EXTERNAL SCIENTIFIC REPORT

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Development of an app for processing data on wildlife density in the field

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Abstract

It is essential to provide tools to wildlife professionals and researchers in order to facilitate data collection on wildlife density estimation following standardized protocols in the field. This is relevant for efficient harmonized data management systems, from the field to final reporting. Our main objective was to facilitate the collection of information in the field using established density estimation protocols. The specific objectives were (i) to evaluate and use already existing data registration IT tools for collecting and storing the data in the field; (ii) to make these data available in real time (cloud-based solution), and (iii) being flexible enough to incorporate new protocols and species, as methods (such as camera trap-based) and needs continuously evolves. We improved an already existing tool, Spatial Monitoring and Reporting Tool (SMART; https://smartconservationtools.org/). It is an open source software, which allows easily collect, visualize, store, analyze, report and act on a wide range of field data relevant for wildlife monitoring. The integration of SMART tools on EOW was successfully done for (i) distance sampling, (ii) hunting data and (iii) camera trap protocols. ENETWILD, therefore, made now available new IT functionalities to wildlife professionals and researchers to facilitate and harmonize wildlife data collection systems.

Key words: Spatial Monitoring and Reporting Tool (SMART), abundance estimation, field protocol, cloud-based, camera traps, distance sampling, hunting statistics

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Summary

The regular observation and recording of wildlife population parameters is essential for further improved decision-making with a technical and scientific basis. However, a comparative assessment between different study sites, regions or countries requires data collection methodologies to follow equivalent or comparable protocols. For that purpose, it is essential to provide tools to wildlife professionals and researchers to facilitate data collection, already from the field. This approach entails the application of standardaized methodology, which is a first step for subsequent efficient harmonized data management systems, from the field to final reporting.

ENETWILD aims to consolidate a network of abundance estimations in Europe by providing analytical tools and by promoting collaborative science. As part of the ENETWILD project, the European Observatory of Wildlife (EOW, https://wildlifeobservatory.org/) is a network of "observation points" provided by collaborators from most European Countries capable to monitor wildlife population. ENETWILD continously evalutes how making available to wildlife professionals and researchers new tools, particularly information technology (IT) functionalities to improve current schemes of wildlife field data collection, and the subsequent harmonised data flow. This is foreseen as a cost effective "from field to screen" strategy, which contributes to facilitate field technicians, researchers and managers collecting information to estimate wildlife abundance following recommended methods (https://wildlifeobservatory.org/guides-and-population-density-cards). Our main objective was to facilitate the collection of information in the field using stablished density estimation protocols. For that, the specific **objectives** of the present report were:

- to evaluate and adapt already existing data registration IT tools for collecting and storing the data in the field;
- making these data available in a desktop app version in real time (cloud-based solution), allowing standardized information being managed and shared in an agile, harmonized and cost/effective way, while keeping confidential for users;
- being flexible enough to incorporate new protocols, species, and continuous improvements in data recording evolving methods (such as camera traps-based), as wildlife monitoring needs and methods evolve.

We first identified the most relevant type of data required to be recorded in the field, which relates with the main recommended density estimation protocols for medium and big sized mammals (lagomorphs, carnivores, ungulates):

- data on the location and circumstances related to the deployment of the network of camera-trap surveys (methods which do not require individual recognition);
- data associated with the collection of information from drive hunting events (potentially used as a drive counts);
- data associated with the estimation of populations based on the distance sampling protocol (transects).

We improved an already existing tool that meets the needs of the project: Spatial Monitoring and Reporting Tool (SMART; https://smartconservationtools.org/). SMART is an open source software, which allows to easily generate or modify new protocols or incorporate new taxa. This platform allows easily collect, visualize, store, analyze, report and act on a wide range of field data relevant for wildlife monitoring and conservation. The application can be connected to common servers where the information collected by different teams can be shared and the collected information can be tracked in real time. SMART Version 7 fits the needs of the EOW and allows direct connection to the server. This app is relatively easy to use at user level (the data collector). SMART Desktop, is a technological solution for data management that allow gathering, analysis and dissemination information to the management of protected areas. SMART Connect is a cloud-based solution enabling online visualization, analysis and sharing of data, centralized database management. Data can be transmitted directly from the field to a

SMART database in real time, rather than via manual download at the end of a survey. Finally, SMART mobile; is a mobile app for field-based data collection with support for Android and iOS, which allows field staff to collect data while on survey using a standardized, user-friendly interface

The integrating SMART tools on EOW was successfully done. We present in this report the (i) Distance sampling, (ii) Hunting data and (iii) Camera trap protocols.

To sum;

- SMART tool is already adapted to the needs of the EOW, interoperable and ready to be incorporated by the EOW members, which already received first specific training on it use. This means ENETWILD is making available to wildlife proffessioals and researchers new IT functionalities.
- SMART's flexibility allows improvements in the data collection models to be agreed upon, and changes to be implemented in an agile way. It is also possible to incorporate new protocols for data collection (e.g. environmental DNA protocol, eDNA, Laramie et al. 2015).
- Although the training of the users in charge of data collection is relatively straightforward, we face the challenge of training the people in the different areas who will be in charge of managing the information collected in each of the study areas. This wil be done during the EOW 2023 (spring) campaign (specific contract 10).
- While the management of information can be centralised, local teams can manage data independently in their servers. The independent management of the information generated in their areas of study entails that mechanisms limiting access to the information could be implemented to maintain the privacy of what they consider sensitive data. This aspect may be important for some institutions that do not feel comfortable sharing all the information collected and want to keep certain data private. However, the use of SMART will guarantee that field technicians/researchers/managers can collect information to estimate wildlife abundance following validated protocols and methods previously recommended, and the final determinations and relevant metadata can be later shared, following the EOW philosophy.

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

This contract was awarded by EFSA to Universidad de Castilla-La Mancha, contract title: Wildlife: collecting and sharing data on wildlife populations, transmitting animal disease agents, contract number: OC/EFSA/ALPHA/2016/01 – 01.

The terms of reference for the present report (specific contract 9, deliverable 3.4) were: Development of an app for processing CT-obtained data including the protocols to collect data in the field in all European languages: App + and advertisement campaign + report about its functioning. D3.4. A final report must be provided in September 2022.

1.2. Scope of the report

Wildlife monitoring is conceived as the surveillance of the natural environment or any of its components. The regular observation and recording of parameters on a long-term scale to show trends over time allow us focusing on a certain species, its population, ecosystem, or human factors involved and the relationship and impacts among them. It provides not only a better understanding of the essential ecological, and epidemiological but also socioeconomic processes. The information collected and analysed, is essential for further understanding ecological relationships and for subsequent improved decision-making with a technical and scientific basis. However, a comparative assessment between different study sites/ regions/countries requires that data collection methodologies follow equivalent or comparable data collection procedures and protocols. For that purpose, it is essential to provide tools to wildlife proffesionals and researchers facilitating data collection already in the field. This approach entails the application of standardaized methodology in an harminized (comparable) way. This is first step for subsequent proper documentation and data management system, from the field to final reporting, in order wildlife monitoring to be effectively implemented.

European wildlife monitoring: needs for an collaborative-science harmoinized approach

Within Specific Contract 9 of the ENETWILD project, we aim to consolidate a network of abundance estimations by providing analytical tools and by promoting collaborative science. As part of the *ENETWILD* project, The European Observatory of Wildlife (EOW, https://wildlifeobservatory.org/) is a collaborative initiative **open to professionals, researchers, administrations (from local to European), NGOs,** etc, willing to contribute by providing at least one observation point for wildlife (terrestrial mammal) monitoring. A network of "observation points" provided by collaborators from all European Countries capable to monitor wildlife population at European level. It aims:

- To generate and provide information and unbiased trends on population abundance for those developing, adopting, implementing, and evaluating environmental policy in Europe.
- To provide sound, independent guidance on methods and protocols for those involved in implementing wildlife monitoring, in close collaboration with European Institutions.
- To develop a network alive for wildlife monitoring, incorporating different stakeholders, such as regional and national administrations, game, protected areas and research Institutions.
- Supporting observation points, providing training and facilitating field design, data processing and analysis.
- Focused on mammals but looking to integrate other taxa and ecological variables and integrated monitoring (wildlife diseases).
- To improve population abundance estimation protocols, calibrating methods, incorporating information technology and citizen science.

- Highlight areas and recommendations for action working, the inequalities existing in wildlife population monitoring over Europe.

The EOW currently comprises more than 50 collaborators from at least 30 european countries.

ENETWILD with the collaboration of the *MammalNet* project (www.mammalnet.com) has promoted some informatic tools to improve the data collection of wildlife distribution and abundance:

- *iMammalia*; a mobil app to incentive the collaboration of citizens to incorporate records about occasional records of Wild Mammals, but also to promote the collection of dead animals and carcasses which may be of interest for health assessment a by local authorities
- *AGOUTI*: A web application focused on improving the standardisation and annotation of camera trap images, which incorporates artificial intelligence functionalities to help EOW collaborators calculate wildlife density estimates.
- *MammalWeb*: A web application based on camera-trapping that is aimed at citizens who want to collaborate as spotters, or trappers generating information on the distribution of wild mammals.

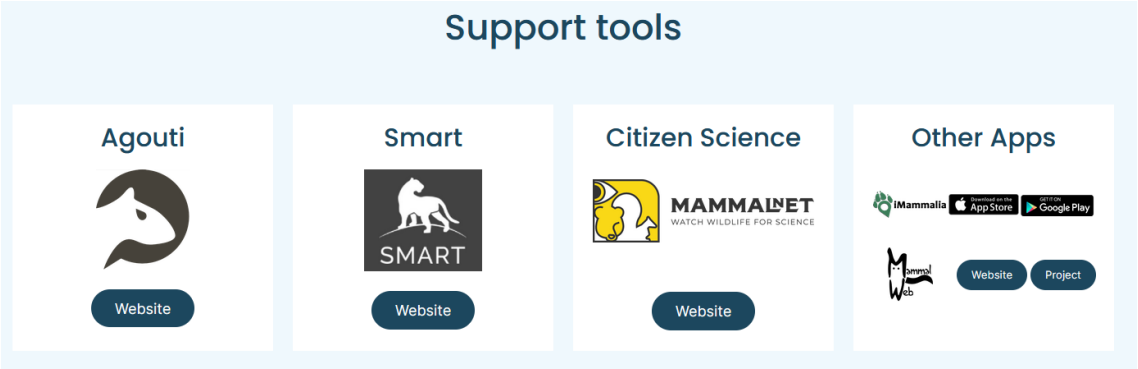

Figure 1. Apps promoted by the ENEWILD and the MammalNet project to improve distributions and abundance of wildlife mammals.

Objectives

ENETWILD aims to make available to wildlife professionals and researchers new information technology (IT) functionalities which currently are not provided by any app. This is crucial to improve current schemes of wildlife monitoring field data collection, and subsequent data flow in a standardised and harmonised way. This is foreseen as a cost effective "from field to screen" strategy which facilitates field technicians/researchers/managers collecting information to estimate wildlife abundance following validated protocols and methods previously recommended (ENETWILD consortium et al. 2018, 2020a, 2020b, 2021).

Our main objective was to facilitate the collection of information in the field using stablished density estimation protocols. For that, the specific **objectives** of the present report were:

- to evaluate and adapt already existing data registration IT tools for collecting and storing the data in the field;
- making these data available in an screen app version in real time (cloud-based solution), allowing standardized information being managed and shared in an agile, harmonized and cost/effective way, while keeping confidential for users;
- being flexible enough to incorporate new protocols, species, and continuous improvements in data recording evolving methods (such as camera traps-based), as wildlife monitoring needs and methods evolve.

2. Results

In this first phase, we identified the most relevant type of data required to be recorded in the field. These data relates to the main recommended density estimation protocols for medium and big sized mammals (lagomorphs, carnivores, ungulates; ENETWILD consortium et al. 2018, 2020a, 2020b, 2021):

- Data on the location and circumstances related to the deployment of the network of camera-trap surveys (methods which do not require individual recognition)
- Data associated with the collection of information from drive hunting events (potentially used as drive counts)
- Data associated with the estimation of populations based on the distance sampling protocol (transects).

We initially considered different alternatives considering the needs of the project and available tools "in the market":

- To generate a new application from scratch
- To improve an already existing tool that could be adapted to the needs of the project.
- Evaluate the use of existing tools that were flexible enough to meet the needs of the project.

We considered the best option was to improve an already existing tool that meets the needs of the Project. The selected tool was Spatial Monitoring and Reporting Tool (SMART; https://smartconservationtools.org/) which offered the following advantages:

- It is an open source software that increase the transparency of the project and the possibility to contribute in the development of tools or plugins.
- It is very flexible and allows to easily generate or modify new protocols (e.g. eDNA or diseases surveys) or even incorporate new taxa.
- This application is maintained by an international consortium of nature conservation organisations to provide long-term support.
- These applications can be connected to common servers where the information collected by different teams can be shared and the collected information can be tracked in real time.
- There is a community behind it that allows for efficient problem solving and there are usually training courses to improve the use of the tools.

SMART is an evolution of CYBERTRACKER (https://cybertracker.org/), which shares similarities in data collection philosophy, but incorporates numerous improvements that make it more powerful and flexible. As CYBERTRACKER is a tool that has been frequently used in wildlife monitoring studies, its similarities will help those users who are still using it to migrate easily to SMART.

SMART Version 7 fits the needs of the EOW and allows direct connection to the server. However, by mid 2022, it still was in beta phase. Since then, we initiated continuous contact and have worked with the development team testing and identifying gaps and bugs to meet our requirements. This app is relatively easy to use at user level (the data collector). The application requires different roles for the management and analysis of the information, which requires specific training to achieve an adequate level of handling of the tool.

Spatial Monitoring and Reporting Tool (SMART)

SMART is supported by a long-term alliance of leading conservation organizations, providing a powerful solution with a wide range of applications in conservation and wildlife monitoring. The SMART Partnership's is a response to support the effective management of conservation areas which provide refuge to threatened fauna and flora, providing this support through technology, capacity building and empowerment of user community.

SMART Tools are open-source, non-proprietary. SMART is a suite of tools that enables you to collect, store, communicate, and evaluate data on wildlife areas. This technology consists of a set of software and analysis tools designed to help standardize and streamline data collection, analysis, and reporting, and can be customised to suit specific needs and contexts (Fig. 2).

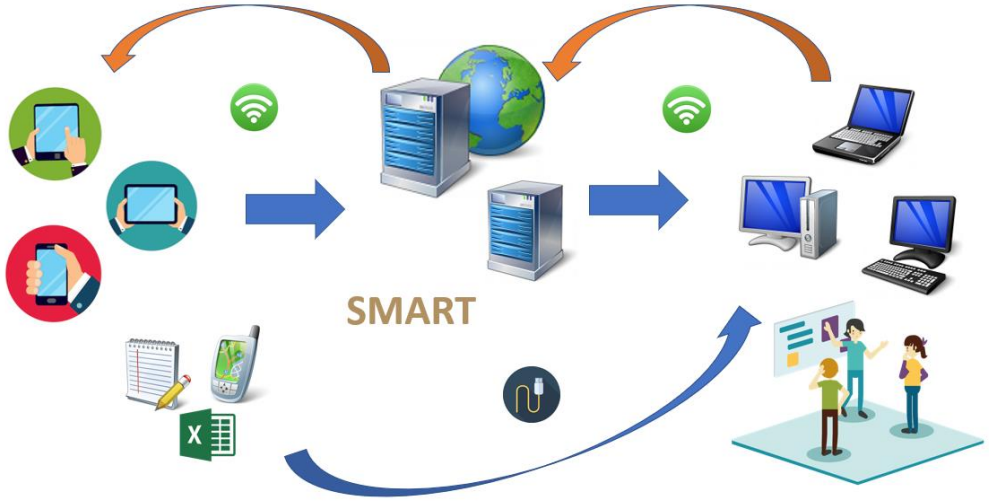

Figure 2. Representation of the data flow on which the SMART platform is based. Information is collected from mobile devices and sent to the server. A desktop application is responsible for processing this information received on the server and generating queries, reports or incorporating information received from other sources, This edited information is re-incorporated into the server's data base to be available and updated on different interconnected destock devices.

SMART is a holistic data management platform, encompassing and integrating mobile, desktop, and cloud-based components with a wide range of applications. This platform allows easily collect, visualize, store, analyze, report and act on a wide range of field data relevant for wildlife management and conservation. Transforming data into usable information helps managers allocate their time and resources more effectively, feeding clear results back to frontline staff.

SMART Desktop, is a technological solution for data management that allow gathering, analysis and dissemination information to the management of protected areas. The SMART Desktop application has built-in cartographic, spatial and statistical analyses, and integrates data from a global positioning system (GPS), mobile devices. The data can be visualised through a sophisticated query interface that offers multiple ways to interrogate the data (Fig.4). From these analyses, managers can automatically generate summary reports to summarise activities and manage resources more effectively. In addition, the software offers multiple optional plug-ins. The SMART Ecological Records plug-in facilitates the collection, mapping, management and analysis of systematic habitat and species data.

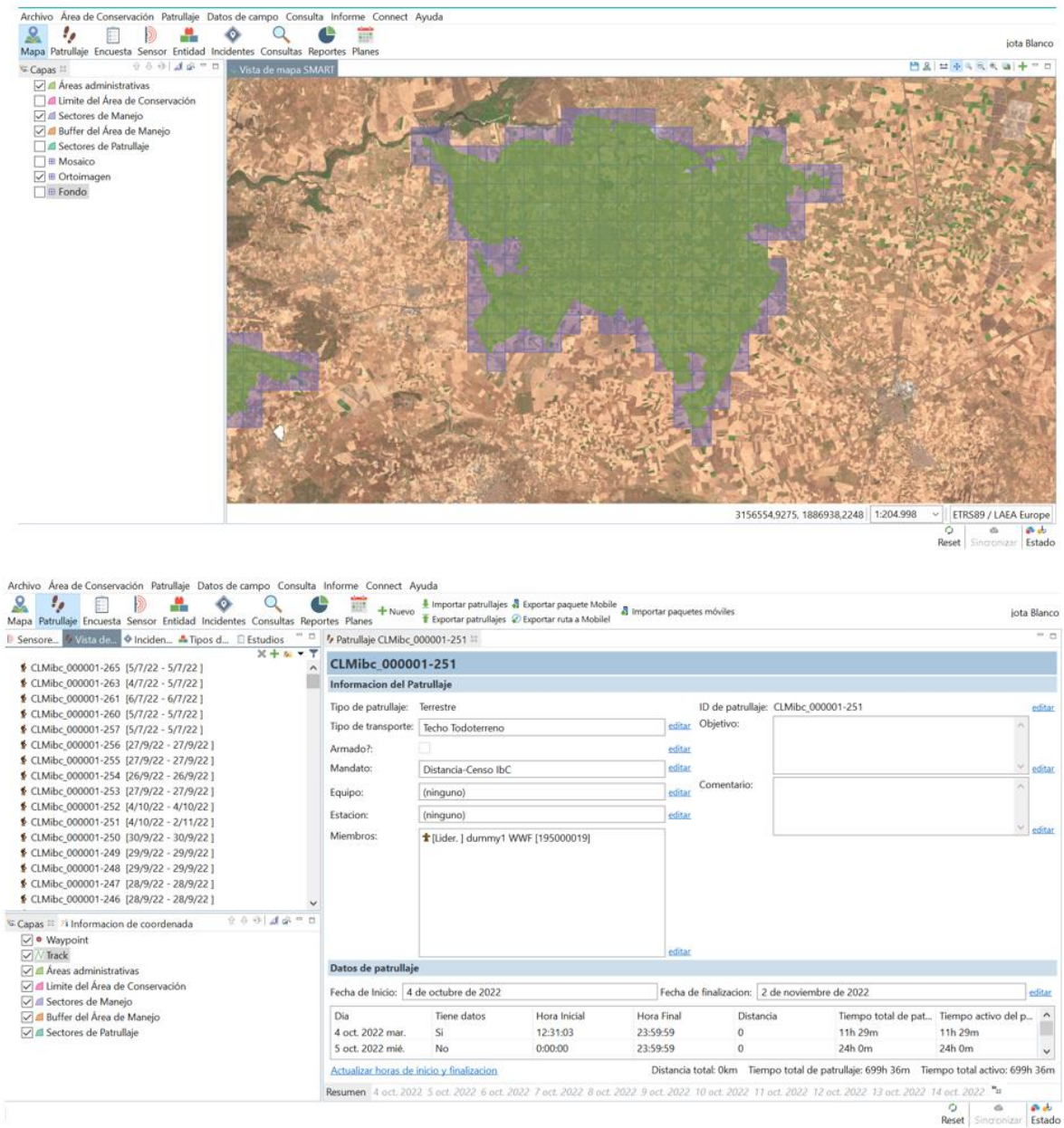

Figure 3. Screenshots of SMART desktop indicating spatial information and metadata of patrol records

SMART Connect is a cloud-based solution enabling online visualization, analysis and sharing of data, centralized database management. Data can be transmitted directly from the field to a SMART database in real time, rather than via manual download at the end of a survey. This enhanced speed of data transfer transforms the SMART solution syncs all data to a central server. This platform also facilitates connections with external sensors, such as cameras and other wildlife tracking devices, as well as to other web platforms, and have their data fed into SMART. SMART Connect also allows SMART data to be provided to other systems via an application programming interface (API).

SMART mobile; is a mobile app for field-based data collection with support for Android and iOS. It allows field staff to collect data while on survey using a standardized, user-friendly interface (Fig 4). The app uses customized data capture workflows based on the specific data model designed for each project.

Standardization and ease of data entry reduce errors and omissions and allow data to be utilized far more rapidly than is possible with manual data entry. All collected data are automatically georeferenced based on GPS data and tagged with time and date. Photos can also be added to document. All data are stored on the device and uploaded to the central database once connectivity is available, either via wireless data connection or USB transfer.

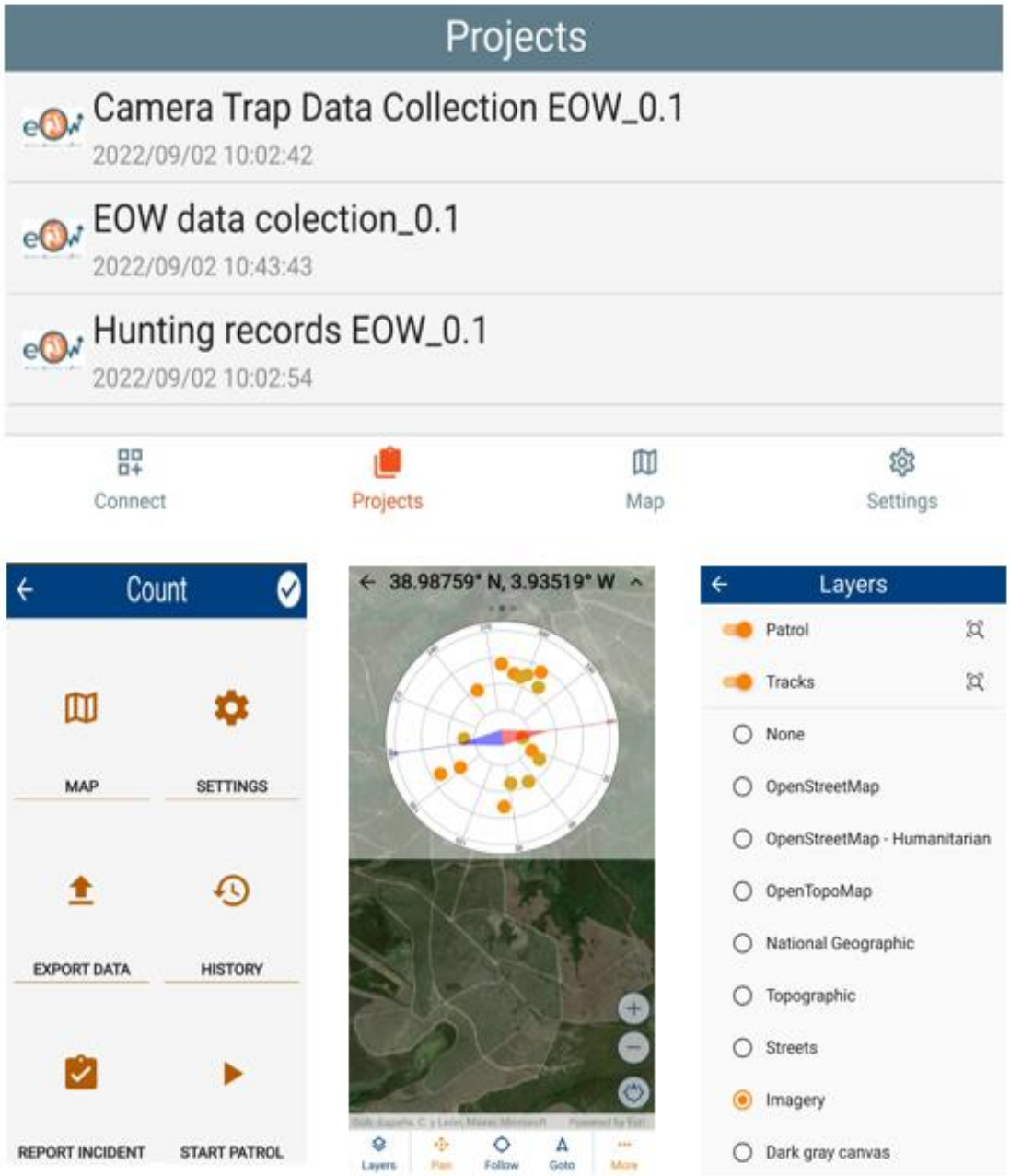

Figure 4. Screenshots of different functionalities of the app. Project selection menu, sampling start menu and options to load online and offline maps.

Integrating SMART tools on EOW

The EOW has taken advantage of the tools offered by SMART to generate "conservation areas" to serve as pilot tests to evaluate the usefulness and connectivity of the tool. Three different patrols were generated to collect data for each of the proposed protocols: camera traps survey, hunting data and distance tracking (Fig. 5).

For each of the patrols associated with each protocol, a metadata file is generated, which incorporates information on the sampling location, the objective of the patrol, the equipment and personnel involved in the sampling, as well as the sampling station and other details associated with the patrol (Fig.5).

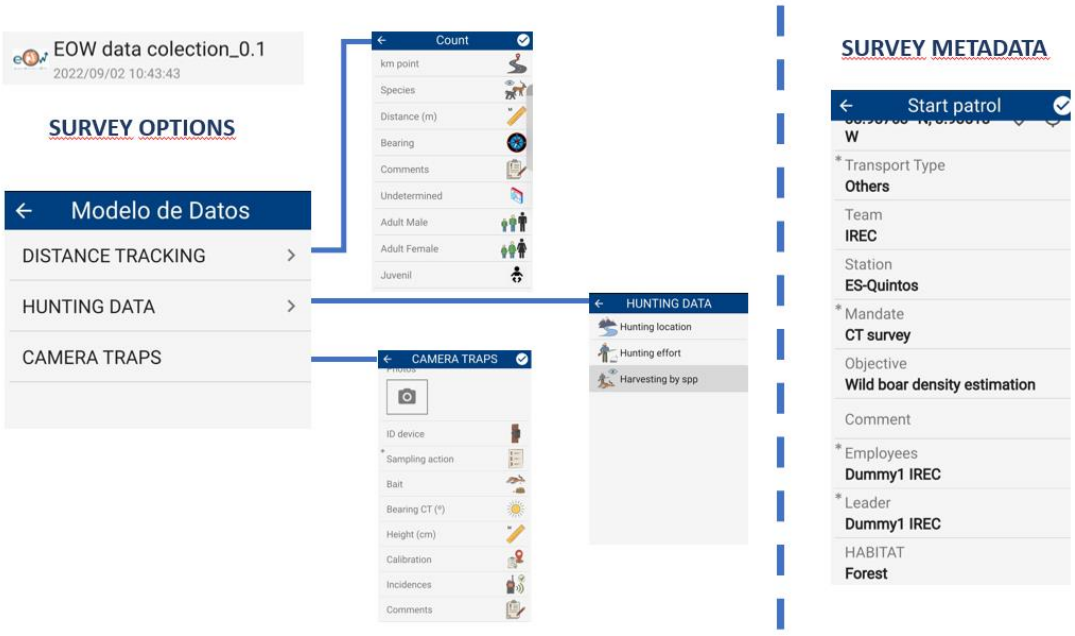

Figure 5. The different data collection patrols implemented in SMART to help EOW field collaborators to improve and standardize data collection: distance sampling, hunting data and camera trap.

Distance sampling protocol allows to collect easily information on the species, sex, age as well as the position, distance, and angle of observation of the observed individuals to be incorporated (Fig. 6).

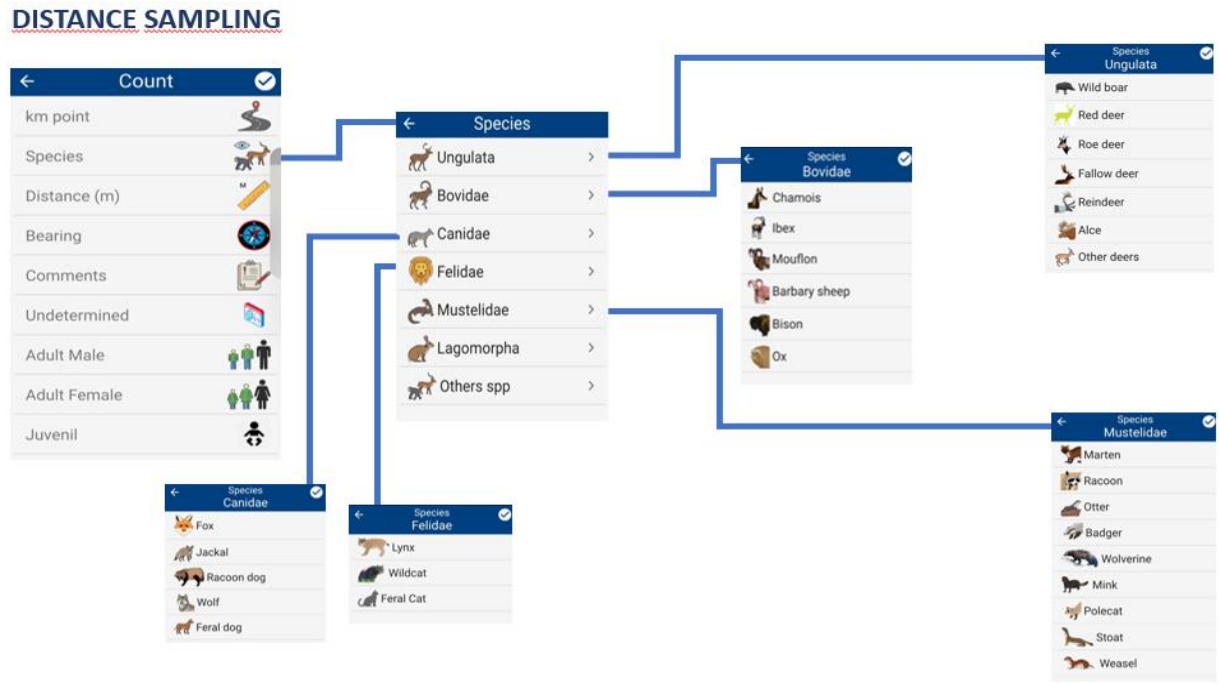

Figure 6. Menu of the distance tracking patrol.

Hunting data protocol (Fig. 7) allows to collect information on local hunting statistics. It allows to collect information on the number of animals observed and hunted during the hunting drive as well as parameters of the effort made by hunters.

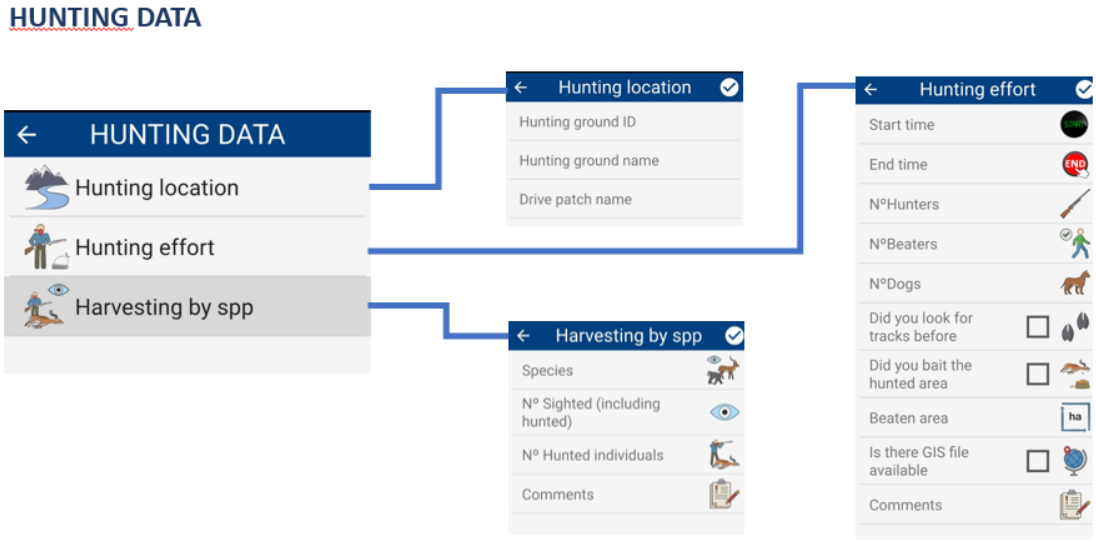

Figure 7. Menu of the hunting data patrol. This patrol allows to collect information on local hunting statistics. It allows to collect information on the number of animals observed and hunted during the hunting drive as well as parameters of the effort made.

Camera trap protocol (Fig. 8) allows to collect descriptive information on the camera trap location (position, bearing, height) and task performed during the sampling (calibration for REM and similar methods requiring distance and movement parameters, incidences…). This patrol also allows to include images from each camera deployment.

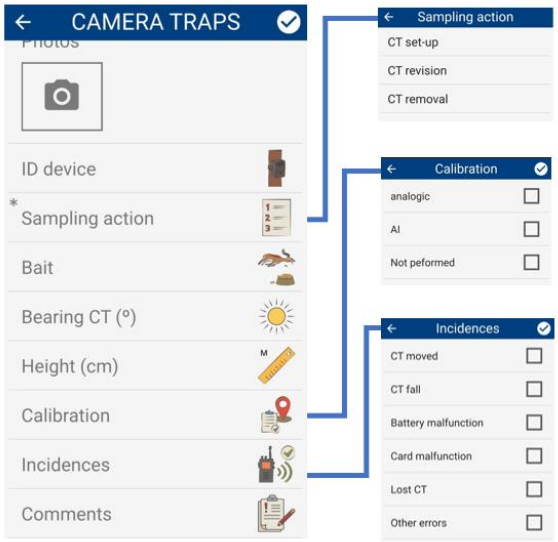

Figure 8. Menu of the camera traps patrol.

3. Conclusions

- SMART tool is already adapted to the needs of the EOW, interoperable and ready to be incorporated by the EOW members, which already received first specific training on it use. This means ENETWILD is making available new information technology (IT) functionalities to wildlife proffessioals and researchers.
- SMART's flexibility allows improvements in the data collection models to be agreed upon, and changes to be implemented in an agile way. It is also possible to incorporate new protocols for data collection (e.g. eADN protocol).
- Although the training of the users in charge of data collection is relatively straightforward, we face the challenge of training the people in the different areas who will be in charge of managing the information collected in each of the study areas. This wil be done during the EOW 2023 (spring) campaign (specific contract 11).
- While the management of information can be centralised, local teams can manage data independently in their servers. The independent management of the information generated in their areas of study entails that mechanisms limiting access to the information could be implemented to maintain the privacy of what they consider sensitive data. This aspect may be important for some institutions that do not feel comfortable sharing all the information collected and want to keep certain data private. However, the use of SMART guarantee that field technicians/researchers/managers will be able to collect information to estimate wildlife abundance following validated protocols and methods previously recommended, and the final determinations and relevant metadata can later be shared, following the EOW philosophy.

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