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EXTERNAL SCIENTIFIC REPORT

ENETWILD

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ENETWILD training: "First online course on the use of camera trapping for monitoring wildlife and density estimation in the framework of the European Observatory of Wildlife (5th May 2022)

ENETWILD-Consortium[1], J Casaer, P Palencia, J Vicente, P Acevedo, P Jansen, M Rowcliffe, T Guerrasio, M Scandura, M Apollonio, JA Blanco

Abstract

One of the main objectives of ENETWILD consortium is to collect data on density, hunting statistics and wildlife occurrence in order to model the geographical distribution and abundance of wildlife species across Europe as a tool to support the assessment of risks associated, for example, with disease transmission. Created in the framework of the ENETwild project, the European Wildlife Observatory (EOW[2]) provides the backbone for an integrated, interdisciplinary, multi-sectoral and multi-institutional approach to wildlife monitoring, initially focusing on terrestrial mammals in Europe. The EOW applies similar camera-trapping-based protocols for population estimation and data collection standards to facilitate harmonization and interoperability. For this purpose, continuous training of the network of wildlife professionals in Europe is a key activity of the EOW. In this context, during the last few years the ENETWILD consortium has organized different online training courses and workshops on the use of camera traps, addressing different approaches from the design and handling of camera traps to the processing of the collected data. Many of the participants in our previous courses are now part of the EOW and require updated information on methodology to process with next steps in the field. The course here reported presented improvements and refinements in the sampling protocols, aimed specially at new collaborators to be incorporated in the network. Therefore, the objectives of this introductory online course held on 5th May 2022 were: (i) to present milestones and achievements of the *ENETWILD* project and the EOW, and (ii) to review scientific methods for determining wildlife abundance and density, providing specific training on camera trapping methods and protocols, specifically the random encounter method (REM) and other methods which do not require identification of individuals. This course was attended by 46 wildlife biologists, animal health professionals and wildlife experts from national hunting and forestry authorities. Detailed explanations, protocols, and examples for applying such protocols were provided.

Key words: wild boar, European wildlife observatory, data collection, abundance, density, camera trapping, training

Question number: EFSA-Q-2022-00056

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[1] www.enetwild.com
[2] https://wildlifeobservatory.org

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Summary

One of the main objectives of ENETWILD (enetwild.com) is to collect data on density, hunting statistics and wildlife occurrence to model the geographical distribution and abundance of wildlife species across Europe as a tool to support the assessment of risks associated, for example, with disease transmission. This subject is of particular concern due to the continued advance of African swine fever (ASF) in Europe. Training, generation of harmonized wild boar abundance data (following standards) and enhancing the network of wildlife professionals in Europe is a key activity of the project, especially in previously identified gap areas.

In this context, the ENETWILD consortium recently developed the European Wildlife Observatory (EOW, https://wildlifeobservatory.org/), as the backbone for an integrated, interdisciplinary, multi-sectoral and multi-institutional approach to wildlife monitoring, initially focusing on terrestrial mammals in Europe. Common camera-trapping-based population estimation protocols and data collection standards to facilitate harmonization and interoperability are applied by a network of professionals. The aim of the EOW is being present (at least one study area) in over 30 countries in 2022.

Therefore, the objectives of this introductory online course held on 5th May were: (i) to present milestones and achievements of the *ENETWILD* project and the EOW, and (ii) to review scientific methods for determining wildlife abundance and density, providing specific training on camera trapping methods and protocols, specifically the random encounter method (REM) and other methods which do not require identification of individuals.

This course was attended by 46 game biologists, animal health professional and wildlife experts from national hunting and forest authorities from 22 countries. This course was useful to update, solve questions and open discussion with participants about scientific methods for determining wildlife abundance and density, and specifically, using camera trapping by applying the REM and random encounter staying time (REST) and CT-DS to improve estimation of terrestrial wildlife density. We introduced standardised and harmonised protocols for estimating wildlife densities in the context of the EOW. We updated about the potential of Information Technology (IT) tools and artificial intelligence (AI) to improve the efficiency of density estimation by automatically calculating the distances and speeds and illustrated with examples the improvements that are being implemented to facilitate the efficiency of density estimation with the AGOUTI tool (https://www.agouti.eu/).

This course on the use of camera trapping for monitoring wildlife and density was useful to complete training of a network of collaborators which are estimating wildlife densities. Participatory meetings allow interaction and improve participants' confidence by sharing experiences, doubts, and concerns. It was an important first step to generate synergies between participants to improve this new collaborative initiative. These outcomes confirmed that the online format for an international training can be an opportunity to access a greater number of professionals and specialists from different countries to disseminate the general principles and activities of the project. By September 2022, a second training for the same audience will complete training on the use of IT tools and AI for data management and analysis to obtain reliable density values.

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1. Terms of Reference as provided by the requestor

This contract was awarded to the Universidad de Castilla-La Mancha by EFSA.

The project is entitled "Wildlife: collecting and sharing data on wildlife populations, transmitting animal disease agents". Specific Contract number: OC/EFSA/ALPHA/2016/01 – 09.

The specific contract 9 includes as a deliverable the organization of two training courses aimed to strengthen the network of international collaborators to promote the generation of density data different regions of Europe, including gap areas, by the application of science-based field protocols, data processing and analysis.

2. The *ENETWILD* project and the European Observatory of Wildlife Diseases

The European Food Safety Authority (EFSA) is funding the new-born European Observatory of Wildlife -EOW (https://wildlifeobservatory.org/) as part of the ENETWILD project (www.enetwil.com). The main aim is improving the European capacities for monitoring wildlife populations. The EOW is conceived as a European network of "observation points" with common population estimation protocols and data collection standards to facilitate harmonization and interoperability among countries, and it is coordinated by researchers of the *ENETWID* consortium.

The aims of the EOW are to provide:

- Guidance on density estimation methods and protocols
- Support and training, facilitating field design, data processing and analysis
- Independent information on wildlife population abundance and trends over time at European level

- Initially, the EOW prioritizes the inclusion of different study areas representing all European countries and bioregions (https://eow.wildlifeobservatory.org/)
- Further, the design of the observatory will be optimized to provide representative unbiased estimates of population trends
- The approach is Integrative, Interdisciplinary, multi-sectoral, multi-institutional wildlife monitoring, initially focused on terrestrial mammals, and willing to meet other wildlife monitoring frameworks under One Health Approach in Europe
- Monitoring applying systematic and rigorous protocols, however, not at odds with the fact that it can be applied routinely and easily

The EOW is born as an international collaborative approach that will benefit the conservation and management of wildlife in Europe, and of course, the European society.

The EOW is open to incorporate contributors from public administrations, the Academy, wildlife managers, protected areas, and national and international frameworks monitoring wildlife and ecosystems. They all work in a network where data will be comparable, interoperable, and openly accessed, with continuous exchange of experiences and optimization of efforts.

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The Given the diversity of available methods to monitor wildlife populations and the geographical diversity of Europe, wildlife managers require support and training to facilitating field design, data processing and analysis, to monitor wildlife. Wildlife camera traps allow a non-invasive way to study wild animal populations and estimate relevant parameters like their density.

The EOW provides to collaborators:

- Training on the population density methods and specific field protocols, mainly based on camera trapping
- Continuous assessment on study design, implementation in the field, data processing and analysis
- Update on new developments of methods so as new tools for data processing and analysis. This includes Information Technology tools (ITs) and artificial intelligence (AI) for wildlife image processing, and a user-friendly online platform for data analysis.

The collaborators contribute to the EOW by implementing the field protocol and developing fieldwork in the study area, as well as processing and analysing data through provided Information Technology and Artificial Intelligence tools (ITs and AI).

The observation areas will act as an international 'Observatory', with a long-term approach which, beyond occasional initiatives, is recommended to provide representative and comparable data to support decision-making.

Because some new participants joined this training, and camera trap methods are on continuous development, training on the methods and/or an update of activities to EOW participants is required.

First, we need to remark to new participants that risk assessment in relation to the transmission of pathogens between wildlife, livestock, and humans requires the knowledge of the geographical distribution and abundance of wildlife species, which can represent a reservoir for pathogens and disease vectors. Many European countries and organizations collect data on geographical distribution and abundance of wildlife species, but each one has its own specific characteristics with respect to the methods used, the type of data acquired, the repository implemented and their accessibility. Through the ENETWILD project (www.enetwild.com), funded by EFSA, comparable data are collected at a pan-European level to analyse the risk of spread of diseases between wildlife, livestock, and humans.

We need also to highlight the key idea that this project aims to improve institutional capacity of European organisations for monitoring wildlife populations, for which the development of standards for data collection and validation was a milestone, and the subsequent creation of a common data repository. Currently, the ENETWILD project is focused on collecting density, hunting and occurrence data and modelling geographical distribution and abundance of wild boar, other ungulates, and carnivores at a pan-European level.

To encourage data sharing, ENETWILD promote networking with the key stakeholders, such us government agencies, universities, and research institutions across Europe. This common network of game biologists, animal health professionals, experts from national forest and hunting authorities has improved communication and collaboration between scientists and organizations and is contributing to improved preparedness and responsiveness to the spread of African Swine Fever (ASF) and better management of wildlife populations co-ordinately at European level.

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3. The ENETWILD training: "First online course on the use of camera trapping for monitoring wildlife and density estimation in the framework of the EOW "

46 participants (wildlife biologists, animal health professionals and experts from national forest and hunting authorities) attended this course (see the final full list of participants in Annex A). Twenty-two European countries (Annex A) were represented in this training course.

The course was broadcasted using *Microsoft Teams* platform, which does not require to install any specific software. *M. Teams* can be accessed from the web browser or a desktop application. Participants received an email confirming they were a part of an *online* group called "First online training course on density estimation by Camera trapping EOW". However, because for some were not available on day 5th May, we recorded the lectures, and we provided a link and invitation to the videos recorded during the course (https://enetwild.com/cycle-of-webinars). Materials provided to participants are included or referred in Annexes B and C.

The overall objective of this workshop was to introduce the novel participants to the use of camera traps as tools to monitor wildlife ecology, assess densities, management and interaction at the interface, use of population data in risk assessment, collaborative science, open science, citizen science. Participants must be able to design the field study and prepare a datasheet ready for analysis and estimation of density by the end of the course.

The specific aims of this workshop were:

1. To understand the objectives and motivations for EOW;
2. To understand the methodological basis of density estimation and be able to apply the study design and protocol (Annex B), providing updates on new developments and protocols;
3. To explain the proposed IT tools in the context of EOW, as AGOUTI, including artificial intelligence opportunities for image processing and analysis.

Overall, this training provided a better understanding on most appropriate methods to estimate the abundance and density of wild boar, ruminants, and carnivores, which are based on camera trap and are being implemented by the EOW.

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4. The program

Title of the Training School	**First online course on the use of camera trapping for monitoring wildlife and density estimation in the framework of the EOW**
Time (dates)	**5th May**
Teachers	Pablo Palencia (UNITO, IREC pablo.palencia@uclm.es, palencia.pablo.m@gmail.com) Jim Casaer (Research Institute for Nature and Forest, jim.casaer@inbo.be) Joaquin Vicente Baños (IREC, Joaquin.Vicente@uclm.es)
Learning objectives and expected outcomes	Introduce the participants to the use of camera traps as tools to monitor wildlife ecology, assess densities, management and interaction at the interface, use of population data in risk assessment, collaborative science, open science, citizen science. Participants must be able to design the field study and prepare a datasheet for analysis and estimation of density by the end of the course.
Content and structure	**5th May** 09:00-09:45h *ENETWILD* and the European Observatory of Wildlife: approach, organization, implementation of protocols, principles of camera trapping Joaquín Vicente 09:45-10:15h Camera trap methods for density estimation Pablo Palencia 10:15-10:30h Coffer break 10:30-11:15h "Introduction to AGOUTÍ Platform: organizing CT surveys, process images, and obtain standardized output. Case example". Jim Casaer 11.15-11:45h Study design field protocol Pablo Palencia 11:45-12:30h Database processing for analysis Pablo Palencia 12:30-13:00h The European Observatory of Wildlife: next steps and questions
Materials provided by the teachers	Presentations (PPTs), database and R-scripts

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Format of the presentation	Presentations (approx. 30-45 min) followed by 15-20 min for questions (by means of a chat). The internet broadcast platform link (Microsoft Teams) will be announced later and will not require license.
Assumed knowledge of participants	Basic management of datasheets

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5. Feedback of participants and final conclusions of the ENETWILD training course on camera trapping (May 2022)

The participants were active during the discussions and participated in the discussion/question sessions,

Some of the questions raised during the workshop were related to:

- How best to optimise different methodologies considering different population densities and habitat characteristics.
- There was a special interest in learning about the potential of new developments being implemented in AGOUTI. In particular, the focus was on the calibration methodology to take advantage of the potential of artificial intelligence to estimate the distance and speed of the animals automatically.

This training provided to the participants a better understanding of the EOW initiative promoted by ENETWILD project, and with some key user inputs:

- Study design, field protocols, data analysis skills and support for determining wild boar (mammals) abundance and density using camera trapping.
- Novelties of the functionalities associated to artificial intelligence.
- Awareness of the need of coordinated harmonized wildlife monitoring at European scale following common standards and science based.
- Generate a participatory and collaborative environment where the needs and concerns associated with wildlife research and monitoring are shared.

Online format demonstrated to be an opportunity to access a greater number of professionals and specialists from different countries to disseminate the general principles and activities of the project, and specific training, even with an important practical component. It is recommendable to organize specific camera trapping training in the future as new collaborators incorporate our network.

To complete this training of EOW participants, *ENETWILD* will organize a second online course by early September. It will focus on the use of **IT tools** and **AI** to process and analyse camera-trappings, and data analysis protocols to finally obtain reliable density values.

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Annex A – List of participants (names and country and map)

Institution	Number by institution	Country
PPNEA (Protection and Preservation of Natural Environment in Albania)	3	Albania
Department of Environment and Sustainable Development	2	Andorra
Faculty of Biology Yerevan State University	6	Armenia
Die Universität für Bodenkultur Wien	1	Austria
Research Institute for Nature and Forest	1	Belgium
Forestry and HuntingBanja Luka,	1	Bosnia & Herzegovina
University of Forestry, Sofia	1	Bulgaria
University of Zagreb · Faculty of Agriculture (AGR)	1	Croatia
University of Veterinary Medicine Hannover-ITAW	1	Germany
Frankfurt Zoological Society / University of Freiburg	1	Germany/Ukraine/ Ireland
Faculty of Veterinary Science	1	Greece
Szent István University	1	Hungary
Aree protette appennino piemontese	1	Italy
Lithuanian Research Centre for Agriculture and Forestry	1	Lithuania

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Institute of Zoology	1	Moldova
Moldova State University	1	Moldova
NGO Wildlife Montenegro	1	Montenegro
Public Enterprise for National Parks of Montenegro	1	Montenegro
Natural History Museum of Montenegro-Department of Biology	1	Montenegro
Agriculture and Forestry Montenegro	1	Montenegro
Hunting Federation of Macedonia (HFM)	2	North Macedonia
Mammal Research Institute (MRI)	2	Poland
University of São Paulo	1	Portugal
Palombar - Conservation of Nature and Rural Heritage	2	Portugal
University of Belgrade - Faculty of Forestry	1	Serbia
National Forest Centre	1	Slovakia
University of Primorska - Department of Biodiversity	1	Slovenia
Aragón Hunting Federation	1	Spain

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Araba caza	1	Spain
University of Murcia- Department of Animal Health	1	Spain
AVA-ASAJA	1	Spain
University of Lleida- Department of Animal Science	1	Spain
University of Jaen- Department of Animal Biology, Vegetal Biology and Ecology	1	Spain
OAPN (National Parks)	1	Spain
University of Gävle	1	Sweden
University of Kastamonu	1	Turkey

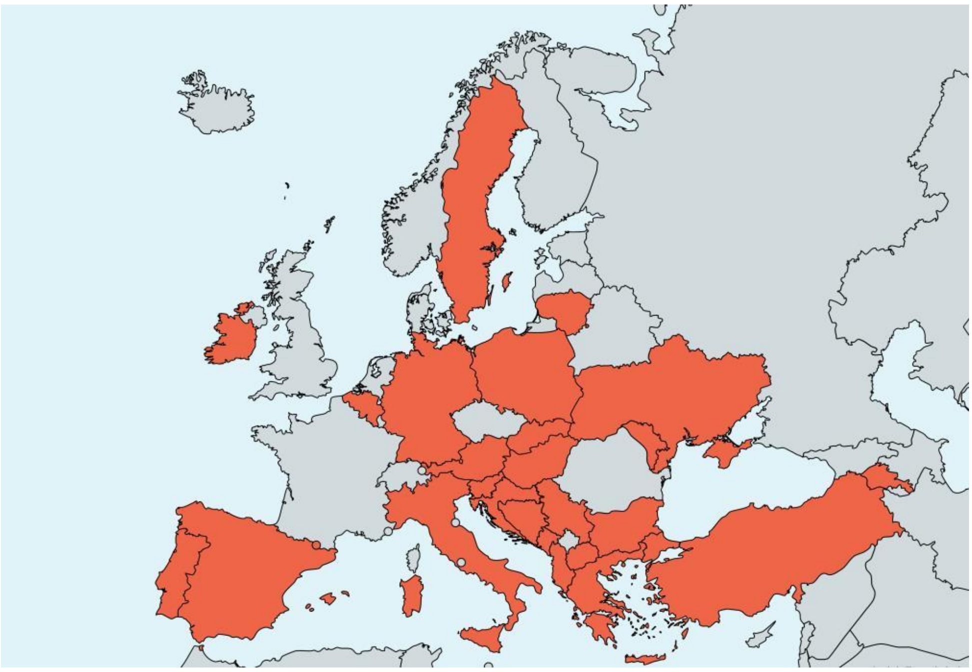

Figure 1. Countries represented at the workshop (in red)

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List of instructors and organizers participating in the Training courses

Instructors

Pablo Palencia (IREC)
Joaquín Vicente Baños (IREC)
Tancredi Guerrasio (UNISS)
Jim Casaer (INBO)

Course organization and coordination:

Tancredi Guerrasio (UNISS)
Joaquín Vicente Baños (IREC)
José A Blanco-Aguiar (IREC)

Annex B – Videos of the presentations.

https://wildlifeobservatory.org/course-on-the-use-of-camera-trapping-for-monitoring-wildlife/

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Annex C – Material provided to participants: Field protocol for camera trap surveys with camera calibration for measuring animal positions for unmarked density estimation

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Background

The random encounter model (REM), camera trap distance sampling and related methods for estimating the density of unmarked animals require data on animal positions relative to camera in order to estimate camera detection zone size and (for REM) animal speed of movement. These positions can be efficiently estimated using a computer vision process based on mapping image pixel positions to real world ground positions relative to camera. This "map" can then be used to estimate the positions of animals in images with minimal effort. To create the map, images of calibration poles are required at each camera deployment in the field. This protocol sets out field methods for generating the necessary calibration images.

Survey design and set up

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, this web app provides an accessible tool for doing this: https://marcusrowcliffe.shinyapps.io/mapping).

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.
In the field, find or make a suitable attachment point for the camera as close as possible to the computer-generated point. If using pre-existing attachment points (rather than placing your own), this will almost inevitably require moving away from the computer-generated point to some extent. When choosing a location away from the computer-generated point, keep in mind the microhabitat in which it fell and aim to place the camera in the same habitat. Do choose a camera viewpoint with sufficient open ground to give some prospect of clear animal images but resist the temptation to choose spots that seem good for animals when doing this. To the extent possible, point cameras at ground that is reasonably even, not extremely rough.

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Making calibration poles

Take a straight, strong pole (e.g., PVC electrical tube) at least 1 m in length, and mark it in a durable way with bands in a contrasting colour, e.g. white duct tape on a black pole (Fig. 2). Place five bands at 20 cm intervals from one end, from 0.2 to 1 m. Indicate height by adding additional bands below the height marker, with the number of bands indicating height increment, so that 1 band = 0.2 m, 2 bands = 0.4 m etc.

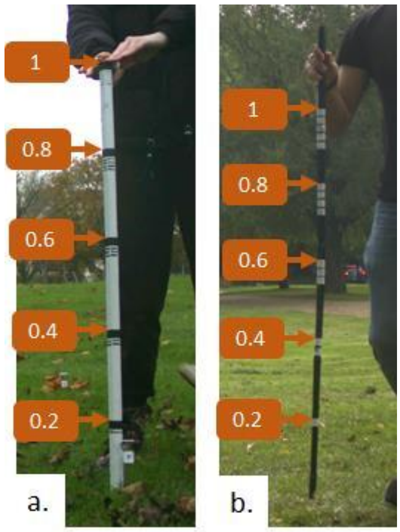

Figure 2. Two examples of calibration poles. The top of each group of bands is at a known height above ground at 20 cm intervals. Heights above ground are indicated in metres, with the number of bands in each group indicating the height increment.

Taking deployment calibration images

Carry out the following procedure at each deployment:

1. Set up the camera firmly to minimize risk of subsequent movement, and in position ready to capture wildlife images. Switch it on ready to trigger photos.

2. 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. 3).

3. Hold the pole still long enough to ensure a clear image (generally 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, in Fig. 1a, the pole is held by pressing on the top with outstretched fingertips. Closer to the camera, the pole top may not be visible, so it may be necessary to signal lower down, for example with a clenched fist held next to the middle of the pole.

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4. Repeat this for further pole placements 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.

Note that if the camera position is moved, even slightly (for example when checking batteries), the calibration process should be repeated for that deployment. If possible, it should also be repeated when removing the camera, as well as when setting and checking it.

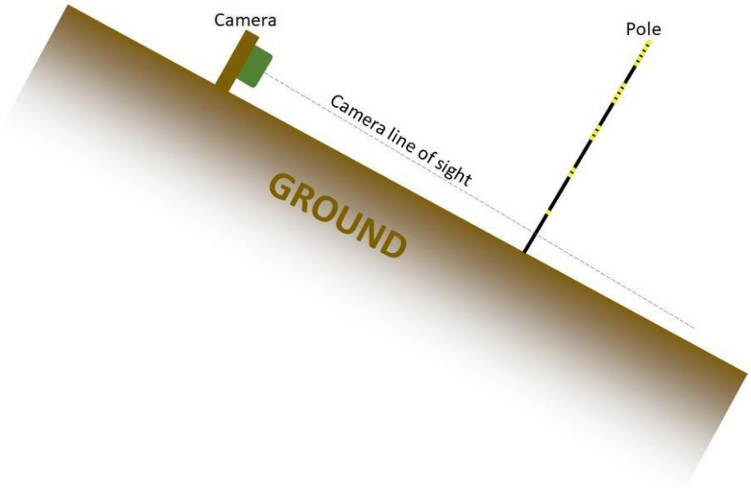

Figure 3. Diagram illustrating a camera set up to observe sloping ground, and the orientation of the calibration pole required to keep it perpendicular to the camera line of sight. Orientation can be judged by eye, and need not be measured precisely in the field.

Training and trialing

Before going to the field, it is important run trials of the deployment calibration process. Complete the deployment calibration process described above (Taking deployment calibration images) in a convenient location and inspect the images. Check that you have taken at least 10, and ideally 20 or more useable images of the pole resting on the ground, distributed reasonably evenly across the surface visible to the camera, ranging from very close (1 m or less) to at least as far as the furthest distance you expect to record animals. Fig. 4 shows an example of a good set of calibration pole images for a deployment. If at first you don't obtain enough useable images, or your coverage of the detection zone is poor, modify your process to obtain a better set of images, for example by waiting a little longer at each pole placement, or taking more pole images at greater density. Do this with your deployment team to ensure that all team members understand the process fully.

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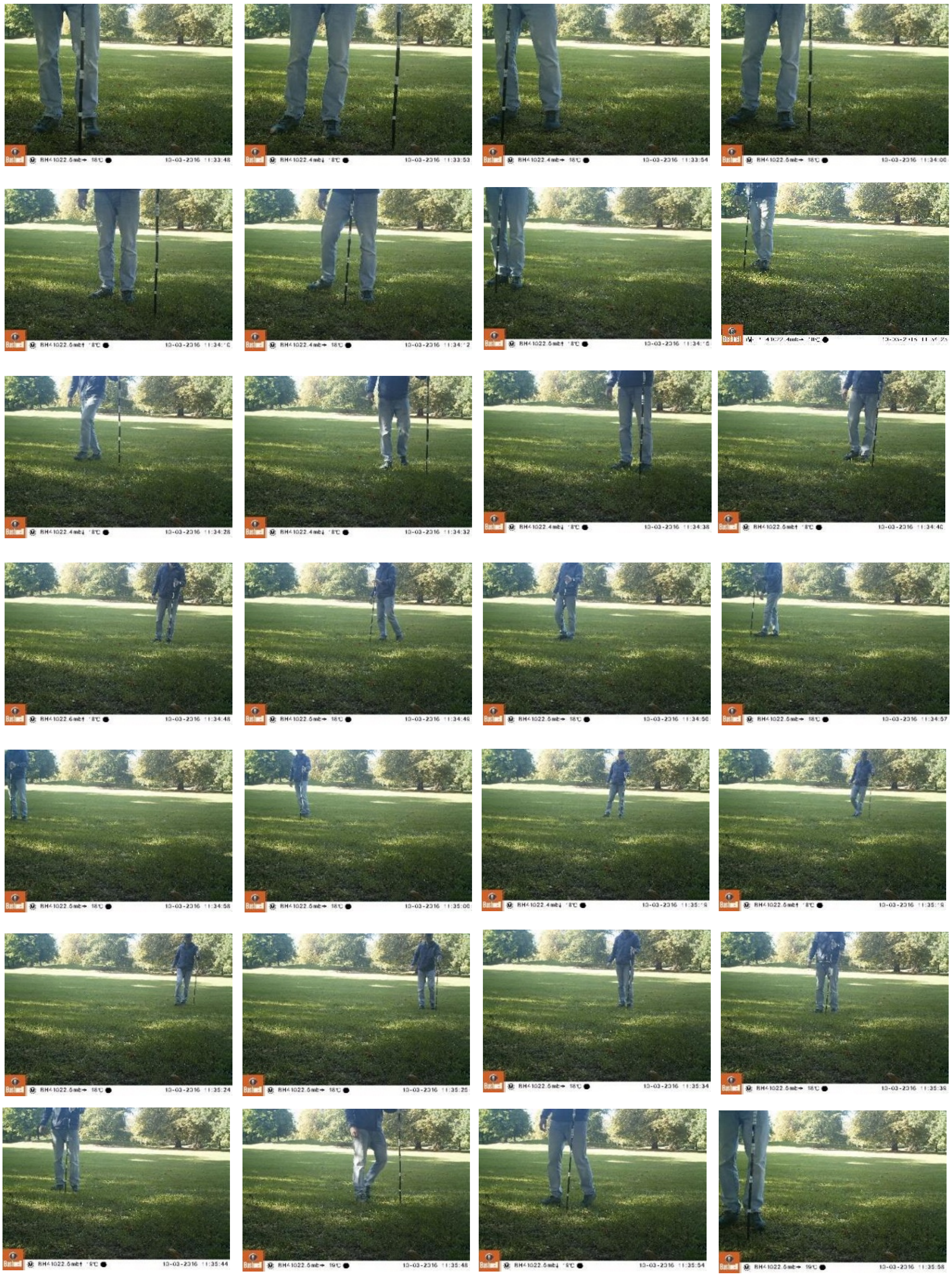

Figure 4. A set of deployment calibration images showing 28 pole positions with good coverage of the detection zone.

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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. 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. 5 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 above: Making calibration poles) at each position on the array, holding up some visible marker of the distance. For example, in Fig. 6, 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.

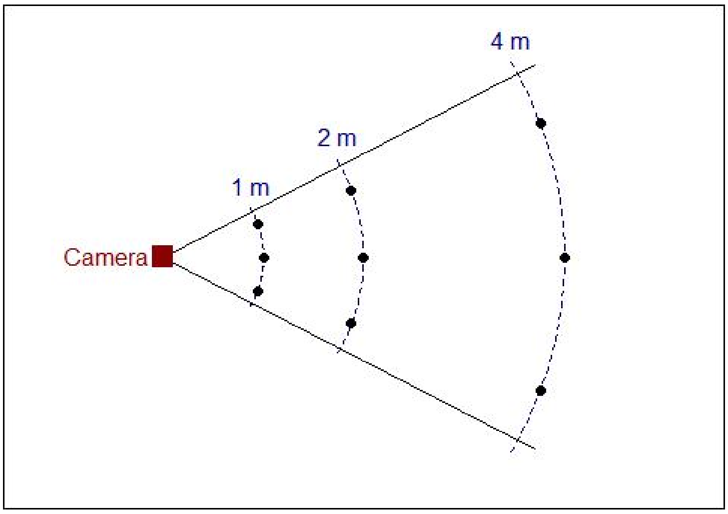

Figure 5. Plan view of an example layout for a camera calibration pole grid.

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Figure 6. A camera calibration image with pole in position 2 m from the camera.

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