collaborative approach of the European Observatory of Wildlife, operating since 2021, which underwent an extension of the network of observation points, a continuous refinement of the methodology and of the technological tools in use. The data generated, which are unprecedented, are already in use for risk assessment regarding wild boar populations and ASF. The precision of the density estimates for wild boar increased in 2023 in all study sites but two. Further increase in the precision is expected with the 2024 campaign, in which efforts were made in order to improve the quality of the study design and to increase the number of CTs deployed at each study site. Specific analyses are underway to understand which factors are most decisive in increasing the accuracy of estimates.

The expansion of the EOW in 2024 (23 new sites) was directed by the priorities set by EFSA within the specific contract 1. Consequently, the new data collection has started considering that:

- study sites represent the different bioregions, with the exception of the Northern one restricted to a few countries (with a large area affected by international conflicts);
- almost all sites host a wild boar population;
- a large number of sites (n=28, 44%) are located in ASF-infected areas or close to the ASF frontline;
- a minimum of 20 sites (31%) contains an interface wild boar – domestic pigs;
- 25 sites (39%) include wetland habitats, of possible interest for Avian Influenza.

These conditions pose the basis for an effective collection of density data (and not only), which will be available for detailed spatial analyses and risk assessment in relation to emerging diseases in Europe.

Perspectives and recommendations: What reported here highlights the feasibility of obtaining harmonized density estimates at a continental scale through the "observatory" approach and that further consolidation and expansion of the network should be set as a priority for the future.

The potential of EOW data to support risk analysis is already a reality, which encourages continuing to grow in terms of study areas, epidemiological contexts, range of monitored species and implementation time. By using the updated available data generated by the EOW, it is possible the calibration of abundance distribution models outputs produced by ENETWILD (forecasting hunting yields) into densities. This will be useful to incorporate them into risk factor analyses for different diseases at selected spatial ranges.

Improvements have been made to the protocol over the years of activity of the EOW with a refined use of photogrammetry and the addition of new functions in Agouti that increased standardization and reduced the chance of human errors. Because of emerging evidence showing the importance of increasing the number of CT locations and CT*days to obtain reliable density estimates with REM, in the last year a great effort has been made to assist participants in reaching optimal conditions for the implementation of the protocol.

Continuity in data collection is of outstanding relevance to produce valuable trend data. Assuring the consistency of the methods implemented and of the monitored areas over time is therefore a key objective of the EOW. Accordingly, on the one hand, a priority is represented by filling the gaps in the distribution of EOW sites, on the other hand, it is important to maintain a minimum number of sites (possibly representative of different ecological and management conditions) for which multi-years data are available.

Table of contents

1 Introduction

The management of sanitary issues deriving from the interaction between wildlife and humans, human goods or domestic animals has raised a growing demand for population data that can guide any intervention. In particular, the abundance of certain animal populations is a key information in the assessment of the risk of pathogen transmission from the wild host to domestic animals and human beings. Emerging viral diseases like the African Swine Fever (ASF) in pigs and the Avian Influenza in birds and mammals represent compelling threats to animal food production worldwide, already causing devastating losses to the pig and poultry industries.

Wild mammals are involved in the spread of these diseases: namely wild boar is the key species for ASF transmission, whilst medium-sized and small carnivores are the group of mammals most often reported with the spread of Avian Influenza (ENETWILD consortium et al. 2024a).

European international and national authorities therefore require increased availability of density data of target wild species to properly assess disease outbreaks through a robust risk assessment that considers population abundances.

In the past years, the ENETWILD consortium has been engaged in revising the available methods to estimate wildlife population abundances, publishing open access guidelines specific for wild boar (ENETWILD consortium et al. 2018), wild ruminants (ENETWILD consortium et al. 2020a) and wild carnivores (ENETWILD consortium et al. 2020b). In addition, an effort was made to collate available hunting statistics for game species as a widely available source of data that, once harmonised, can be suitable for spatial models. Analyses at a continental scale are possible only if reliable data are generated in a representative number of areas (and countries) across Europe and are comparable, i.e., are gathered applying the same methodology or are similarly reliable.

Among the methods reviewed, those relying on the use of automated remote sensing applications (like camera trapping) turned out to represent a good compromise between reliability of the estimations and effort required, allowing wide application in a harmonized way. Hence, the consortium developed an integrated protocol based on camera trapping and IT tools that could be implemented not only by skilled researchers but also by other professional staff.

1.1 Background and terms of reference as provided by the requestor

The contract entitled “Wildlife and One Health: wildlife ecology, health surveillance and interaction with livestock, human population, and environment” (framework contract number: OC/EFSA/BIOHAW/2022/01) was awarded to the University of Torino by EFSA. From here, we refer to this framework contract as to the ENETWILD project. The Specific Contract 1 (SC1) of the framework contract refers to “Wildlife ecology, health surveillance and interaction with livestock, human population and environment”.

Within SC1, Work Package 3 (WP3 – Data generation) refers to the generation of new data of presence and abundance of wildlife in a network of sites across Europe.

Specifically, task 3.1. of WP3 deals with the extension and improvement of a network of points of observation through camera traps (CTs) in Europe, especially for wild boar monitoring. In addition, this task implies the placement of CTs in operation in at least 15 more selected locations in Europe, representing all four bioregions, both in wild habitat and at interface with domestic pig farms, according to indications of EFSA WG on ASF.

The network of sites, named European Observatory of Wildlife (EOW, www.wildlifeobservatory.org, ENETWILD Consortium et al. 2022a, 2022b, 2023), was established during the previous framework contract entitled "Wildlife: collecting and sharing data on wildlife populations, transmitting animal disease agents" (Specific Contract number: OC/EFSA/ALPHA/2016/01 – 07). This network has been active since 2021.

Deliverables of this task are:

• Report about extended network of points of observation through camera traps in Europe in all Member States (MSs) and neighbouring countries both for recording ungulates (wild boar, interface with pigs) and for carnivores in selected areas (wetlands, farms, etc.) to be published in EFSA website.

• Data generated by CTs to be stored in an accessible platform for EFSA.

1.2 Scope of the report

This report summarizes the activities in relation to the generation of reliable density data of wildlife (selected species of wild ungulates and carnivores) using a harmonized protocol based on camera trapping in a network of areas in Europe.

First, an update on CT campaign 2023 and data generated in the period 2021-2023 is provided. Results are summarized for three common species, two ungulates and a carnivore, namely wild boar (*Sus scrofa*), European roe deer (*Capreolus capreolus*) and red fox (*Vulpes vulpes*). Second, activities to extend the network of areas where CT surveys are taking place in 2024 are reported. Sites distribution is considered with respect to bioregion, African Swine Fever risk and presence of wetlands.

2 The observatory approach

2.1 Network constitution and organization

The European Observatory of Wildlife had its birth in 2021, when it was established as an international network of study sites where target wildlife species and pathogens are monitored in a harmonized way (but see the first implementation of a common field protocol through some study areas by the consortium, ENETWILD consortium et al. 2019). In the first year of life, the network included 19 sites in 13 countries, where an experimental protocol was adopted for wild boar density estimation. This protocol was based on camera trapping and applied a method that does not require individual recognition: the random encounter model (REM, Rowcliffe et al. 2008). Participants were initially trained on study design, field activities, data processing and analysis. This first experience resulted promising and was the start for a progressive expansion of the network. The first experimental campaign (2021) was followed by the campaign 2022 joined by as many as 36 participants, monitoring 48 study sites in 28 different countries (results reported to EFSA in February 2023; ENETWILD consortium et al. 2023a). Although the ENETWILD project was going to end in July 2023, a new EOW campaign was launched in summer 2023 and finished in December, when the new ENETWILD 2.0 project was already in place. Nonetheless, there was a considerable participation in the new data collection (30 participants, 44 sites and 22 countries).

From the beginning, the EOW opted for improving, adapting, and using a common online already existing application (**Agouti**; Casaer et al. 2019; Fig. 1) to act as repository of the digital material collected by camera trapping and as multi-function platform to execute all the steps necessary to achieve the estimation of density values (device and spatial calibration, species recognition, image annotation, tracking of animal movements). Agouti was created and is currently managed by two ENETWILD partners: the University of Wageningen (WUR) and the Research Institute for Nature and Forest in Brussels (INBO). Every year new functions were added to Agouti with the aim to automatize the full process, thus speeding it up and reducing the operator’s effort.

The winning **rationale** of the EOW is to establish a diffused international observatory, represented by a network of monitored sites where single stakeholders or institutions can jointly contribute to a coordinated data collection They voluntarily adhere, on a yearly basis, to a specific data collection campaign, agreeing to implement the protocol in use and providing all the needed information for the selected study sites. Once joined the network, they receive all the needed documentation, online training, access to online tools and continuous support from the EOW coordinating staff.

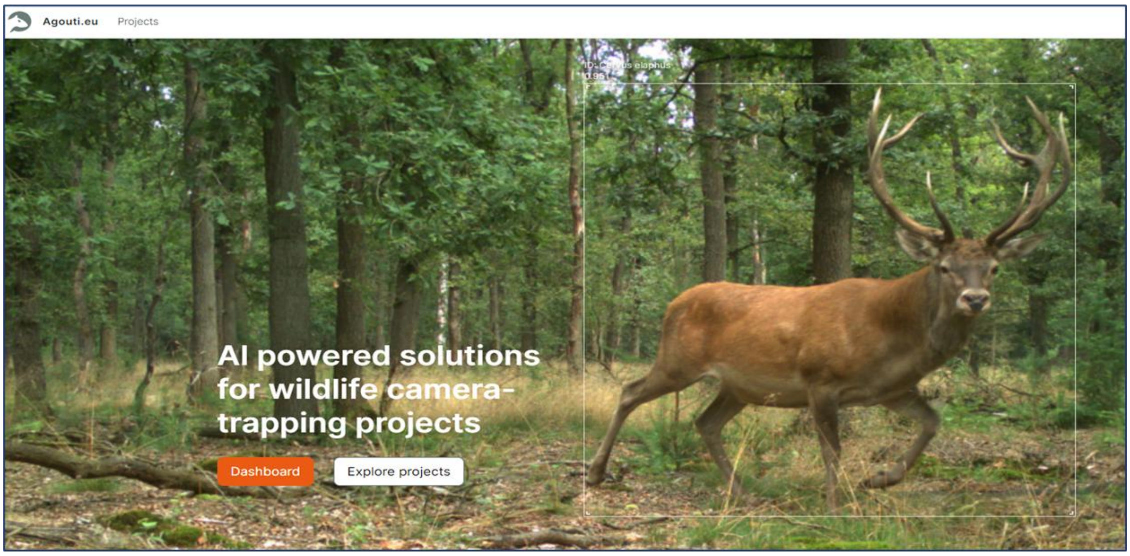


Figure 1. Homepage of the Agouti (agouti.eu) platform for the online processing and management of camera-trap images.

Implementing the same validated protocol makes possible the generation of fully comparable data that does not need an ex-post harmonization effort (like in the case of hunting bags data). From the side of participants, joining the EOW represents the mean to obtain reliable density estimates usable for different purposes (hunting quotas, damage prevention, sanitary risk), reduce the effort to obtain them and have the chance to compare them with areas located in similar or different ecological contexts or management regimes. This is particularly valuable for administrations or other institutions that want to contribute to an integrated and evidence-based management of wildlife populations.

Initially **EOW members** were represented by a small number of participants interested in density estimates and ENETWILD partners that selected study areas where other monitoring activities were ongoing; but year after year, by voluntary addition, a growing number of other participants joined the EOW, expanding the network. They include academics, wildlife or forestry research institutes, environmental agencies, territorial administrations, NGOs, natural parks and hunting associations.

Coordination of the network has been held by ENETWILD partners, namely IREC and UNISS. EOW coordinators maintain the contacts with all participants, invite participants to sign in the annual agreement, distribute updated versions of the protocol and other EOW documentation, organize bimonthly online meetings and training sessions, assist participants in all phases of the protocol implementation (site selection, study design, fieldwork, image processing, data analysis), consult the advisory board (see below), interact with the Agouti managing team to improve the performances of digital tools, collect ideas and complains from participants that can elicit a methodological improvement, and draft reports on EOW achievements.

In 2024 an **advisory board** was constituted, including Marcus Rowcliffe (Institute of Zoology, Zoological Society of London), Jim Casaer (Research Institute for Nature and Forest - INBO, Brussels) and Pablo Palencia (University of Oviedo). The advisory board was committed to provide suggestions on the assessment of data quality, methodological improvements and data analysis.

2.2 Protocol for density estimation

The goal of the EOW is a coordinated and collaborative data collection in a network of "observatory" sites in Europe, where the data can refer to either animal populations or pathogens. Nevertheless, the primary objective was to refine abundance data on potential hosts of pathogens that are responsible of emerging diseases.

For the determination of reliable density estimates of multiple species, considering all the pros and cons of the available methods (ENETWILD consortium et al. 2018, 2020a, 2020b), camera trapping was selected as a non-invasive and widely applicable and affordable method to collect robust population data. As a limitation, this method can only be applied on limited extensions (i.e., sampling units, that is why the observatory approach is well suited).

In general, CT-based surveys imply the definition of several trapping sites, whose position should follow a specific sampling design, where CTs are installed, set according to pre-defined settings, and activated for a minimum period of pre-defined length. Once triggered by the movement of people or animals in front of them, cameras start recording photos or short videos on a memory card. All the images recorded during the deployment period are then classified (i.e. species recognition), also taking advantage of the use of artificial intelligence (AI) and are available for further analyses.

Different methods were developed to determine the abundance of wildlife populations by camera trapping in the last 20 years. Some of them require that individuals in the population are distinguishable (either by the presence of natural marks or because they have been marked). As this is not a practicable option for most of wildlife targeted by the project, the EOW focused only on methods that do not require individual identification. Among them, the most used are:

- Random encounter model (REM; Rowcliffe et al. 2008)
- Camera trap distance sampling (CTDS; Howe et al. 2017)
- Random encounter and staying time model (REST; Nakashima et al. 2018)
- Time-to-event model (TTE; Moeller et al. 2018)
- Association model (AM; Campos-Candela et al. 2018)

Based on preliminary tests carried out in Iberia (Palencia et al. 2022), the EOW opted for the implementation of a standardized REM approach. This model uses the 'ideal gas theory' applied to animals (i.e., animals treated as gas molecules; Hutchinson & Waser 2007) to estimate population density on the basis of the contact rate (i.e., number of encounters per time unit), animal speed and intrinsic measurements of the detection field of the camera. Animal speed is the most challenging parameter to estimate and can be derived from spatial ecology studies (based on the application of GPS collars) or directly from CT data (Rowcliffe et al. 2016).

The formula to estimate the density with REM is:

$$D = \frac{y}{t}\frac{\pi}{vr(2+\theta)}$$

where y is the number of encounters, t is the total survey effort, ν is the daily range (i.e., product of animal's activity and speed), r is the effective detection radius, and θ is the effective detection angle.

Assumptions of the REM method are as follows:

i. CTs are placed randomly with respect to the spatial distribution of animals;
ii. animals passing in a certain field of view of the camera (detection area) are detected with certainty;
iii. animal movements and behaviour are not affected by the cameras;
iv. the population is closed during the study period.

REM is not sensitive to non-random or non-independent movement of animals (Rowcliffe et al. 2013).

Several papers have confirmed the wide applicability and reliability of this method with different mammal taxa (Anile et al 2014, Cusack et al. 2015, Caravaggi et al. 2016, Waltert et al. 2020, Palencia et al. 2021, 2022, Guerrasio et al. 2022, Jensen et al 2022, Morrison et al. 2022). Nonetheless, several technical aspects in the application of REM are crucial in determining the accuracy and precision of the final estimates. Therefore, the EOW has progressively introduced technical improvements that have reduced the manual steps, which were often introducing biases in the estimation of parameters (ENETWILD et al. 2022c).

The updated protocol implemented by the EOW participants, based on the REM approach, is fully described in the distributed document (Appendix D). In short, it implies the following ten steps:

1. study site selection
2. study design
3. camera deployment
4. deployment calibration
5. camera calibration
6. project creation and setting in Agouti
7. upload of the images
8. image processing (classification and annotation)
9. animal tracking
10. estimation of parameters in R

The study area is usually selected based on practical or management reasons but should meet a few requirements. Sampling (camera) sites are defined according to a fully random, systematic random or random within a grid design; usually it relies on the creation of a systematic grid with points located at regular intervals. A minimum of 36 camera locations should be monitored. Camera locations can be monitored all in one round or split into two or three rounds of a minimum of 4 weeks, after which cameras are moved to new locations in the grid. No bait or attractant (food, water, salt, smell) must be used at camera sites.

To estimate animal speed while active, which is a crucial parameter in REM, a technique named photogrammetry is used to generate a three-dimensional digital representation of the scene captured by the camera. It requires a double calibration: camera model calibration and deployment calibration (Wearn et al. 2022). The camera model calibration is specific to the camera model in use and its settings and is usually realized in a convenient location before starting the field survey. The deployment calibration makes use of a calibration pole and is realized on the camera location, obtaining pictures of the operator holding the calibration pole with its base resting on the ground and keeping it perpendicularly to the line of sight of the CT, in as many different points as possible of the field of view of the camera. The calibration is then digitized in Agouti and saved for all following steps, that will be implemented in this application.

In brief, after the project has been created in Agouti, both calibration images and deployment images are imported. Images are automatically collapsed to sequences, that are annotated adding additional information (species, amount, sex, age, behaviour). Sequence annotation can be assisted by AI, either for just annotating blank sequences and those triggered by humans, or even to recognize animal species. The animal movements are then tracked to re-create the trajectory followed by the animal in the detection zone and measure the distance travelled and the time elapsed (Fig. 2).

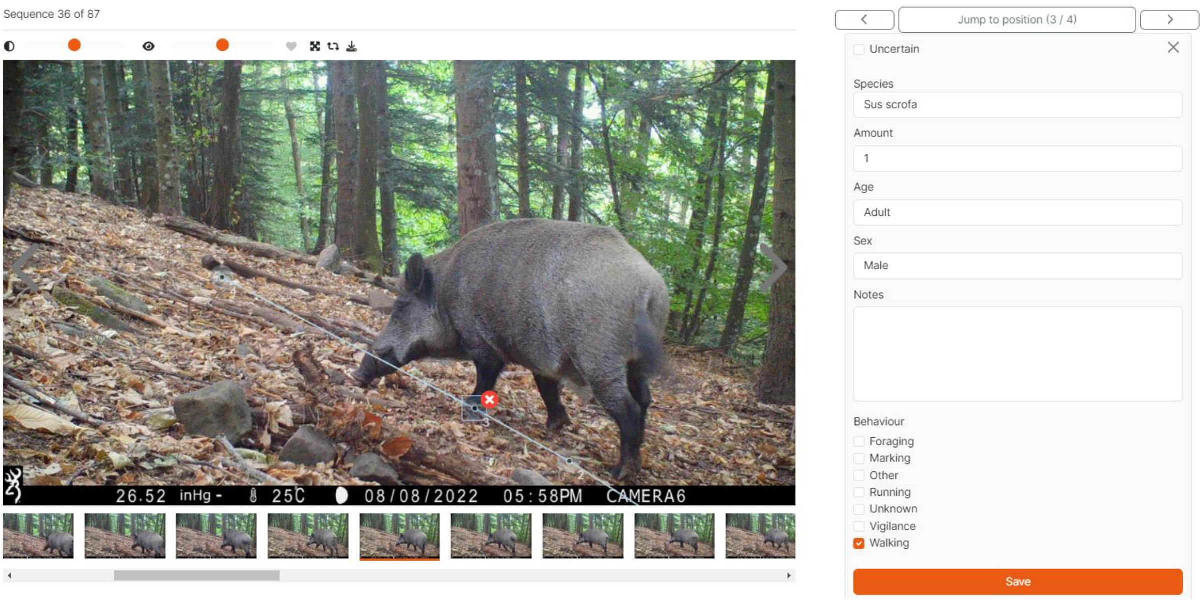


Figure 2. Screenshot of the Agouti tool for tracking the path of animal movement.

As a last step, data for each species are exported from Agouti in *camtrapdp* format as a zipfile and loaded into R-Studio (Posit team; 2024. RStudio: Integrated Development Environment for R. Posit Software, PBC, Boston, MA. URL http://www.posit.co/) to be analysed with *camptrapDensity* (https://github.com/bencevans/camtrap-detector), a package, named specifically developed to calculate and graph all model parameters and density estimates.

2.3 Data management and use

After all EOW members have concluded their fieldwork, they can start the analysis of the data. So, in the months following the termination of the field season, results are gathered by participants in a standardized way and transmitted to the coordinating team through the completion of a shared spreadsheet.

The collated EOW data were formally checked to detect inconsistencies possibly deriving from a wrong application of the protocol and/or data processing and analysis. A flow of information between the coordinating team and the EOW participants is crucial at this step, as it can lead to the correction of possible errors or to the identification of criticalities in the method implementation.

A final dataset is thus constituted including information on the study sites of the EOW, data referred to the conducted survey (e.g. nr. of cameras, nr. of rounds, etc.) and the values of each single REM parameter obtained for each single species considered.

This dataset can be then used for metanalyses on single species at a European scale or for refining spatial abundance models based on hunting statistics.

3 Update on data collected until 2023

Here we report on results of the EOW activities carried out until 2023 to generate wildlife density values by following the REM protocol.

First, we present data collected during the last EOW campaign (2023) by a total of 30 participants who committed to collect data in 44 sites (22 different countries). Data are reported for three common mammal species: wild boar, European roe deer and red fox.

In the following subchapter we summarize the data so far collected by the EOW during the period 2021-2023. Temporal series of density data are exemplified for wild boar.

3.1 EOW campaign 2023

A total of 30 institutions joined the campaign 2023 monitoring 44 study sites (Fig. 3). The list of the sites and the institutions engaged in 2023 is shown in Appendix A.

Figure 3. Study sites monitored by the EOW in 2023.

These study sites are distributed in 22 different countries spanning Europe from north to south (with additional study areas in Israel and Armenia), representing different habitats and management conditions (e.g., hunting grounds and protected areas). With respect to the subdivision into bioregions, 21 sites fall in the Western, 15 in the Southern and 8 in the Eastern bioregion. No study site lies in the Northern bioregion.

In the 44 monitored sites a global effort of 79,092 CT activity days was produced, with 1,722 CT deployments. The effort in each EOW site is shown in Appendix B. Most sites (n=27) adopted a regular/systematic random design, but some of them used a fully random (n=8) or random within grid cell scheme (n=8). The number of camera locations varied between 26 and 90 (on average 39.1). Deployments were carried out in a maximum of three rounds (one round n=17, two rounds n=13, three rounds n=14). A large majority of sites (n=37) used photogrammetry to measure the distance travelled by the detected animals.

Across all study sites a total number of 42 different wild mammal species were detected. Although the technique is clearly not targeted to flying species (birds and bats), 22 bird species were also reported.

The most reported species by the EOW members (measured as the number of sites where CT sequences of the species were reported) in the monitored areas was wild boar (40 sites, Fig. 4), followed by the European badger (37), red fox (36) and European roe deer (35). Even if detected, many species had a low contact rate and consequently the number of CT sequences obtained were insufficient to estimate reliable densities.

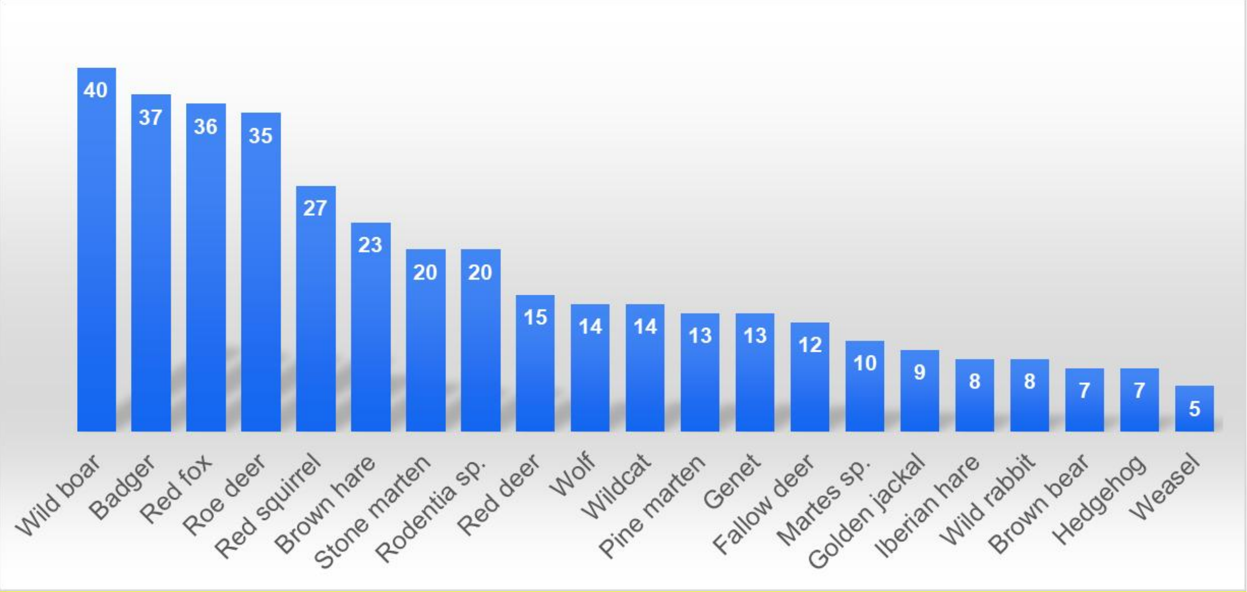


Figure 4. Wild mammals detected at EOW sites. Numbers refer to the number of sites where CT sequences of the species were reported. Species reported at <5 sites are not shown.

3.1.1 Wild boar density

Wild boar density data were provided for a total of 40 study sites covering 22 countries.

In most of the areas wild boar was hunted (n=32), and in 8 of them supplementary feeding was practiced during the year. Seven sites fell in ASF-infected areas (Fig. 5). Only 3 areas were fenced (one of them partially).

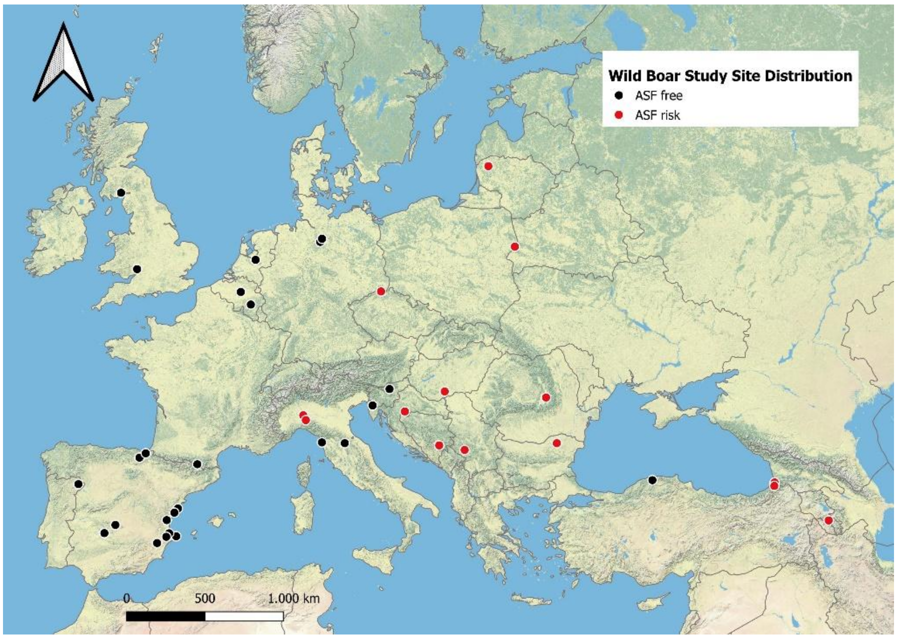


Figure 5. - EOW study sites, where wild boar density was estimated through the REM method in 2023. Sites in ASF-infected areas or nearby (<100km) are in red.

The number of wild boar CT sequences obtained in the monitored areas varied between 11 and 3932. Only sites with >20 sequences are reported (39 sites in 21 countries).

The estimated parameters of the REM method are summarized in Table 1 and their distributions across study sites are shown in the following Figs. 6-8.

The trapping rate was mostly lower than 1 trapped individual per day of camera activation. Higher values were obtained only in four sites, in Croatia, Hungary and Italy, and a maximum of 2.3 ind./day in a Mediterranean coastal area in Central Italy. The estimated daily range travelled by the animals was typically comprised between 2 and 15 km/day, but an outlier value of 43.5 km/day was obtained in Veluwe NP, The Netherlands.

In almost two thirds of the sites wild boar density was lower than 10 ind./km^2. Higher values (up to about 40 ind./km^2) were obtained for some areas in the Western and Southern bioregions (except a site in Hungary). All estimated density values but four had a CV lower than 50%, with a peak between 20% and 40%. The four with the highest CV (54-85%) correspond to areas with very low density of wild boar (< 1 ind./km^2).

Table 1. Parameters estimated for wild boar by applying the EOW protocol based on the REM method in 39 study sites.

WILD BOAR				
Parameter	**Min.**	**Max.**	**Mean**	**SE**
y/t: Trapping rate ((ind·(cam·day)-1)	0.01	2.30	0.41	0.46
v: Daily range (km per day)	2.00	43.52	10.19	6.36
r: Radius of detection (m)	2.28	11.80	7.11	2.04
Θ: Angle of detection (radians)	0.24	1.39	0.74	0.16
Density (ind/km2)	0.15	39.73	7.89	9.14
CV (%)	14.3	84.9	34.5	14.5

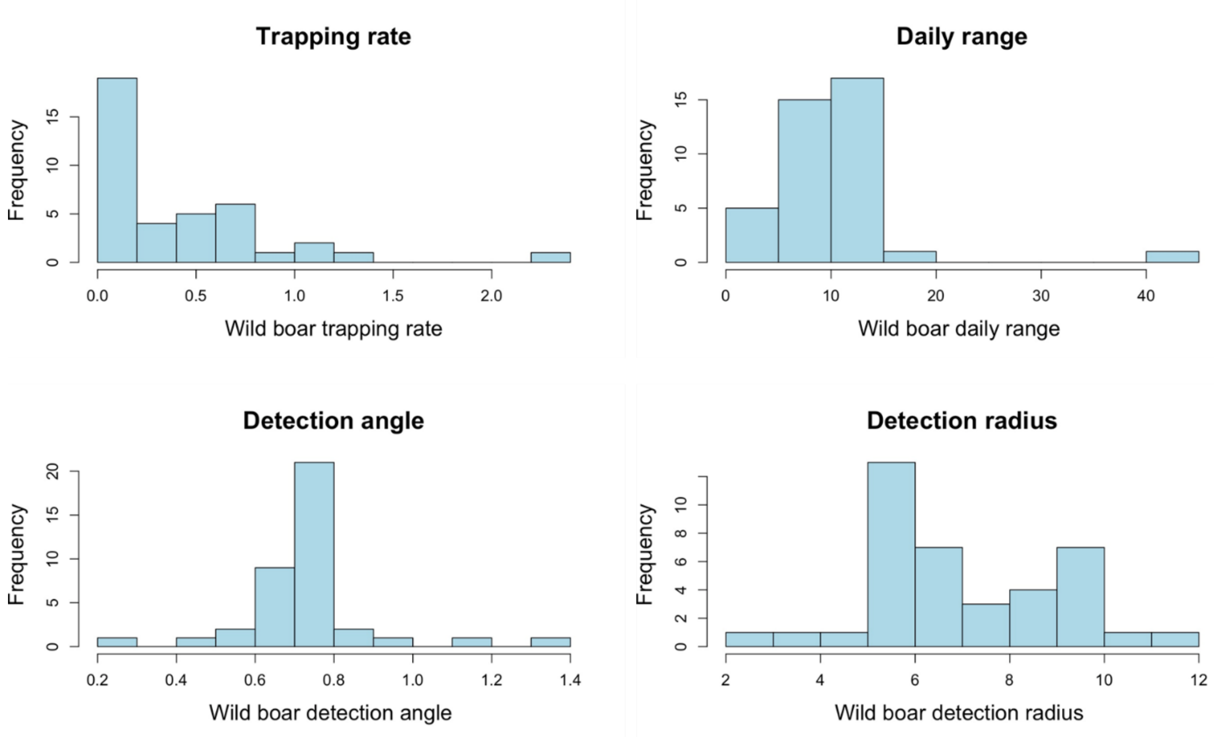


Figure 6. Distributions of the REM parameters estimated from Wild Boar CT sequences in 39 EOW study sites in 2023.

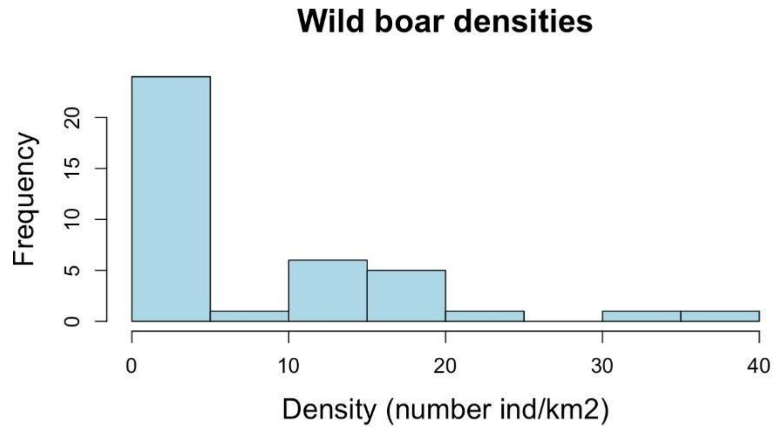


Figure 7. Distribution of Wild Boar densities estimated from CT sequences in 39 EOW study sites in 2023.

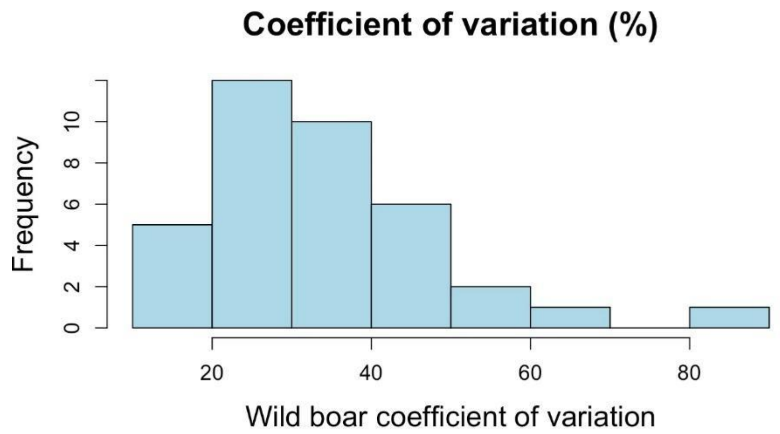


Figure 8. Coefficient of variation of Wild Boar densities estimated from CT sequences in 39 EOW study sites in 2023.

3.1.2 Roe deer density

A total of 35 sites provided roe deer density data (Fig. 9). They covered 20 countries.

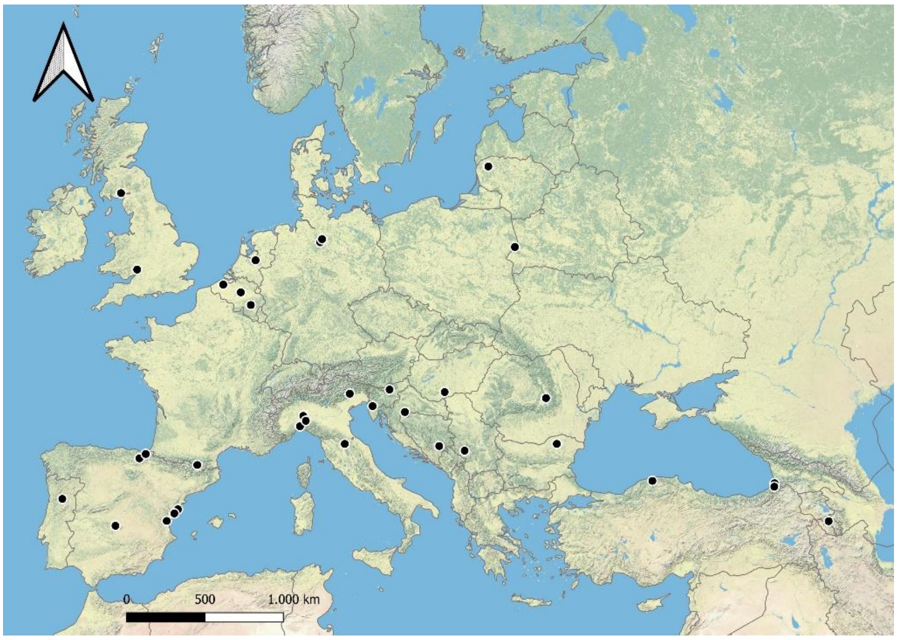


Figure 9. EOW study sites where Roe Deer density was estimated through the REM method.

The number of roe deer CT sequences obtained in the monitored areas varies between 7 and 3162. Only sites with >20 sequences are reported (34 sites in 19 countries).

The estimated parameters of the REM method are summarized in Table 2 and their distributions across study sites are shown in the Figs. 10-12.

The trapping rate was mostly lower than 1 individual per day of camera activation. A higher value (1.3 ind/day) was obtained only in a site of Serbia. The estimated daily range travelled by the animals was typically comprised between 1 and 15 km/day, with a peak around the mean at 6-8 km/day. The highest value was obtained in Bulgaria (21.5 km/day).

Roe deer density was typically lower than 15 ind/km^2, but in 60% of the study sites values were lower than 5 ind/km^2. Densities higher than 20 ind/km^2 were obtained for a few areas in Belgium, Slovenia and Serbia. All estimated density values but six had a CV lower than 50%, with a peak between 20% and 30%. Very high CV values (72-87%) corresponded to areas with low number of sequences (<60).

Table 2. Parameters estimated for the Roe Deer by applying the EOW protocol based on the REM method in 34 study sites.

ROE DEER				
Parameter	**Min.**	**Max.**	**Mean**	**SE**
y/t: Trapping rate ((ind·(cam·day)-1)	0.01	1.28	0.28	0.26
v: Daily range (km per day)	1.38	21.51	7.91	4.24

r: Radius of detection (m)	2.70	14.51	7.06	2.45
θ: Angle of detection (radians)	0.31	1.06	0.71	0.13
Density (ind/km2)	0.15	25.6	7.04	7.81
CV (%)	15.9	87.5	34.3	18.4

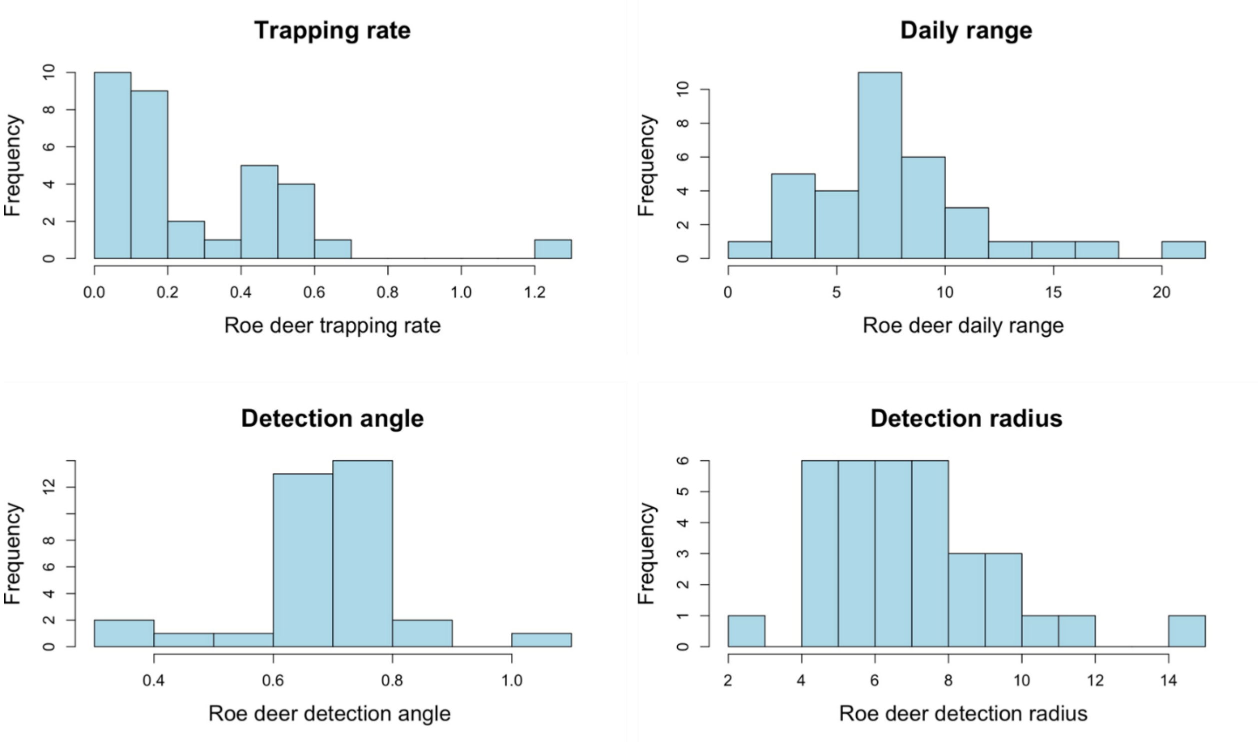


Figure 10. Distributions of the REM parameters estimated from Roe Deer CT sequences in 34 EOW study sites in 2023.

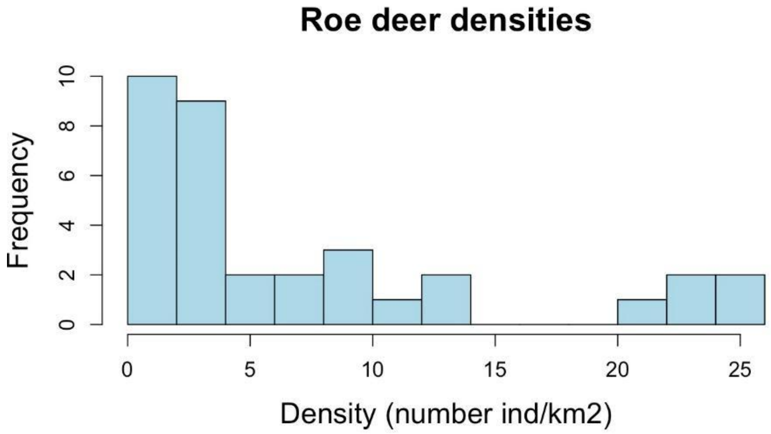


Figure 11. Distribution of Roe Deer densities estimated from CT sequences in 34 EOW study sites in 2023.

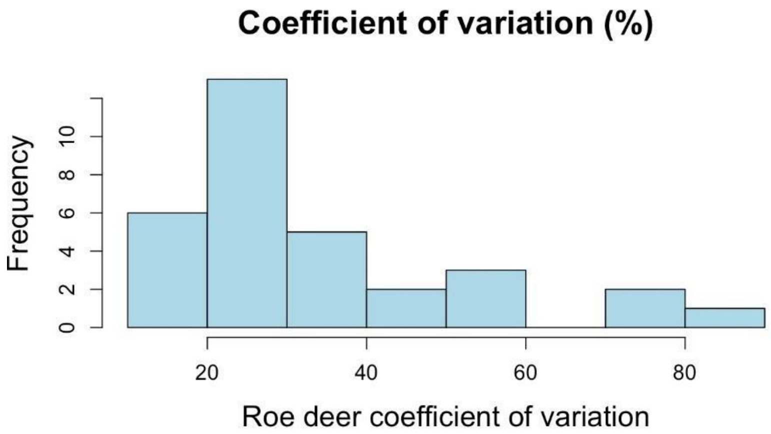


Figure 12. Coefficient of variation of Roe Deer densities estimated from CT sequences in 34 EOW study sites in 2023.

3.1.3 Red fox density

Red fox density data were provided for 30 study sites covering 15 countries (Fig. 13).

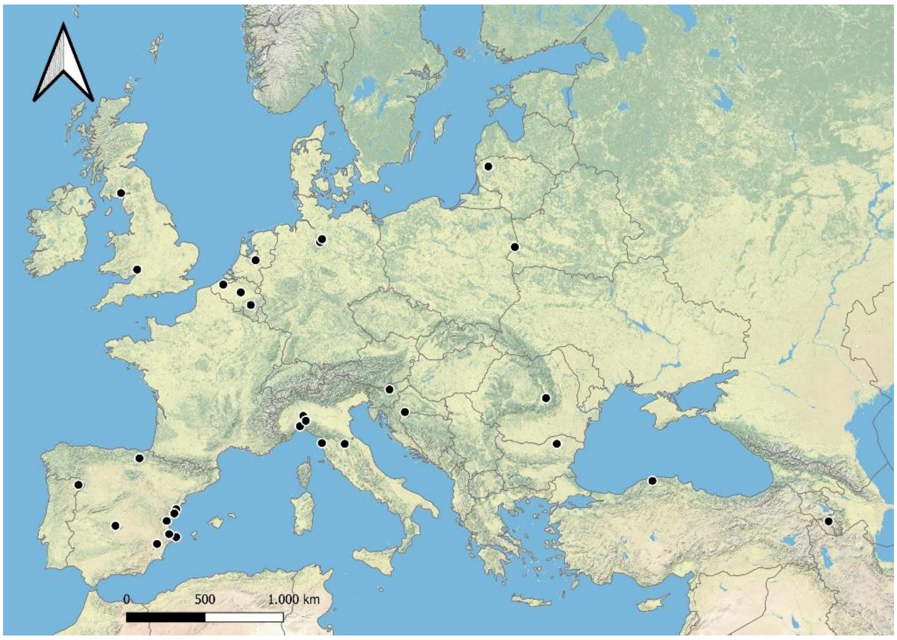


Figure 13. EOW study sites where Red Fox density was estimated through the REM method.

The number of red fox CT sequences obtained in the monitored areas varies between 13 and 593. Only sites with >20 sequences are reported (28 sites in 13 countries).

The estimated parameters of the REM method are summarized in Table 3 and their distributions across study sites are shown in Figs. 13-15.

The trapping rate was always lower than 0.5 individual per day of camera activation, with many areas showing a rate <0.2 ind/day. On the contrary, a high variation in the distance travelled by foxes was observed. The estimated daily range (13.8 km/day) was on average higher than that estimated for wild boar and roe deer with six areas, located in Spain, Netherlands, Poland and Romania, showing rather high values (21-32 km/day).

Table 3. Parameters estimated for red fox by applying the EOW protocol based on the REM method in 28 study sites.

RED FOX				
Parameter	**Min.**	**Max.**	**Mean**	**SE**
y/t: Trapping rate ((ind·(cam·day)-1)	0.02	0.40	0.13	0.10
v: Daily range (km per day)	2.78	32.01	13.76	7.25
r: Radius of detection (m)	3.76	10.59	6.26	1.85
ϴ: Angle of detection (radians)	0.37	1.00	0.66	0.14

Density (ind/km2)	0.17	14.97	2.25	3.06
CV (%)	12.02	68.4	39.8	14.3

Red fox density was typically lower than 4 ind/km^2, but a large majority of the study sites had values lower than 2 ind/km^2. In only two areas (in Italy and Slovenia, respectively) density was > 8 ind/km^2. CVs were slightly higher than for the other two species. Nonetheless, only six sites had CV > 50% (57-69%), and this seems to be irrespective of the number of sequences or density values.

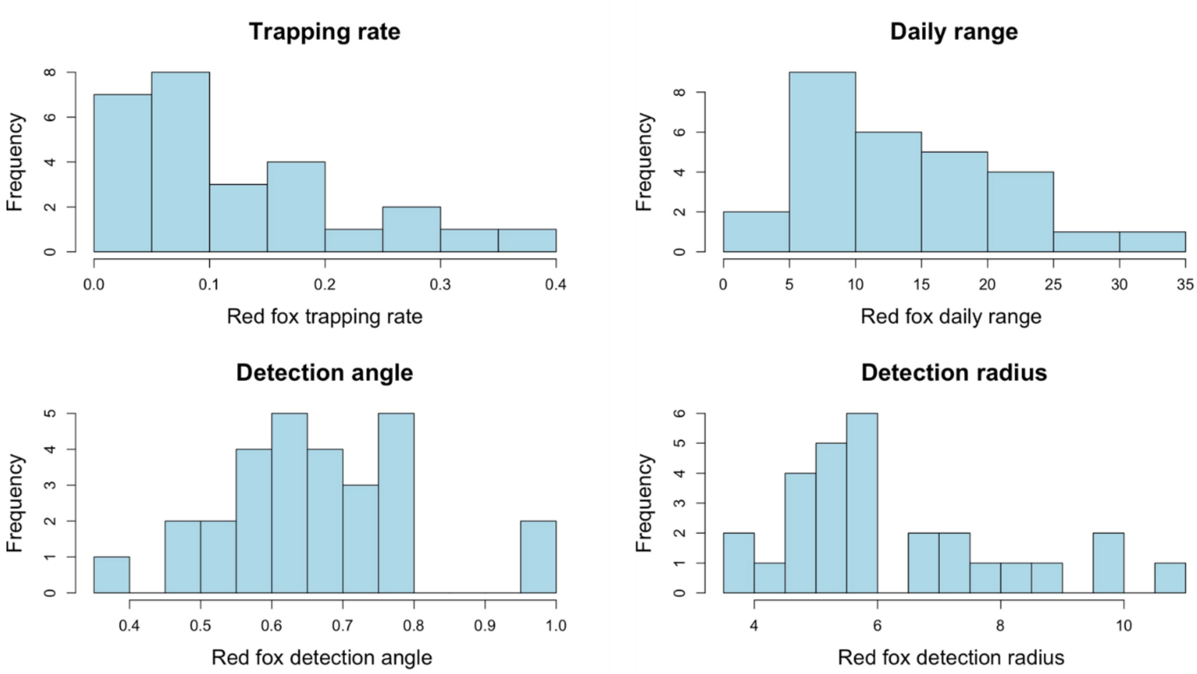


Figure 13. Distributions of the REM parameters estimated from red fox CT sequences in 28 EOW study sites in 2023.

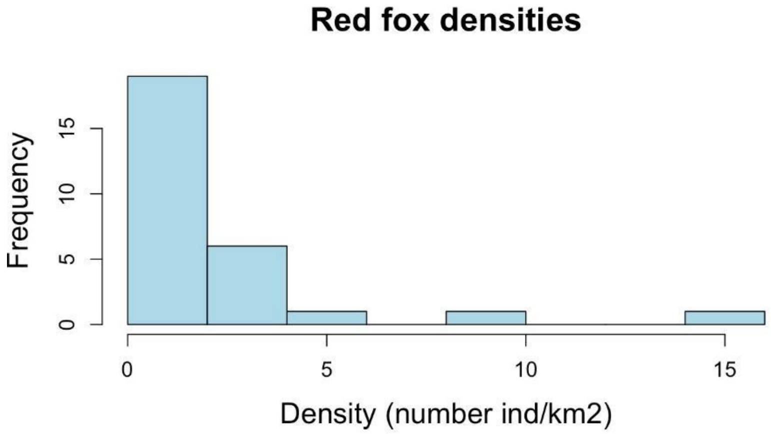


Figure 14. Distribution of red fox densities estimated from CT sequences in 28 EOW study sites in 2023.

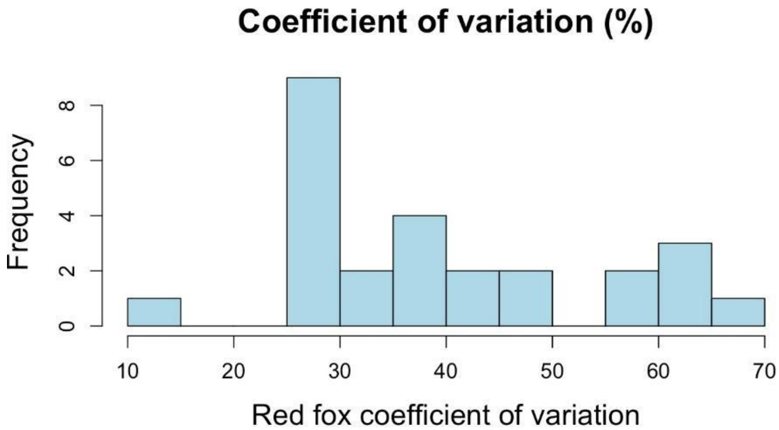


Figure 15. Coefficient of variation of red fox densities estimated from CT sequences in 28 EOW study sites in 2023.

3.2 EOW sites with multiannual data (2021-2023)

EOW study sites monitored over multiple seasons are particularly important to monitor population trends over time. The availability of multiannual density estimates for these sites, indeed, represents an added value of the network, allowing to build up historical data series that can be related to global or local changes (e.g. climate, landscape or management changes).

In a total of 24 study sites (Table 4) wild boar densities were surveyed for more than one year.

Table 4. Sites with multi-annual wild boar density estimates. Years of monitoring are in green.

Country	Name study site	Bioregion	Latitude	Longitude	2021	2022	2023
Andorra	Vedat de caça de la Vall de Ransol	Western	42,60	1,64			
Belgium	Game Management Unit 8	Western	50,81	4,67			
Belgium	Marche-en-Famenne	Western	50,25	5,37			
Bosnia - Herzegovina	Romanija	Western	43,56	18,49			
Bulgaria	Voden	Eastern	43,67	26,68			
Croatia	Prolom	Eastern	45,25	16,10			
Germany	Alt Oerrel	Western	52,96	10,20			
Germany	Süsing	Western	53,09	10,33			
Hungary	Gemenc	Eastern	46,22	18,87			
Israel	Ramat Hanadiv Nature park	Eastern	32,55	34,93			
Italy	La Mandria	Western	45,17	7,56			
Italy	Alpe di Catenaia	Western	43,67	11,91			
Lithuania	MMMPV	Eastern	56,02	2,19			
Netherlands	Veluwe	Western	52,20	5,70			
Poland	Białowieża Forest	Eastern	52,76	23,76			
Portugal	ZCA Santulhão	Southern	41,57	-6,64			
Serbia	Studenica	Eastern	43,33	20,26			
Slovenia	Rizana	Western	45,54	13,85			
Spain	Arriola (Araba)	Southern	42,94	-2,39			
Spain	Montgó (Alacant)	Southern	38,80	0,17			
Spain	Parc Natural de la Serra d'Irta	Southern	40,30	0,34			
Spain	Parc Natural del Desert de les Palmes	Southern	40,07	0,02			
Spain	Parque Natural Sierra del Carche	Southern	38,43	-1,16			
Turkey	Kartdag Wildlife Reserve	Southern	41,78	33,34			

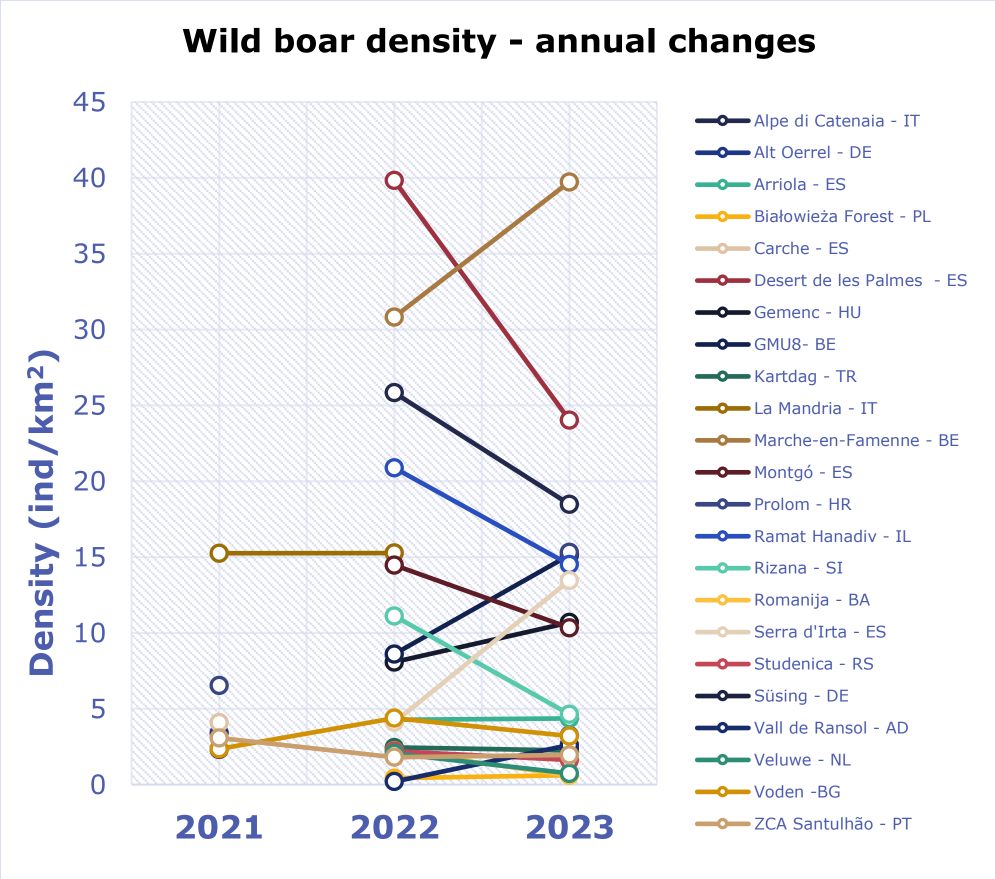


Figure 16. Variation in wild boar density in EOW sites during the period 2021-2023. Only sites monitored for 2 or more years are shown.

Density values obtained for the same areas are mostly consistent among years (Fig. 16). Net of expected variations between years, most areas remain in the same density range (<5 or >5 ind/km²). In the few areas monitored both in 2021 and 2022 densities showed no or slight changes. Areas with low density values (< 5 ind/km²) showed more stationary values over the years. Interestingly, most of the areas with intermediate to high densities (> 5 ind/km²) showed a decline from 2022 to 2023 (up to 50%). Only two of these sites showed an increase.

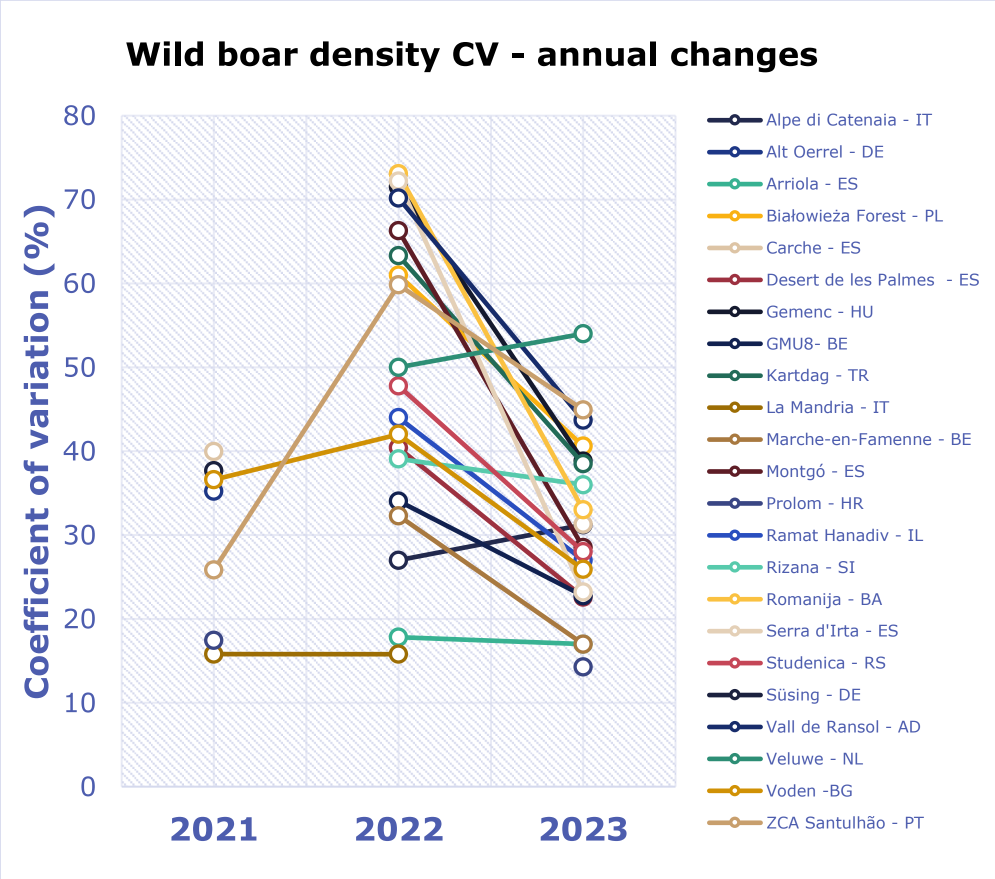


Figure 17. Variation in the coefficient of variation (CV) of wild boar densities in EOW sites during the period 2021-2023.

Notably the coefficient of variation of the estimated densities declined in almost all study sites monitored both in 2022 and 2023 (Fig. 17). This result can be interpreted as a consequence of the improvements to the protocol that led to an increase in the precision of the estimations and could partially have contributed to the changes in densities observed between years in the same locality (if due to an overestimation in the previous years).

4 EOW network extension (2024)

With the start of ENETWILD 2.0, according to the objectives of SC1, a big effort was produced to expand the EOW. The network was promoted considering the priorities indicated by EFSA. Presentations at international meetings or congresses and direct engagement of researchers and institutions were the most used ways to extend the participation in the EOW. The new participants were invited to join the new data collection campaign (2024), signing an agreement and receiving support in different forms.

4.1 EOW campaign 2024

A total of 40 participants, including EOW members having contributed to previous data collections and new members, have joined the campaign in 2024. They are cumulatively monitoring 64 study sites, encompassing 27 different countries. All participants have declared their willingness to implement the updated EOW protocol (Appendix C). Because of international conflicts, monitoring activities in some countries (Ukraine, Belarus and Russia) has become unfeasible.

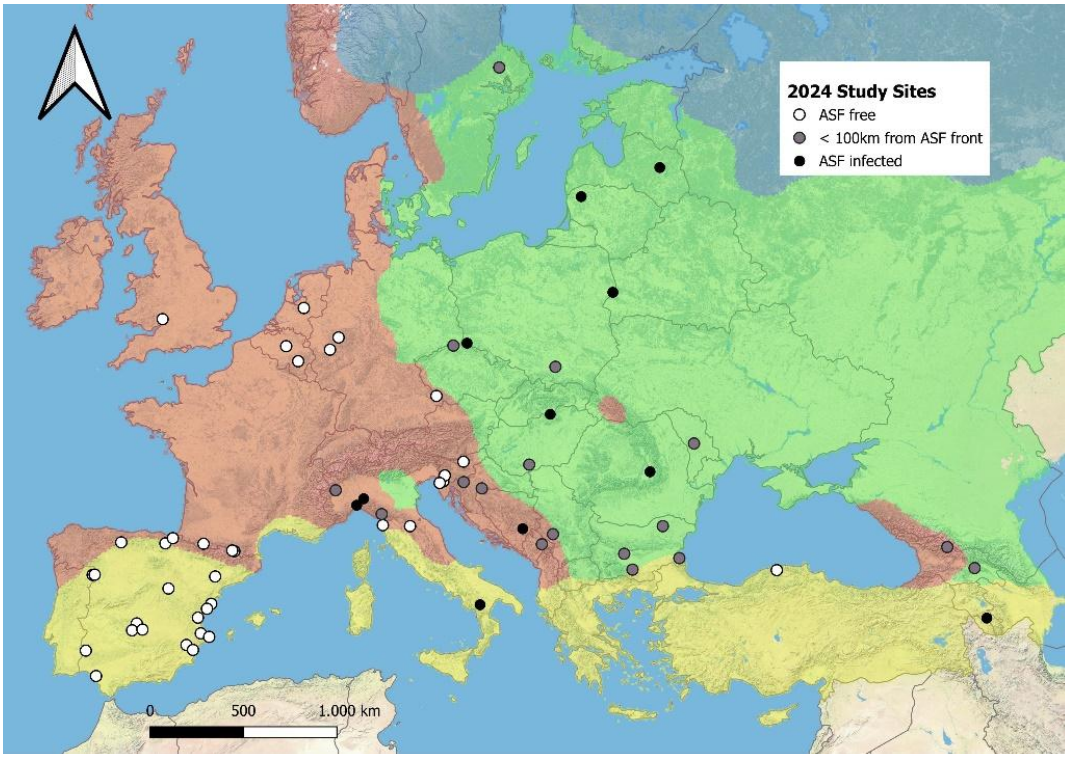


Figure 18. Distribution of the EOW sites with respect to their location in ASF-infected areas, in proximity of ASF (<100km from an infected area) or far from ASF (>100km from an infected area). Colours represent bioregions: Southern (yellow), Western (red), Eastern (green) and Northern (blue).

The geographic distribution of study sites monitored in 2024 is shown in Fig. 18.

Sites are not evenly distributed among bioregions, with Western (n=25) and Southern (n=22) bioregions more represented than the others and the Northern one currently not represented. Its inclusion, indeed, revealed challenging because it only includes a restricted number of countries - northern Scandinavia and Russia – and a large area of it is affected by embargos determined by international conflicts.

New sites were added in ASF infected areas or in areas close to the ASF infection. Out of a total of 64 sites, 33 fall in a country where ASF is present and 28 are either in infected areas or at less than 100km from the ASF frontline (according to the ASF distribution presented by Forcella S., European Commission - *Overview of ASF in the EU and European Commission Activities* 8-9 April 2024). The distribution of study sites in relation to ASF is shown in Fig. 18.

Considering ASF prevention measures in the European Union (EU ASF Zoning measures, 2024 Sante G2, 19 August 2024), 12 study sites lie in restricted zones, but 11 sites are in non-member states, so they are not affected by EU restrictions (see Fig. 19).

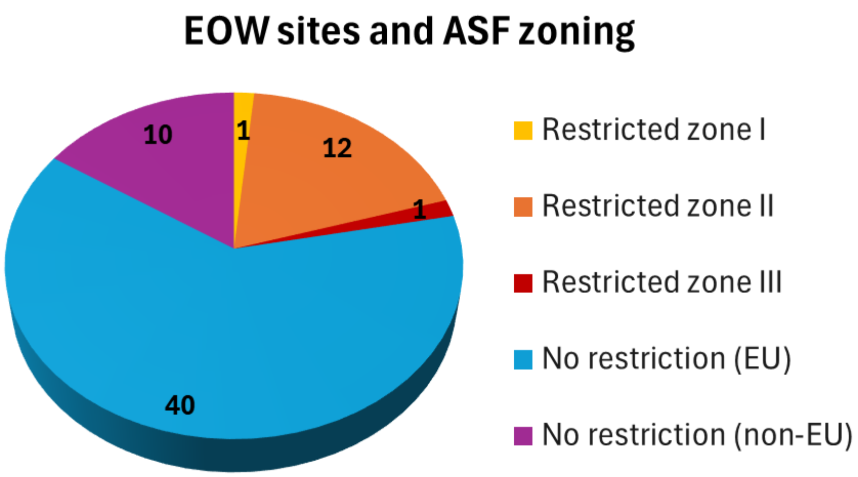


Figure 19. Distribution of EOW sites according to the EU zoning for ASF.

According to the information provided by EOW participants, pig farming is practiced at least in 20 study sites. In most of them (n=12) backyard pigs are present, but in some sites (n=4 and 5 respectively) intensive or extensive pig farming is present. Of these, four sites have multiple forms of pig husbandry.

Twenty-five sites are in wetlands or include lakes, ponds or freshwater environments of possible interest for Avian Influenza (see Fig. 20).

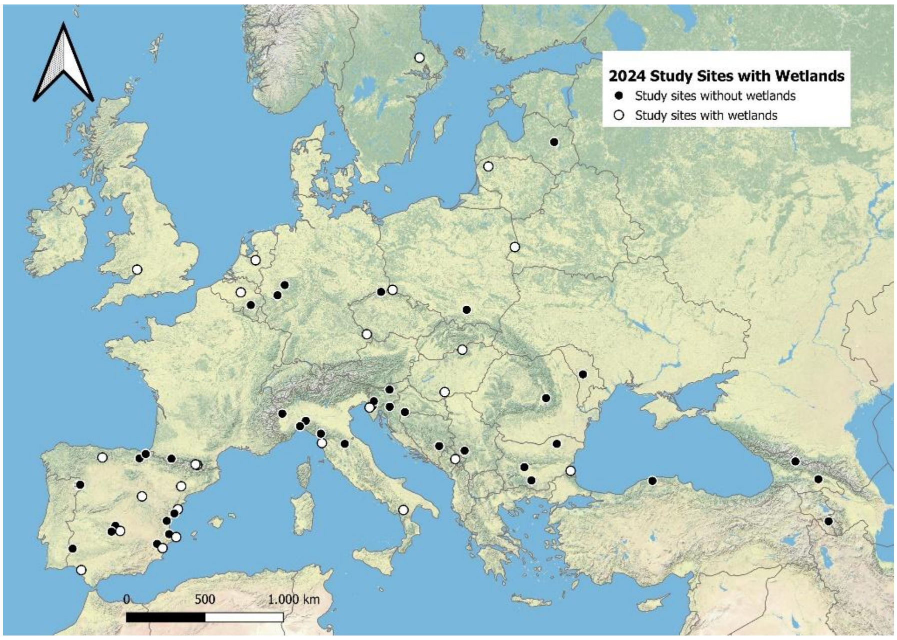


Figure 20. Distribution of the EOW sites with respect to the presence of wetlands

4.2 Networking initiatives

In 2023 and 2024 several initiatives have been taking place to establish synergies with other ongoing international initiatives with a focus on wildlife monitoring and disease prevention. This activity took the form of a direct participation in international partnerships or of a bridging activity with related international projects. The general goal was to share the experience of the EOW to improve wildlife data collection in Europe, advertise EOW activity attracting new potential members interested in density estimation and develop common policies of data collection and harmonization.

Networking activities involved the following projects:

European Partnership on Animal Health and Welfare (EUP AH&W, https://www.eupahw.eu) – research and innovation initiative funded by the European Commission (EC) within the Horizon Cofund framework (call HORIZON-CL6-2023-FARM2FORK-01). It involves 90 partners from EU and non-EU countries, and aims at enhancing cross sector collaboration, including the harmonization of monitoring activities for wild mammals and birds.

BIG_PICTURE (https://www.biodiversa.eu/2024/04/15/big_picture) - European project funded within the Bioiversa+ framework, aimed at coordinating the access to robust and harmonised monitoring data from large spatial and temporal scales to address the current biodiversity crisis. Particularly, involving the stakeholders involved in camera trapping of wildlife, the project aims at overcoming the legal, institutional, social, technical and practical barriers to processing, annotating, organising and sharing the vast amounts of CT data that are being collected across Europe.

Euromammals (https://euromammals.org) – Research network of experts in the study of wild mammals, aimed at addressing scientific, management and conservation questions regarding terrestrial mammal species in Europe, with a focus on spatial ecology. The key characteristic of the network is the sharing of scientific data to produce science.

SnapShot Europe (https://app.wildlifeinsights.org/initiatives/2000166/Snapshot-Europe) – Coordinated initiative to collect CT data on wildlife occurrence and to make data available for metanalyses. It is linked to twin initiative Snapshot USA and is sustained by Euromammals.

EuropaBON (https://europabon.org) –European Horizon project that hosted its final Stakeholder Conference on May 27/28, 2024 in Brussels, where ENETWILD presented its activities (including the EOW). EuropaBON proposed an EU Biodiversity Observation Coordination Centre (EBOCC) that should implement and oversee an EU Biodiversity Observation Network to integrate data-streams to support numerous European biodiversity policies.

PRO-COAST (PROactive approach for COmmunities to enAble Societal Transformation, https://www.pro-coast.eu/en/c) - a project, funded within Horizon Europe, which addresses complex social-ecological issues related to coastal ecosystem dynamics and biodiversity loss, and aims to empower local communities and citizens to play an active role in the restoration and conservation of biodiversity and ecosystem processes.

5 Conclusions

Wildlife data generation through harmonized protocols over a large geographic scale is usually challenging. It is more feasible when it is limited to detecting the presence of species (i.e. for biodiversity survey purposes), but it is very demanding when data serve to estimate population parameters, like density.

In this report, we summarize the activities realized by the ENETWILD consortium in 2023 and 2024 to enhance the generation of reliable density data for selected species of wild ungulates and carnivores across Europe. This was possible through the collaborative approach of the European Observatory of Wildlife, acting since 2021, which underwent an extension of the network of observation points, a continuous refinement of the methodology and of the technological tools in use. The data generated, which are unprecedented, are already in use for risk assessment regarding wild boar populations and ASF (ENETWILD consortium et al. 2023b). This exemplifies its potential to support risk analysis, which is continuing to grow as the number of study areas, epidemiological contexts, monitored species and time series do.

The continuous growth of the network, reaching 40 participants and 64 sites in 2024 (Fig. 21), testifies the interest of European stakeholders, including academia, wildlife and/or forestry departments (at national or regional level), wildlife private professionals, hunting federations, NGOs and protected areas. The possibility to gather valuable data for scientific purposes or for wildlife management, and the opportunity of professional growth by training on the use of updated protocols and techniques may represent two key motivational factors explaining this interest.

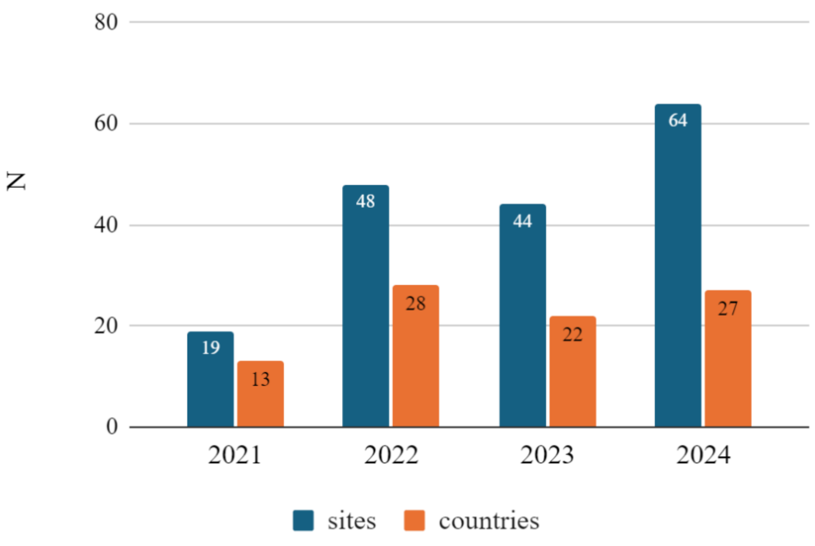


Figure 21. Number of observation sites and countries covered by the EOW

Although the EOW campaign 2023 was launched just before the end of the first ENETWILD project, most participant of 2022 confirmed their participation, and valuable data were generated.

The implementation of the REM protocol was mostly straightforward because of several improvements introduced after the end of the 2022 campaign and of the experience gained by the operators during the previous data collection. Nonetheless, the protocol was not always correctly implemented, as revealed by the data shared by participants after data analysis. This might be due to logistical difficulties that arose during the survey, rather than to shortcomings in the study design.

Despite this, the quality of data (on wild boar) collected in 2023 improved with respect to the previous campaign. As shown in Figure 17, the precision of the estimates (expressed by the CV) was higher than that obtained in the same areas in 2022 with the exception of two study sites. Further increase in the precision is expected with the 2024 campaign, in which efforts were made in order to improve the quality of the study designs and to increase the number of CTs deployed at each study site. Specific analyses are going to be performed to have a better understanding of the factors in the method implementation that mostly affect the precision of the estimates.

It should be noticed that the accuracy (i.e. the closeness to real values) of the estimated densities cannot be verified, as the real abundance of all monitored populations is unknown. However, in some areas multiple methods are implemented to estimate animal densities, so the obtained estimates could be compared and the consistency of the values verified. Nevertheless, it is largely known that the performance of different methods can vary in relation to several factors like species, habitat, density range, etc. Thus, a final confirmation of the ‘goodness’ of the estimated densities is hard to obtain.

Despite this limitation, the gathered data represent an outstanding reference for two uses: 1) to be compared for the same site over years, leading to trend data, 2) to improve models based on hunting bag data (for game species, ENETWILD consortium et al. 2024b).

The expansion of the EOW in 2024 (23 new sites) was directed by the priorities set by EFSA within the specific contract 1. Consequently, the new data collection campaign has started including:

- sites representing the different bioregions, with the exception of the Northern one restricted to a few countries (part of which affected by international conflicts);
- sites (almost all) hosting a wild boar population;
- a large number of sites (n=28, 43,7%) located in ASF-infected areas or close to the ASF frontline;
- 20 sites (31%) with an interface wild boar – domestic pigs;
- 25 sites (39%) including wetland habitats, of possible interest for Avian Influenza.

These conditions pose the basis for an effective collection of density data (but not only) that will be made available for detailed spatial analyses and risk assessment in relation to emerging diseases in Europe.

6 Perspectives and recommendations

All the above reported achievements highlight that a harmonised “observatory” approach for the estimation of wildlife populations’ densities is possible at a continental scale, applying practical systematic and rigorous protocols, not at odds with the fact that they are feasible, and we proved that they can be applied routinely and easily after a basic training.

Three years of EOW activity have led to the constitution of a well-trained, close-knit and motivated group of professionals that are able to implement a standardized protocol for multi-species density estimation and that contributed to establish a network of observation sites across Europe, representing a variety of environmental and management conditions. Consolidating and expanding this group should be set as a priority for the coming years.

As highlighted at the 3rd ENETWILD annual general meeting (ENETWILD consortium et al. 2023c), one of the main goals for wildlife management in Europe should be the establishment of a transnational (and national) harmonized monitoring system to collect comparable data that are necessary to perceive spatiotemporal changes in wildlife abundance These data are fundamental to guide EU policies in topics like biodiversity conservation, human-wildlife conflicts and disease prevention.

This potential of EOW data to support risk analysis is already a reality, which encourages continuation in terms of the growth of study areas, epidemiological contexts, range of monitored species and time duration. By using the updated available data generated by the EOW, it is possible to calibrate abundance distribution models outputs produced by ENETWILD (forecasting hunting yields) into densities. This will be useful to incorporate them into risk factor analyses for different diseases at selected spatial range.

In this perspective, the ‘observatory’ approach of the EOW is leading the way and its role is receiving international recognition. EUROPABON - a European initiative funded from the European Union’s Horizon2020 Research and Innovation Programme - defined 70 Essential Biodiversity Variables (EBVs) and traced gaps in available biodiversity information and data integration. One area of big gaps and bottlenecks was specifically identified in the EBV ‘*Species abundance of selected terrestrial mammals’*, referring to Carnivora and Artiodactyla (together with bats). In their final report, EUROPABON explicitly mentioned the EOW as one of the few initiatives contributing to filling these gaps (Morán-Ordóñez et al. 2023).

With the aim to further expand the number of participants, monitored habitats and species (including parasites and pathogens), and with a view to continuously improving the methodology, a collaboration and opinion exchange with professionals involved in other related projects is meaningful. This is the reason why networking activities have been taking place to connect the EOW to other ongoing international initiatives focused on wildlife monitoring (e.g. Euromammals, Snapshot Europe and several Biodiversa+ and Horizon Europe projects).

Although the great progresses in network organization, workflow and in the protocol currently implemented by the EOW, there is still room for improvements.

Protocol implementation

REM has proved to be a reliable methodology, and its implementation benefited enormously by the use of the photogrammetry approach and the tools offered by Agouti. The increase in standardization and reduction of man-made errors reached by the automated estimation of animal speed and CT detection field in Agouti are considerable, if compared with the original manual approach. At the same time, this level of automation, and the consequent gain in terms of reducing human effort, has increased the appeal of the EOW methodology, favouring the engagement of new participants.

However, any change in the protocol requires time to be properly assimilated and put into practice. In its first implementation, the new calibration (using a graduated pole) was not always straightforward, and some users did not collect a sufficient number of pictures to be used for the calibration. This point was stressed during the following training sessions and will lead to a better implementation of this step, improving the quality of the next estimations.

Because of emerging evidence showing the importance of increasing the number of CT locations and CT*days to obtain reliable density estimates with REM, in the last year a great effort has been made to assist participants in reaching optimal conditions for the implementation of the protocol. This support has included the provision of material (i.e. CTs) to assure a minimum set of simultaneous CT locations and reduce the number of rounds. We are therefore confident that this improvement can further increase the quality of the data collected in 2024.

Site number and distribution

One of the goals set in 2023, that is the increase of the number of sites to 60 (see final recommendations in ENETWILD consortium et al. 2023a), has been achieved. Additionally, for the reasons expressed above, we are very confident that this number can further increase in the coming years. But a larger network requires a great coordination effort, so the feasibility of this enlargement should be carefully evaluated according to the available resources.

Since one of the main objectives of ENETWILD is the extrapolation of abundance data at European scale and the analysis of population trends, an area of improvement is surely the representativeness of the study sites. Unfortunately, we failed to expand the network of monitored sites to the Northern bioregion. Although this bioregion is poorly represented in Europe and a large area cannot be covered for objective reasons (embargos determined by international conflicts), a special effort should be put in seeking collaborators in northern Scandinavia. At the same time, site distribution should be extended to MSs that currently are out of the network (e.g. Greece, Denmark, Austria and Ireland).

Continuity in data collection is of outstanding relevance to produce valuable trend data. Assuring the consistency of the methods implemented and of the monitored areas over time is therefore a key objective of the EOW.

Accordingly, if on one hand a priority is represented by filling the gaps in the distribution of EOW sites, on the other hand, it is important to maintain a minimum number of sites (possibly representative of different ecological and management conditions) for which multi-years data are available.

7 References

Anile S, Ragni B, Randi E, Mattucci F, Rovero F. (2014). Wildcat population density on the Etna volcano, Italy: A comparison of density estimation methods. Journal of Zoology 293, 252–261.

Campos-Candela A, Palmer M, Balle S, Alos J. 2018. A camera based method for estimating absolute density in animals displaying home range behaviour. Journal of Animal Ecology 87, 825–837.

Caravaggi A, Zaccaroni M, Riga F, Schai-Braun SC, Dick JT, Montgomery WI. 2016. An invasive-native mammalian species replacement process captured by camera trap survey random encounter models. Remote Sensing in Ecology and Conservation, 2, 45–58

Casaer J, Milotic T, Liefting Y, Desmet P, Jansen P. 2019. Agouti: A platform for processing and archiving of camera trap images. Biodiversity Information Science and Standards 3: e46690.

Cusack JJ, Swanson A, Coulson T, Packer C, Carbone C, Dickman AJ, et al. (2015). Applying a random encounter model to estimate lion density from camera traps in Serengeti National Park, Tanzania. The Journal of Wildlife Management 79, 1014–1021

ENETWILD Consortium, Acevedo P, Aleksovski V, Apollonio M, Berdión O, Blanco-Aguiar JA, del Rio L, Ertürk A, Fajdiga L, Escribano F, Ferroglio E, Gruychev G, Gutiérrez I, Häberlein V, Hoxha B, Kavčić K, Keuling O, Martínez-Carrasco C, Palencia P, Pereira P, Plhal R, Plis K, Podgórski T, Ruiz C, Scandura M, Santos J, Sereno J, Sergeyev A, Shakun V, Soriguer R, Soyumert A, Sprem N, Stoyanov S, Smith GC, Trajçe A Urbani N, Zanet S and Vicente J. 2022a. Wild boar density data generated by camera trapping in nineteen European areas. EFSA supporting publication 2022:EN-7214. 21pp. doi:10.2903/sp.efsa.2022.EN-7214

ENETWILD consortium, Croft S, Blanco-Aguiar JA, Acevedo P, Illanas S, Vicente J, Warren DA, Smith GC. 2024b. Modelling Wild Boar abundance at high resolution. EFSA supporting publication 2024:EN-8965. 29 pp.doi:10.2903/sp.efsa.2024.EN-8965

ENETWILD consortium, Grignolio S., Apollonio M., Brivio F., Vicente J., AcevedoP., Palencia P., Petrovic K., Keuling O. 2020a. Guidance on estimation of abundance and density data of wild ruminant population: methods, challenges, possibilities. EFSA supporting publication 2020:EN-1876. 54 pp. doi:10.2903/sp.efsa.2020.EN-1876

ENETWILD consortium, Guerrasio T, Acevedo P, Aleksovski V, Apollonio M, Arnon A, Barroqueiro C, Belova O, Berdión O, Blanco-Aguiar JA, Bijl H, Bleier N, Bučko J, Bužan E, Carniato D, Carro F, Casaer J, Carvalho J, Csányi S, del Rio L, Del Val Aliaga H, Ertürk A, Escribano F, Duniš L, Fernández-Lopez J, Ferroglio E, Fonseca C, Gačić D, Gavashelishvili A, Giannakopoulos A, Gómez-Molina A, Gómez-Peris C, Gruychev G, Gutiérrez I, Häberlein V, Hasan SM, Hillström L, Hoxha B, Iranzo M, Janječić M, Jansen P, Illanas S, Kashyap B, Keuling O, Laguna E, Lefranc H, Licoppe A, Liefting Y, Martínez-Carrasco C, Mrđenović D, Nezaj M, Pardavila X, Palencia P, Pereira G, Pereira P, Pinto N, Plhal R, Plis K, Podgórski T, Pokorny B, Preite L, Radonjic M, Rowcliffe M, Ruiz-Rodríguez C, Santos J, Rodríguez O, Scandura M, Sebastian M, Sereno J, Šestovic B, Shyti I, Somoza E, Soriguer R, Solà de la Torre J, Soyumert A, Šprem N, Stoyanov S, Smith GC, Sulce M, Torres RT, Trajçe A, Urbaitis G, Urbani N, Uguzashvili T, Vada R, Zanet S and Vicente J. 2023a. Wild ungulate density data generated by camera trapping in 37 European areas: first output of the European Observatory of Wildlife (EOW). EFSA supporting publication 2023:EN-7892. 90 pp. doi:10.2903/sp.efsa.2023.EN-7892

ENETWILD consortium, Guerrasio T, Apollonio M, Blanco JA, Scandura M, Keuling O, Podgorski T, Plis K, Smith G, Ferroglio E, Vada R, Zanet S, Ruiz C, Casaer J, Jansen P, Sereno J, Carniato D, Acevedo P, Vicente J. 2022b. Data generated by camera trapping in at least 40 areas in Europe including East and South Europe: Report of the field activities. EFSA supporting publication 2022:EN-7456. 42 pp. doi:10.2903/sp.efsa.2022.EN-7456

ENETWILD consortium, Keuling O, Sange M, Acevedo P, Podgorski T, Smith G, Scandura M, Apollonio M, Ferroglio E, Body G, Vicente J. 2018. Guidance on estimation of wild boar population abundance and density: methods, challenges, possibilities. EFSA supporting publication 2018:EN-1449. 48 pp. doi:10.2903/sp.efsa.2018.EN-1449

ENETWILD consortium, Liefting Y, Casaer J, Desmet P, Rowcliffe JM, Jansen PA. 2022c. Update on the development of the Agouti platform for collaborative science with camera traps and a tool for wildlife abundance estimation. 2022:EN-7327. 23 pp.

ENETWILD consortium, Occhibove F, Knauf S, Sauter-LC, Staubach C, Allendorf V, Anton A, Barron S, Bergmann H, Bröjer C, Buzan E, Cerny J, Denzin N, Gethöffer F, Globig A, Gethmann J, Gonzálvez M, García-Bocanegra I, Harder T, Jori F, Keuling O, Neimanis A, Neumann Heise J, Pastori I, Parreira Perin P, Rijks J, Schulz K, Trogu T, Plis K, Vada R, Vercher G, Wischnewski N, Zanet S, Ferroglio E. 2024. The role of mammals in Avian Influenza: a review. EFSA supporting publication 2024:EN-8692. 54 pp. doi:10.2903/sp.efsa.2024.EN-8692

ENETWILD consortium, Plis K, Gomez Molina A, Casaer J, Blanco-Aguiar JA, Ferroglio E, Illanas S, Jansen P, Liefting Y, Gavier-Widen D, Keuling O, Acevedo P, Podgórski T, Scandura M, Smith GC, Soriguer R, Zanet S and Vicente J, 2023c. Report of the 3rd Annual General Meeting of ENETWILD (Brussels, 24-25 May 2023). 10.5281/zenodo.8214218

ENETWILD consortium, Podgórski T, Acevedo P, Apollonio M, Berezowska-Cnota T, Bevilacqua C, Blanco JA, Borowik T, Garrote G, Huber D, Keuling O, Kowalczyk R, Mitchler B, Michler FU, Olszańska A, Scandura M, Schmidt K, Selva N, Sergiel A, Stoyanov S, Vada R, Vicente J. 2020b. Guidance on estimation of abundance and density of wild carnivore populations: methods, challenges, possibilities. EFSA supporting publication 2020:EN-1947. 200 pp. doi:10.2903/sp.efsa.2020.EN-1947

ENETWILD consortium. Vicente J, Apollonio M, Armenteros JA, Avecedo P, Blanco-Aguiar JA, Brivio F, Colomer J, Escribano F, Esteve C, Ferreres J, Ferroglio E, González Quirós P, Guibert M, Fafian A, Hernández Palacios O, Keuling O, Laguna E, Lopez JF, Martínez-Carrasco C, Palencia P, Pareja P, Petrović K, Podgórski T, Rosell C, Scandura M, Smith GC, Soriguer R, Torres JA, Villanúa D, Zanet S. 2019. Harmonization of the use of hunting statistics forwild boar density estimation in different study areas. EFSA supporting publication 2019:EN-1706.29 pp. doi:10.2903/sp.efsa.2019.EN-1706

ENETWILD consortium, Vicente J, Blanco JA, Apollonio M, Guerrasio T, Plis K, Podgorski T, Fernandez-Lopez J, Smith G, Scandura M, Ferroglio E. 2023b. Update on available data on wild boar population and ASF epidemiology. EFSA supporting publication, 2023, 10.5281/zenodo.10527290

Guerrasio T, Brogi R, Marcon A, Apollonio M. 2022. Assessing the precision of wild boar density estimations. Wildlife Society Bulletin 46:e1335.

Howe EJ, Buckland ST, Despres-Einspenner M, Kuhl HS. 2017. Distance sampling with camera traps. Methods in Ecology and Evolution, 8(11), 1558–1565.

Jensen PO, Wirsing AJ, Thornton DH. 2022. Using camera traps to estimate density of snowshoe hare (Lepus americanus): a keystone boreal forest herbivore. Journal of Mammalogy, 103(3) 693–710

Moeller AK, Lukacs PM, Horne JS. 2018. Three novel methods to estimate abundance of unmarked animals using remote cameras. Ecosphere 9, e02331.

Morán-Ordóñez A, Beja P, Fraixedas S, Herrando S, Junker J, Kissling WD, Lumbierres M, Solheim AL, Miret G, Moe J, Moreira F, Pereira H, Santana J, Villero D, BrotonsL. 2023. D3.3 - Identification of current monitoring workflows and bottlenecks. EUROPABON Project Report https://doi.org/10.3897/arphapreprints.e103765.

Morrison J, Omengo F, Jones M, Symeonakis E, Walker SL, Cain B. 2022. Estimating elephant density using motion-sensitive cameras: challenges, opportunities, and parameters for consideration. Journal of Wildlife Management 86:e22203

Nakashima Y, Fukasawa K, Samejima H. 2018. Estimating animal density without individual recognition using information derivable exclusively from camera traps. Journal of Applied Ecology 55: 735–744.

Palencia P, Barroso P, Vicente J, Hofmeester TR, Ferreres J, Acevedo P. 2022. Random encounter model is a reliable method for estimating population density of multiple species using camera traps. Remote Sensing in Ecology and Conservation 8(5): 670-682.

Palencia P, Rowcliffe JM, Vicente J, Acevedo P. 2021. Assessing the camera trap methodologies used to estimate density of unmarked populations. Journal of Applied Ecology, 58, 1583–1592.

Rowcliffe JM, Field J, Turvey ST, Carbone C. 2008. Estimating animal density using camera traps without the need for individual recognition. Journal of Applied Ecology 45: 1228–1236.

Rowcliffe JM, Kays R, Carbone C, Jansen PA. 2013. Clarifying assumptions behind the estimation of animal density from camera trap rates. Journal of Wildlife Management. Doi. 10.1002/jwmg.533

Rowcliffe M, Jansen PA, Kays R, Kranstauber B, Carbone C. 2016. Wildlife speed cameras: Measuring animal travel speed and day range using camera traps. Remote Sensing in Ecology and Conservation, 2, 84–94.

Waltert M, Grammes J, Schwenninger J. et al. 2020. A case of underestimation of density by direct line transect sampling in a hunted roe deer (Capreolus capreolus) population. Mamm Res 65, 151–160

Wearn OR, Bell TEM, Bolitho A, Durrant J, Haysom JK, Bijhawan S, Thorley J, Rowcliffe M. 2022. Estimating animal density for a community of species using information obtained only from camera-traps. Methods in Ecology and Evolution. 13(10) 2248-2261

8 Abbreviations

AI	artificial intelligence
ASF	African Swine Fever
CT	camera trap
EFSA	European Food Safety Authority
EOW	European Observatory of Wildlife
FOV	field of view
IT	information technology
MS	Member State
REM	Random Encounter Model
REST	Random Encounter and Staying Time

Appendix A – EOW study sites 2023

Study site	Country	Bioregion	Institution	Area type	Size (ha)
Vedat de caça de la Vall de Ransol	Andorra	Western	Département de l'Environnement et du Développement durable	Hunting ground	2813
Artavan	Armenia	Eastern	Yerevan State University	Village territories	1300
Drongengoed	Belgium	Western	Research Institute for Nature and Forest	Public Forest, Nature Reserve, Private land	2023
Marche-en-Famenne	Belgium	Western	Department of Natural and Agricultural Environment Studies, Wallonia	Military camp	2500
Game Management Unit 8	Belgium	Western	Research Institute for Nature and Forest	Protected Area	3700
Romanija	Bosnia & Herzegovina	Western	University of Banja Luka	State Forest land	6000
Voden	Bulgaria	Eastern	University of Forestry, Sofia	Hunting ground	8000
Prolom	Croatia	Western	Faculty of Agriculture, University of Zagreb	Hunting ground	7700
Jizerské Mts.	Czech Republic	Eastern	Czech University of Life Sciences Prague (CZU)	Hunting ground	3761
Mtirala National Park	Georgia	Western	Ilia State University	Protected Area	15806
Machakhela National Park	Georgia	Western	Ilia State University	Protected Area	7359
Alt Oerrel	Germany	Western	Institute for Terrestrial and Aquatic Wildlife Research- ITAW	Hunting ground	4130
Süsing	Germany	Western	Institute for Terrestrial and Aquatic Wildlife Research- ITAW	Hunting ground	2720
Gemenc	Hungary	Eastern	Szent István University	State Forest land	20000
Ramat Hanadiv Nature Park	Israel	Southern	Ganei Ramat Hanadiv	Community interest company (CIC)	1160
Nevegal	Italy	Western	Provincial Administration of Belluno	Hunting ground	2900
Alpe di Catenaia	Italy	Western	University of Sassari	Protected Area	2700

San Rossore	Italy	Western	University of Sassari	Protected Area	4650
Marcarolo	Italy	Western	University of Turin	Protected Area	8288
Zona Bianca	Italy	Western	University of Turin	Hunting ground	6033
Varzi	Italy	Western	University of Turin	Hunting ground	26600
MMMPV	Lithuania	Eastern	Lithuanian Research Centre for Agriculture and Forestry	Protected Area	5646
Veluwe	Netherlands	Western	Wageningen University and Research	State Forest land	9000
Białowieża Forest	Poland	Eastern	Mammal Research Institute (MRI)	State Forest land	2947
Vila Nova Paiva	Portugal	Southern	University of Aveiro	Hunting ground	14073
ZCA Santulhão	Portugal	Southern	Palombar - Conservation of Nature and Rural Heritage	Hunting ground	2998
Covasna	Romania	Eastern	Environmental Protection Agency	Hunting ground	6000
Studenica	Serbia	Eastern	University of Belgrade - Faculty of Forestry	Hunting ground	11000
Oljka	Slovenia	Western	Faculty of Environmental Protection	Hunting ground	2637
Rižana	Slovenia	Western	Faculty of Environmental Protection	Hunting ground	3675
Arriola (Araba)	Spain	Southern	Araba caza (hunting management company)	Hunting ground	4000
Montgó (Alacant)	Spain	Southern	Generalitat Valenciana (Regional Government)	Protected Area	2086
Parc Natural de la Serra d´Irta	Spain	Southern	Generalitat Valenciana (Regional Government)	Protected Area	2690
Parc Natural del Desert de les Palmes	Spain	Southern	Generalitat Valenciana (Regional Government)	Protected Area	3096

Parc Natural de la Serra Calderona_MUP Portacoeli	Spain	Southern	Generalitat Valenciana (Regional Government)	Protected Area	2461
Leitzaran	Spain	Southern	Gipuzkoa Provincial Council	Hunting ground	3493
Quatretonda	Spain	Southern	Generalitat Valenciana (Regional Government)	Hunting ground	2918
Rosario	Spain	Southern	IREC	Hunting ground	2000
Quintos	Spain	Southern	IREC	Hunting ground	6700
Carche	Spain	Southern	IREC	Protected Area	5942
Agres	Spain	Southern	IREC	Protected Area	1632
Kartdag Wildlife Reserve	Turkey	Southern	University of Kastamonu	Protected Area	10000
Forest of Dean	United Kingdom	Western	Animal and Plant Health Agency	State Forest land	4000
Dumfries	United Kingdom	Western	Animal and Plant Health Agency	State Forest land	3100

Appendix B – Study design and effort at EOW sites 2023

Study site	Country	Study design	N of camera locations	N of rounds	Photogrammetry	N of activity days	Start	End
Vedat de caça de la Vall de Ransol	Andorra	Systematic random	35	3	Yes	1603	20/06/2023	13/11/2023
Artavan	Armenia	Fully random	36	3	Yes	691	27/07/2023	18/11/2023
Drongengoed	Belgium	Random within grid cells	36	1	Yes	1006	21/10/2023	22/11/2023
Marche-en-Famenne	Belgium	Fully random	35	3	Yes	1048	28/06/2023	29/09/2023
Game Management Unit 8	Belgium	Random within grid cells	90	3	Yes	2699	28/08/2023	29/11/2023
Romanija	Bosnia & Herzegovina	Systematic random	32	2	Yes	1598	14/07/2023	02/11/2023
Voden	Bulgaria	Systematic random	54	2	Yes	2768	24/08/2023	19/01/2024
Prolom	Croatia	Systematic random	75	2	Yes	3622	17/07/2023	29/10/2023
Jizerské Mts.	Czech Republic	Fully random	33	1	No	8432	11/01/2023	30/12/2023
Mtirala National Park	Georgia	Random within grid cells	35	1	Yes	4876	18/04/2023	19/08/2023
Machakhela National Park	Georgia	Random within grid cells	34	3	Yes	1486	10/05/2023	08/11/2023
Alt Oerrel	Germany	Systematic random	33	1	No	924	01/02/2023	28/02/2023
Süsing	Germany	Systematic random	33	1	No	924	01/02/2023	28/02/2023
Gemenc	Hungary	Systematic random	36	3	Yes	1078	20/09/2023	16/12/2023
Ramat Hanadiv Nature Park	Israel	Systematic random	37	3	Yes	1236	10/09/2023	20/11/2023

Nevegal	Italy	Systematic random	46	2	Yes	1380	12/09/2023	10/01/2024
Alpe di Catenaia	Italy	Systematic random	36	2	Yes	1502	18/07/2023	06/11/2023
San Rossore	Italy	Systematic random	60	3	Yes	1685	25/09/2023	20/12/2023
Marcarolo	Italy	Fully random	39	1	Yes	1642	17/04/2023	06/06/2023
Zona Bianca	Italy	Fully random	30	1	Yes	2795	27/07/2023	08/11/2023
Varzi	Italy	Fully random	40	1	Yes	2157	10/07/2023	20/09/2023
MMMPV	Lithuania	Fully random	34	2	No	1716		
Veluwe	Netherlands	Systematic random	44	1	Yes	2382	16/10/2023	12/12/2023
Białowieża Forest	Poland	Systematic random	47	2	Yes	2614	18/07/2023	09/11/2023
Vila Nova Paiva	Portugal	Systematic random	30	1	Yes	1084	27/10/2023	13/12/2023
ZCA Santulhão	Portugal	Systematic random	45	3	Yes	1151	07/08/2023	03/11/2023
Covasna	Romania	Systematic random	36	3	Yes	1148	24/09/2023	05/01/2024
Studenica	Serbia	Systematic random	35	2	Yes	1789	25/06/2023	30/09/2023
Oljka	Slovenia	Systematic random	34	3	Yes	1750	22/03/2023	11/08/2023
Rižana	Slovenia	Systematic random	36	3	Yes	1424	12/04/2023	17/08/2023
Arriola (Araba)	Spain	Systematic random	42	3	Yes	2165	08/08/2023	11/12/2023
Montgó (Alacant)	Spain	Systematic random	26	1	Yes	1069	12/09/2023	25/10/2023
Parc Natural de la Serra d´Irta	Spain	Random within grid cells	27	1	Yes	1154	05/09/2023	27/10/2023
Parc Natural del Desert de les Palmes	Spain	Random within grid cells	27	1	Yes	1273	07/11/2023	05/01/2024
Parc Natural de la Serra Calderona_MUP Portacoeli	Spain	Random within grid cells	34	1	Yes	1205	02/11/2023	18/12/2023
Leitzaran	Spain	Systematic random	35	1	Yes	1752	09/01/2024	15/03/2024
Quatretonda	Spain	Systematic random	45	3	Yes	1723	21/09/2023	19/01/2024

Rosario	Spain	Systematic random	42	2	Yes	842	Autumn	
Quintos	Spain	Systematic random	40	2	Yes	664	Autumn	
Carche	Spain	Fully random	36	2	Yes	1604	03/10/2023	06/02/2024
Agres	Spain	Random within grid cells	36	2		986	1st round: 18/09/2023 - 26/10/2023	2nd round: 18/12/2023 - 26/01/2024
Kartdag Wildlife Reserve	Turkey	Systematic random	35	2	Yes	1845	16/08/2023	25/12/2023
Forest of Dean	United Kingdom	Systematic random	40	1	Yes	1360	28/08/2023	06/10/2023
Dumfries	United Kingdom	Systematic random	31	1	Yes	1240	04/09/2023	20/10/2023

Appendix C – List of participants and study sites 2024

Name study site	Country	Bioregion	Institution	Latitude	Longitude	Adminstrative figure	Area (ha)	Wetland	ASF	Distance from ASF frontline	Pig farms
Vall de Ransol	Andorra	Western	Département de l'Environnement et du Développement durable	42.60	1.64	Hunting ground	2813	Yes	No	> 100 km	No
Vall de Ordino	Andorra	Southern	Center for Ecological Research and Forestry Applications (CREAF)	42.63	1.52	Protected area	3660	Yes	No	> 100 km	No
Artavan	Armenia	Eastern	Yerevan State University	41.88	45.6143	Village territories	4000	No	Yes	N/A	No
Marche-en-Famenne	Belgium	Western	Department of Natural and Agricultural Environment Studies, Wallonia	50.25	5.37	Military camp	2500	No	No	> 100 km	No
Game Management Unit 8	Belgium	Western	Research Institute for Nature and Forest	50.81	4.67	Protected area	3700	Yes	No	> 100 km	Yes
Romanija	Bosnia and Herzegovina	Western	University of Banja Luka	43.56	18.49	State forestry	6000	No	Yes	N/A	No
Voden	Bulgaria	Eastern	University of Forestry, Sofia	43.67	26.68	Hunting ground	8000	No	No	< 100 km	
Panagyurishte	Bulgaria	Eastern	University of Forestry, Sofia	42.49	24.42	Hunting ground	3600	No	No	< 100 km	
Ropotamo	Bulgaria	Eastern	University of Forestry, Sofia	42.30	27.64			Yes	No	< 100 km	

Kormisosh	Bulgaria	Eastern	University of Forestry, Sofia	41.80	24.91			No	No	< 100 km	
Prolom	Croatia	Western	Faculty of Agriculture, University of Zagreb	45.25	16.1	Hunting ground	7700	No	No	< 100 km	Yes
Lužické hory	Czech Republic	Eastern	Czech University of Life Sciences Prague (CZU)	50.83	14.44	Hunting ground	3761	No	No	< 100 km	No
Jizerské Mts.	Czech Republic	Eastern	Czech University of Life Sciences Prague (CZU)	50.92	15.24	Hunting ground	2500	Yes	Yes	N/A	No
Pyrenees	France	Western	CIRAD-INRAE-Université de Montpellier	42.92	-0.16			No	No	> 100 km	
Lukhuni	Georgia	Western	Ilia State University	42.78	43.3	Protected area	4000	No	No	< 100 km	No
Tbilisi national park	Georgia	Western	NACRES – Centre for Biodiversity Conservation and Research	41.87	44.9	Protected area	10000	No	No	< 100 km	
Bavarian Forest National Park	Germany	Western	Bavarian Forest National Park Administration	48.93	13.45	Protected area	14235	Yes	No	> 100 km	Yes
Siebengebirge	Germany	Western	European Forest Institute	50.68	7.23			No	No	> 100 km	
Ebbegebirge	Germany	Western	European Forest Institute	51.13	7.73			No	No	> 100 km	
Gemenc	Hungary	Eastern	Szent István University	46.22	18.87	State forestry	20000	Yes	No	< 100 km	No
Appennino Lucano	Italy	Southern	UNIMOL	40.25	16	Protected area	25000	Yes	Yes	N/A	No
Alpe di Catenaia	Italy	Western	University of Sassari	43.67	11.91	Protected area	2700	No	No	> 100 km	Yes

San Rossore	Italy	Western	University of Sassari	43.71	10.32	Protected area	4650	Yes	No	> 100 km	No
Lunigiana-Garfagnana	Italy	Western	University of Sassari	44.18	10.25	Hunting ground	9600	No	No	< 100 km	Yes
Varzi	Italy	Western	Università degli Studi di Torino	44.82	9.2	Hunting ground	26600	No	Yes	N/A	No
Marcarolo	Italy	Western	Università degli Studi di Torino	44.55	8.79	Protected area	8288	No	Yes	N/A	No
La Mandria	Italy	Western	Università degli Studi di Torino	45.17	7.56	Protected area	1604	No	No	< 100 km	Yes
Lubāns’	Latvia	Eastern	Latvian State Forest Research Institute ‘’Silava’’	56.96	26.5	Hunting ground	2400	No	Yes	N/A	No
MMMPV	Lithuania	Eastern	Lithuanian Research Centre for Agriculture and Forestry	56,02	21,91	Protected area	5646	Yes			
Codrii Natural Reserve	Moldova	Eastern	Moldova State University, Institute of Zoology	47.07	28.5	Protected area	5177	No	No	< 100 km	
Bjelasica Mountain	Montenegro	Western	Public Enterprise for National Parks in Montenegro and NGO Wildlife Montenegro	42.90	19.61	Protected area	5650	Yes	No	< 100 km	No
Veluwe	Netherlands	Western	Wageningen University and Research	52.20	5.7	State Forest land	9000	Yes	No	> 100 km	
Białowieża Forest	Poland	Eastern	Mammal Research Institute	52.76	23.76	State Forest land	2947	Yes	Yes	N/A	No
Forest Niepołomice	Poland	Eastern	Institute of Environmental Sciences, Faculty of Biology, Jagiellonian University	50.04	20.4	Hunting ground	5300	No	No	< 100 km	No

Herdade da Coitadinha - Noudar NP	Portugal	Southern	EDIA, S.A.	38.17	-7.04	Hunting ground	995	No	No	> 100 km	Yes
ZCA Santulhão	Portugal	Southern	Palombar - Conservation of Nature and Rural Heritage	41.57	-6.64	Hunting ground	2998	No	No	> 100 km	Yes
Freguesia de Vimioso	Portugal	Southern	Palombar - Conservation of Nature and Rural Heritage	41.58	-6.52	Hunting ground	4911	No	No	> 100 km	Yes
Covasna	Romania	Eastern	-	45.93	25.93	Hunting ground	6000	No	Yes	N/A	No
Studenica	Serbia	Eastern	University of Belgrade - Faculty of Forestry	43.33	20.26	Hunting ground	11000	No	No	< 100 km	Yes
Cerová highlands	Slovakia	Eastern	Technical University in Zvolen	48.22	20.1	Hunting ground	5500	Yes	Yes	N/A	Yes
Oljka	Slovenia	Western	Faculty of Environmental Protection	46.34	15.03	Hunting ground	2637	No	No	> 100 km	No
Rižana	Slovenia	Western	Faculty of Environmental Protection	45.54	13.85	Hunting ground	3675	No	No	> 100 km	Yes
Sinji Vrh	Slovenia	Western	Faculty of Environmental Protection	45.45	15.15	Hunting ground	4279	No	No	< 100 km	No
Vrhe Vrabče	Slovenia	Western	Faculty of Environmental Protection	45.78	13.94	Hunting ground	3950	No	No	> 100 km	Yes
Strunjan Park	Slovenia	Western	University of Primorska	45.47	13.64	Hunting ground	3309	Yes	No	> 100 km	Yes
Quintos de Mora	Spain	Southern	IREC	39.41	-4.06	Hunting ground	6700	No	no	> 100 km	No
Rosario	Spain	Southern	IREC	39.09	-4.333582	Hunting ground	2000	No	no	> 100 km	No

Riaño	Spain	Southern	IREC	42.98	-4.97			Yes	no	> 100 km	No
Utxesa	Spain	Southern	IREC	41.50	0.52	Protected area	1042	Yes	no	> 100 km	Yes
Daimiel	Spain	Southern	IREC	39.13	-3.73	Protected area	4337	Yes	no	> 100 km	No
Doñana National Park	Spain	Southern	IREC	36.99	-6.44	Protected area	6500	Yes	no	> 100 km	No
El Carche	Spain	Southern	IREC	38.43	-1.16	Protected area	5942	No	no	> 100 km	No
Quatretonda	Spain	Southern	IREC	38.96	-0.32	Hunting ground	2918	No	no	> 100 km	No
Arriola (Araba)	Spain	Southern	Araba caza (hunting management company)	42.94	-2.39	Hunting ground	4000	No	No	> 100 km	Yes
Montgó (Alacant)	Spain	Southern	Generalitat Valenciana (Regional Government)	38.80	0.17	Protected area	2086	Yes	No	> 100 km	No
Serra d´Irta	Spain	Southern	Generalitat Valenciana (Regional Government)	40.29	0.29	Protected area	2690	Yes	No	> 100 km	No
Desert de les Palmes	Spain	Southern	Generalitat Valenciana (Regional Government)	40.07	0.04	Protected area	3096	No	No	> 100 km	Yes
Serra Calderona	Spain	Southern	Generalitat Valenciana (Regional Government)	39.67	-0.49	Protected area	2461	No	No	> 100 km	No

El Hondo	Spain	Southern	Generalitat Valenciana (Regional Government)	38.20	-0.78	Protected area	994	Yes	No	> 100 km	
Leitzaran	Spain	Southern	Gipuzkoa Provincial Council	43.16	-1.95	Hunting ground	3493	No	No	> 100 km	Yes
Solanillos (Sistema Ibérico Sur)	Spain	Southern	Fundación Española de Renaturalización – Rewilding Spain	40.97	-2.21	Public Utility Property	2800	Yes	No	> 100 km	No
Stalbo	Sweden	Northern	University of Gävle	60.02	17.12	Hunting ground	2500	Yes	No	< 100 km	No
Kartdag Wildlife Reserve	Turkey	Southern	University of Kastamonu	41.78	33.34	Protected area	> 10000	No	No	> 100 km	No
Forest of Dean	United Kingdom	Western	Animal and Plant Health Agency	51.80	-2.55	State forestry	4000	Yes	No	> 100 km	Yes

Appendix D – Updated EOW protocol (v. 2.0) for field activities and density estimation

1. STUDY SITE SELECTION

The following are the criteria for the selection of a good study site for the project:

- Study site extension ideally between 2000 - 6000 ha.
- It is safe for camera trap deployment.
- It contains forest habitat (interspersed with other habitats)
- Intensive feeding is not provided to wild ungulates (occasional feeding when the cameras are not in field or baiting for hunting is not a problem)
- Hunting statistics are recorded by event (hunting*day) (in case collective hunting is practiced). When ungulates are hunted mainly by communal hunting (drive hunts), fine resolution hunting statistics per event (nº animals shot, sighted and surface beaten) must be recorded (see form attached).
- A temporal overlap of camera trapping and hunting activities must be avoided to the extent possible. The optimum situation is hunting activities to start immediately once the camera trap field trial ends, but partial overlapping is possible (e.g., camera trapping carried out in Sep-Oct and hunting is from Oct onwards).

2. STUDY DESIGN

Unmarked camera trap density estimation methods require representative sampling, placing cameras randomly with respect to animal movement. This is best achieved by preselecting camera deployment locations using computer-generated random points. Usually, these points should be in a systematic grid with fixed spacing between them across a defined study area (if you don't have the necessary GIS skills in your team, follow the instructions found at this link: Study design).

In cases where the study area covers more than one clearly distinct habitat, and especially when animals of interest are strongly attracted to a relatively rare habitat, it may be useful to stratify your grid, selecting a similar number of points in each habitat, rather than planning a single consistently spaced grid across the whole area.

Survey designs that CANNOT be used to estimate the density of unmarked populations include preferentially placing cameras on animal or human trails, targeting spots preferred by the animals such as water sources, mineral licks, or high value foods, and using bait to attract animals. Using unmarked density estimation analysis on data gathered in these ways will give results that are biased to an unpredictable extent, and therefore of no value.

For a study area of 2000-6000 has the suggested minimum number of CT deployments is 36. The distance between deployments in the study area can vary, however, in cases of larger study areas a higher number of CT points is recommended. Each CT should be active for at least 4 weeks, ideally 6 weeks. Unless you have enough CTs to simultaneously cover all the CT points you will be performing more rounds, in this case each round is going to uniformly cover the whole surface of the study area (see Figure A1). To obtain that you can simply select one point every other (or more depending on the number of rounds). The optimal number of rounds would be 3 and a higher number of rounds would only be recommended if the duration of CT deployment increases. If possible, the grid should cover at least one patch beaten for hunting big game during the hunting season.

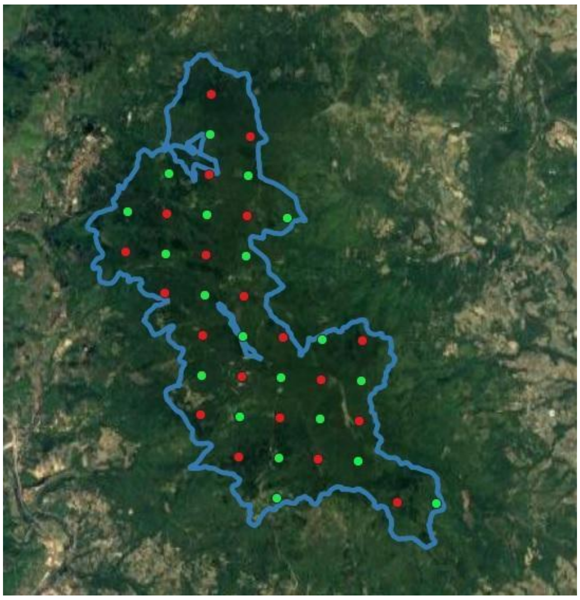


Figure A1. Example of study design. Red dots represent round #1 while green ones represent round #2.

3. CAMERA DEPLOYMENT

- If the exact location is not suitable for the deployment of the CT (extremely steep, too dense vegetation…etc) aim for the nearest suitable point but always aiming for the same environment. If the there is no suitable spot with the same environment of the original one, then aim for the nearest suitable point within 100 m even if the environment is different. If it is not possible to find a suitable spot to set up the camera within 100 m from the original point skip the point.
- The CT will be placed on poles or vegetation 50cm above the ground.
- The CT is configured with the operation of 24 hours per day and to take up to eight consecutive images (the maximum number possible), with the minimum waiting time (0 sec. if possible) between activations. Use medium sensitivity. Make sure the time lapse between consecutive pictures is not > 2-3 sec. as this might influence the protocol application.

- The flash intensity should be set at medium (if possible) to avoid "overexposed photos".
- Check that the date and time are correctly set, and that they are printed automatically on each image.
- The CT should be reviewed at least in half of the study period (ideally once a month) to check its functioning and placement. Normally it will not be necessary to change the batteries and the memory cards, since the CTs are placed at random points and high wildlife activity is not expected.
- Choose a field of vision of the CT that is cleared of vegetation (it is not necessary to be totally clean, but that allows the detection of any wild boar that passes within the first 5 m), being better a north orientation.
- A form (see Table A1) must be filled in, collecting the information of each CT during its placement (see below). All the information that is subsequently extracted must keep the traceability of the CT (mark the source camera of each memory card extracted and keep this nomenclature in the folders that are created on the computer to archive the images). Shortly, Enetwild will provide an app based on Smart which will be useful to collect this information in the field.

See "Study_design_protocol" for the recording of the course about chapter 3.

4. CALIBRATION POLE

Thoroughly follow the detailed explanation found at this link to make your calibration pole: Calibration_pole_instructions

5. DEPLOYMENT CALIBRATION

Once the CT has been firmly set up and all the settings have been checked you are ready to switch it on (please note that it won't have to be touched again until it is removed or checked) you will take the deployment calibration pictures which are fundamental to allow Agouti to perform the automatic estimation of camera parameters (radius and angle of detection) and animal day range.

- Starting about 1m directly in front of the camera, hold the pole with its base on the ground so that it is clearly visible to the camera. Take care to ensure that the pole is held perpendicular to the camera's line of sight. On level ground with camera line of sight roughly parallel to the ground surface, the pole should be roughly vertical, but if the camera is angled to observe a slope the pole may need to be tilted accordingly (see Fig. A2).

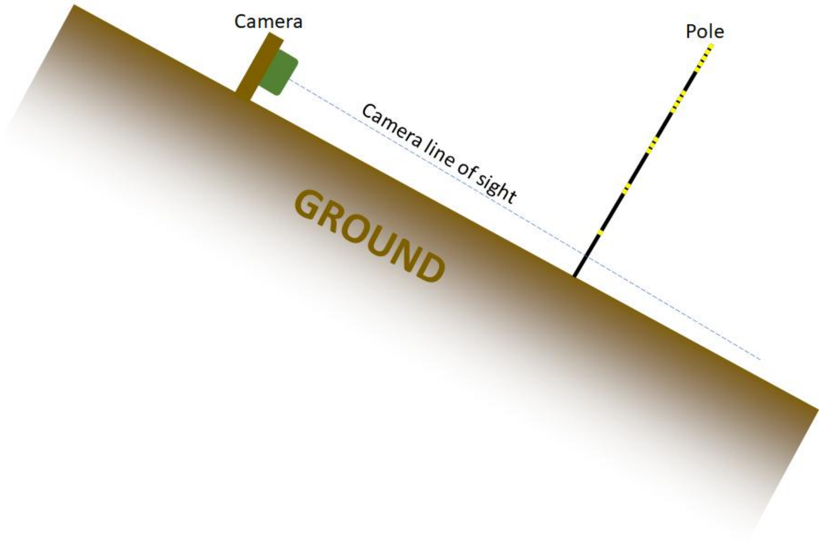


Figure A2. Diagram illustrating a camera set up to observe sloping ground, and the orientation of the calibration pole required to keep it perpendicular to the camera line of sight. Orientation can be judged by eye and need not be measured precisely in the in the field.

- Hold the pole still long enough to ensure a clear image (5-10 seconds). In order to indicate when the pole is resting on the ground, give a distinctive hand gesture when this is the case. For example, thumbs up! **This is fundamental, as often it is not going to be visible whether the pole is actually touching the ground or not and, if it is not, the picture is not going to be useful**.
- Repeat this for further pole placements (at least 25-30) across the field of view and away from the camera, with placements spaced about 0.5 m apart. Continue away from the camera to the maximum extent that any animals are likely to be captured, or if possible, a bit beyond. As you reach greater distances, it may help to have a second person next to the camera to keep it triggering. See Figure A3 for an example of a good coverage of deployment calibration pictures. **Before going to the field, it is important run trials of the deployment calibration process.** Complete the deployment calibration process described above in a convenient location and inspect the images making sure that the results is good.

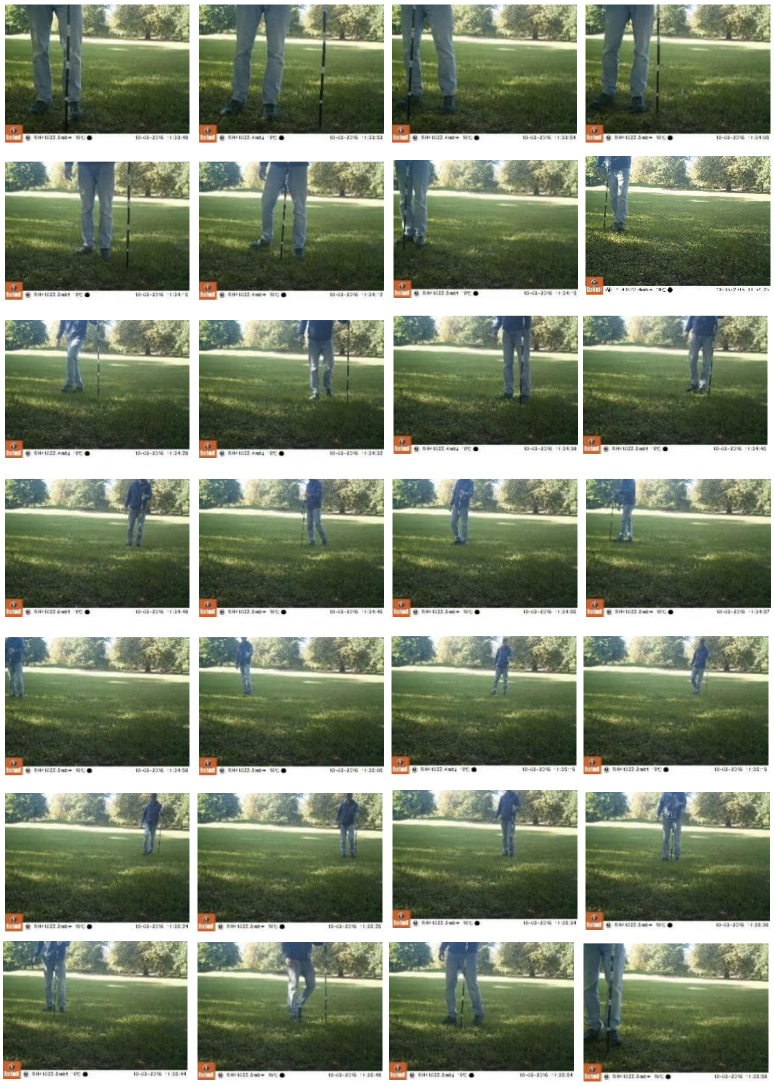


Figure A3. A set of deployment calibration images showing 28 pole positions with good coverage of the detection zone.

- This is another crucial stage of the calibration as you are not going to be able to see how many pictures have been taken and if the pictures are not enough the precision of the estimates for that deployment is going to be low. Make sure you spent enough time on this process and, **if in doubt, take some more pictures as the precision of the estimates strongly depend on this process**. See figure A4.
- Every CT deployment needs its own calibration. If you change the batteries and/or card, which indeed typically changes the camera view in most circumstances, you effectively start a new deployment on the same location. **Therefore, the calibration should be repeated when removing the camera, as well as when setting and checking it**.

- In figure 4 you can see an example of a good distribution of pictures for a deployment calibration.

See "Distance calibration" for the recording of the course about chapter 5.

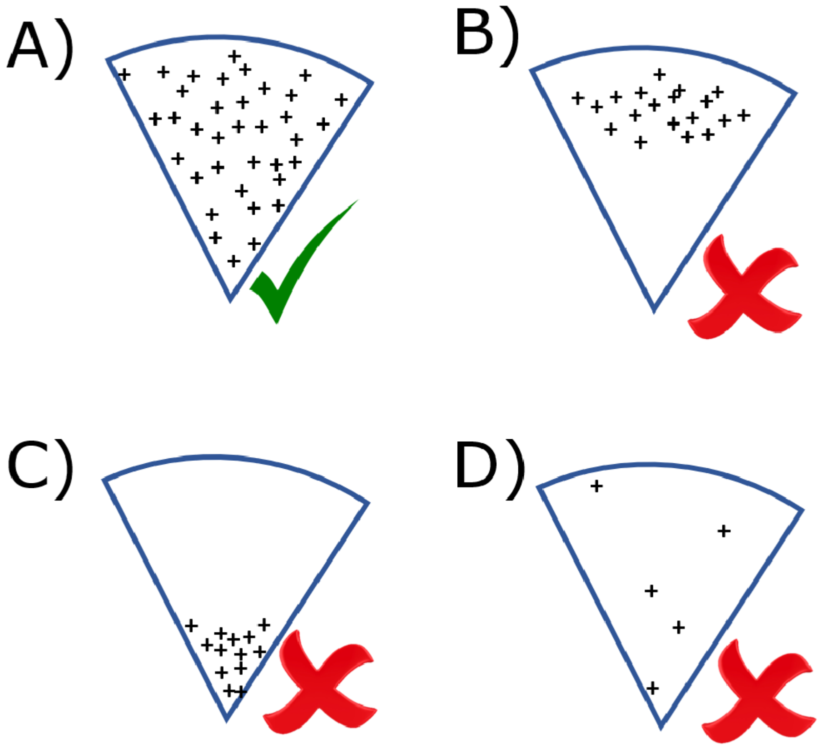


Figure A4. Example of four schemes of calibration of a single camera trap. Crosses represent all the locations of the calibration pole. Panel A represents an adequate calibration (more than 20 points covering homogenously all the detection zone). Panels B, C and D represent wrong calibrations; in panels B and C the points are not homogenously distributed; in panel D, few points were recorded.

6. TAKING CAMERA CALIBRATION IMAGES

The goal is to take pictures of objects of known size at a range of known distances from the camera to calculate the camera model's intrinsic properties, which then allow us to calculate the distance of calibration poles in deployment calibration. This needs to be done for each combination of camera model and image resolution setting used in the field. It's best to keep image resolution consistent throughout deployments; if you do this, and use a consistent camera model, you only need to calibrate one camera, once (no need to repeat it if you already did it last year for the same combination of camera model and resolution). The steps are as follows:

1. Set up the camera in a convenient location in front of a level surface, either indoors or outside.

2. Mark out nine positions at a range of radial and angular distances from the camera, measuring the distances from camera accurately. Fig. A4 gives an example of placement positions, with poles at three distances (1, 2 and 4 m), and a range of angles. It's not necessary to measure angle, but it should be variable, and within the camera's field of view (usually about 20 degrees either side of the midline), but you may need to check the field of view for your camera.

3. With a camera positioned in front of the arena and switched on, take images of a calibration pole (making instructions: Calibration pole instruction) at each position on the array, holding up some visible marker of the distance. For example, in Fig. A5, the pole is placed at 2 m from the camera, with distance indicated in metres by the number of fingers displayed. As in the deployment calibration process, care should be taken to hold the pole perpendicular to the camera's line of sight.

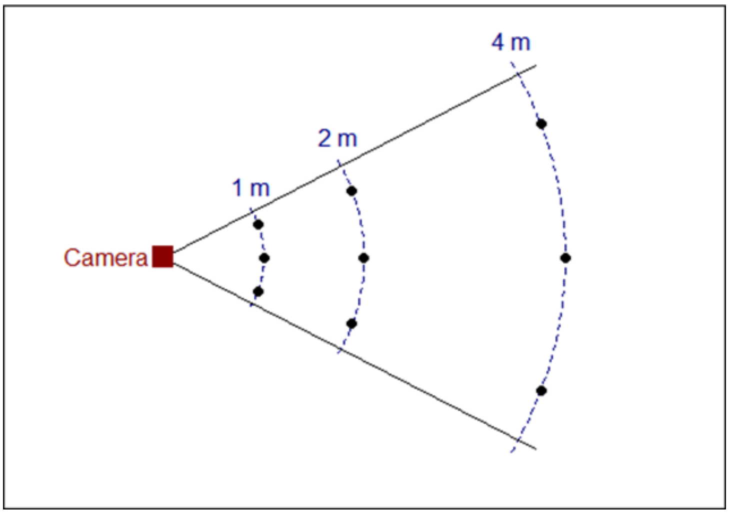


Figure A5. Plan view of an example layout for a camera calibration pole grid.

Figure A6. A camera calibration image with pole in position 2 m from the camera.

7. AGOUTI PLATFORM

7.1. Project creation

Navigate to https://www.agouti.eu/ and create your own account. Then follow the following steps for the creation of a new project:

- From the agouti homepage or directly from your email write a message to agouti@wur.nl. please include whether you are working in a commercial or non-profit setting.
- You will receive a response with an invitation link to your newly created project. Please use the link and notify agouti@wur.nl when that's done.
- The admins will make you PI on the project. You can now enter the project from your personal dashboard and get started.

7.2. Project settings

- In the main project menu go to "Project settings". In the "General" page choose the "Default UTC offset" keeping in mind to also consider the eventual daylight-saving time (DST). So, if the CTs are deployed in a country using the DST and during a period of DST application remember to also consider that when choosing the UTC offset. So, for example, in a project implemented in Italy (UTC +1:00) during in summer is going to have the Default UTC offset of +2:00 (Kaliningrad, South Africa), in this way all the projects are going to have the Greenwich standard time.
- Below, if you like you can add project description and picture. Further down specify the project owner, PI and organisation.
- In the "Sampling design" section select "No bait", 0 seconds quiet period and "Systematic random".
- In the "Annotation" section the sequence cut-off will be set on 120 seconds by default, and it won't be possible to modify this setting as it has to be the same for all the projects.

- In the automatic annotation box, you can select an AI model to automatically process your deployments. You can either select a "species model" (e.g., "Western Europe species model", if more versions are available make sure you selected the latest) or the "Generic blank/human model", that is only going to annotate for you the blank pictures and those with humans, leaving to you the sequences with animals. After selecting a model, a button 'Annotate by AI' will show up for each deployment listed on the Annotate page.
- In the "Species" page press "Add species list" and select the list for your study area. Once you saved the species will be available for the manual annotation. If you were to record any species that is not included in the list, you can then manually add it using the "add species" button and then browsing the species.
- In the "Behaviour" section you can decide which behavioural classes to add to the annotation page.

Se "Project creation and settings" for the recording of the course about chapters 7.1 and 7.2.

7.3. Import

In your project, within the "Import" section, select "New Deployment" and then "Select Files" in the window that pops up (or drag all the pictures of the deployment onto the window), then browse to the folder of the deployment and select all the pictures that you want to upload for that camera deployment and press "ok". If possible, make sure that you have a good internet connection. Especially if the deployment counts many pictures, it might take some time to complete the import.
Once the uploading is over press "Create Sequences" and, in the "New Deployment" folder where you are redirected, press "Add Sampling Point" (or select from the drop-down menu if you already uploaded the sampling points) and insert the requested data for the deployment in the new window, then press "Save".

7.4. Image processing and animal tracking

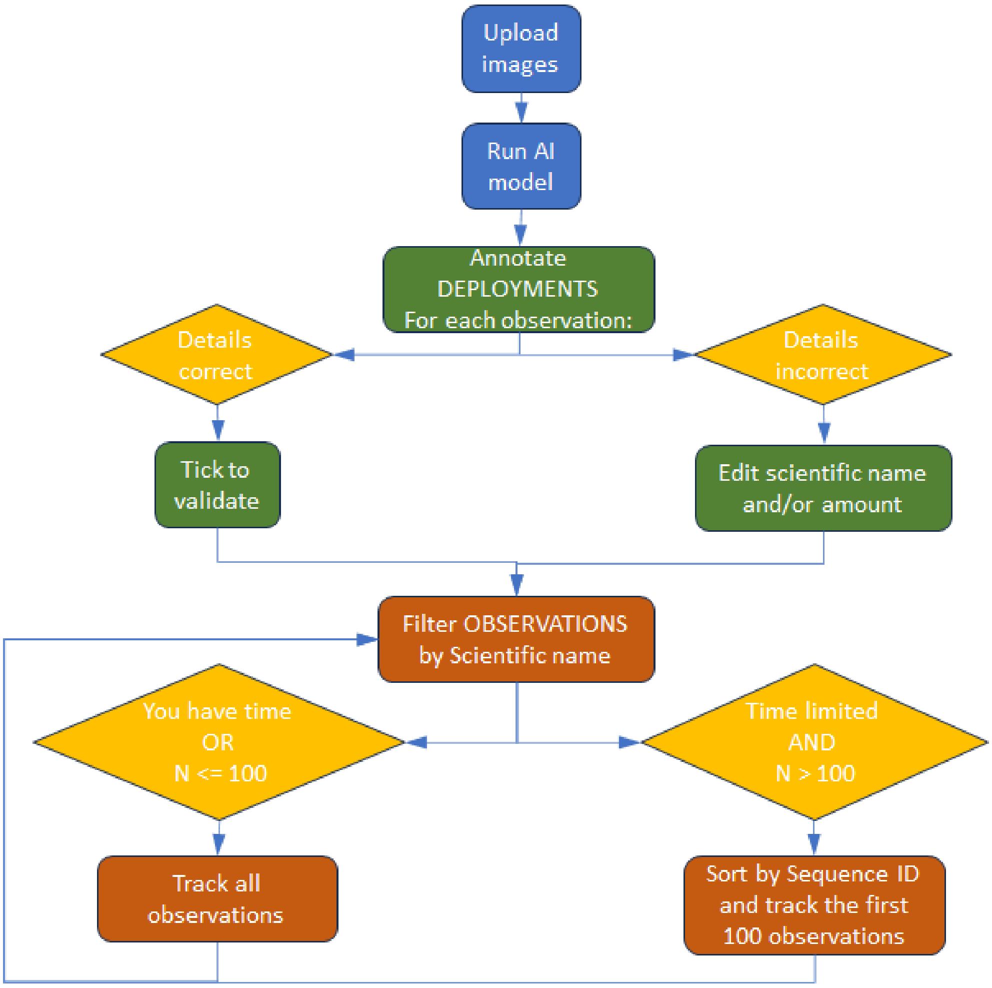
The animal tracking procedure, together with the deployment calibrations is going to allow the calculation of both, camera parameters and animal movements.

1. Upload images and run the appropriate AI detection and classification model.
2. From the DEPLOYMENTS page, annotate each deployment. For each AI-defined observation, EITHER:
    a. Tick the Validate box to confirm the AI-defined species and amount; OR
    b. Edit the observation to correct species and/or amount. NB amount should be a count of the number times an animal passes through the camera detection zone, which AI will often get wrong. Be careful to pick up cases where animals leave and enter multiple times within a sequence; keeping an eye on the timestamp can help to identify such cases.
3. In the OBSERVATIONS page, filter by species (type a species scientific name into the Scientific box), then edit observations to digitise animal tracks. If observation Amount > 1, replace the existing observation with a multiple observations and associated tracks, one per animal passage, each with Amount = 1. You can EITHER:

a. If the total number of observations after filtering is less than or equal to 100, or you plan to track all observations regardless, edit all the available sequences for this species; OR:

b. If you are sampling sequences for tracking to reduce time requirements, and the total number of results after filtering is greater than 100, randomise the sequences by sorting the Observations table by Sequence ID, then track just the first 100 observations.

4. Repeat step 3 for each species.



The performing of the tracking is going to be allowed only when you are editing a sequence, to do so you just have to click on the point on the picture to create a point. For each picture of a sequence (and within a specific observation) you can only add one point. The animal tracking must be performed on the **frontmost foot on the ground** (often further down the image than you think). The first point is the point of entry, and you then keep tracking **the same foot** (when on the ground) throughout the sequence. If the foot is not visible (e.g., covered by a stone or behind a tree) you can still mark it as the point on the thing covering it where you believe the foot is. The most steps tracked the more accurate is going to be the estimate, however if the path is straight the most important are the first and the last points.

See "Animal tracking" for the recording of the course about chapter 7.4.

7.5. Manual Annotation

In "Annotate" section select "Annotate" next to the deployment. The pictures of the deployment will be shown as divided in sequences; each sequence is made of the group of pictures the camera took until it stopped being activated for 120 seconds. Browsing through the pictures of each sequence you will then press "Add Observation" when you recognize an animal activating the camera. In the "Identification" menu select the species, quantity, sex, age and behavior, then press "Save Observation". It is fundamental that you create different observations in the same sequence for animals belonging to different classes (e.g., sow with piglets will need an observation for the sow, adult female, and one for the piglets, juvenile with unknown sex). Remember that **every time an individual goes out from the field of view of the camera and then comes back in it must be counted as a new individual**.

In case there is no observation to add you will be able to select one the following options:

- Blank: empty sequence (e.g., activated by the wind)
- Setup/Pickup: people deploying or collecting camera.
- Deployment calibration: pictures of the "taped stick" for the photogrammetry method.
- Unknown: unknown species in the sequence.
- Vehicle: camera activated by some kind of vehicle.

See "Sequence annotation and tools" for the recording of the course about chapters 7.3 and 7.5.

8. REM ANALYSIS

1. If you don't already have them, install:
    - R: https://cran.r-project.org/
    - RStudio: https://posit.co/download/rstudio-desktop/

2. Extract your data from Agouti
    - in your Agouti project, go to the "Export data" section, create a new export file and download the zip file.
    - Unzip the Agouti export file to a specific destination folder.

3. Download example files:
    - Go to: https://github.com/MarcusRowcliffe/camtrapDensity - here you will find a description of steps for the REM analysis (scroll down to the ReadMe section, click the table icon in the top left of that section for a table of contents).

- Download the camtrapDensity_example.R file (linked from the page or using this link), this contains R codes for running REM density analysis. Move the file from the downloads to the folder where you unzipped the Agouti export.

4. Open RStudio and set up a new project
   - File > New Project > Existing Directory > Browse to the folder you just extracted from the Agouti export > Create Project.
   - In the lower right RStudio pane you should see a tab called Files – click on this (if not already highlighted) and you will see your project files. Click on camtrapDensity_example.R.
   - Before you can start analysing, you will need to install some additional packages as a one-off (code chunk 1 in the camtrapDensity_example file). These will then be available in future analysis sessions without having to reinstall. Running the first chunk of code (INITIAL SETUP) does this installation. To run a line of code, place the cursor on it and press Ctrl+Enter (Win) or Cmd+Enter (Mac), or click run at the top of the code pane.

5. Start analysing.
   - At the start of each session, load the necessary libraries (run code chunk 2, LOAD PACKAGES).
   - Load the data using the function *read_camtrapDP* (code chunk 3). If you set up the project in the directory created by unzipping the Agouti export (as directed above), you only have to run the code

     pkg <- read_camtrapDP("./datapackage.json")

     (without the "." On Mac). See here for details on loading data from other folders if you have stored it elsewhere.

6. Create a subpackage (code chunk 4). **Note: you only have to do this in case you have deployments from previous years in the same Agouti project.** In the example line with the function *subset_deployments* should return only the deployments made in the 2023 campaign but will need to be edited if any of your deployments cover dates outside that year. **Note: in this case you must then change the object of the following lines from** *pkg* **to** *subpkg* **(or whatever name you choose to give to it). Take care to always use the correct data object.**

7. Check deployment schedule (code chunk 5). This allows you to check visually whether all the expected deployments are present in the data, and whether all observation timestamps fall within their given deployment periods (see here).

8. Check deployment calibration models (code chunk 6). Running the lines in this section, R asks you to check all the deployment diagnostic plots and say which species you want to analyse before running the analysis. Diagnostic plots should show reasonably good fits

between trend line and data points. Very poorly fitting models should be marked for exclusion so that the unreliable animal position data from these deployments can be excluded from detection zone and speed models. If you don't remember the explanation of how to evaluate diagnostic plots, see this recording of the online courses at this link from minute 18:20. Also refer to the document "*Interpreting deployment model diagnostic plots*" for guidance on how to decide whether a calibration model is adequate, available here.

9. One step REM analysis (code chunk 7). Run the line in this section and enter the row number of the species you want to run the analysis for. Here you can also see the number of sequences available for the analysis of each species. Clearly the analysis can only be run for the species for which sufficient sequences have been digitized in Agouti.

10. Evaluate how well the activity, detection radius and detection angle models fit (plots produced by code chunk 8). This can reveal potential problems with limited data that might suggest a less reliable result.
11. Inspect model estimates (code chunk 9). Run the lines to inspect the estimate values and report them in the shared spreadsheet (LINK PROVIDED).
12. Run the analysis (steps 9-11) for other species.

13. When leaving RStudio, save your workspace so your work is preserved (code chunk 10).

Table A1. Field sheet (print as many as you need to report the data from all the CT deployments).

Nº of the study point	Nº CT and memory card	Coordinate X	Coordinate Y	Date setting-up CT in the field	Time setting-up CT in the field	Dep. calibration? (Y/N)	Date CT removal	Time CT removal	Observations: any eventuality, indicate if revision is made, the date of this, aspects of functioning of the CT, if it dropped down, if still correctly attached, any failure, change of memory or batteries, etc.
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								