

# Deliverable 2.1

*Study design, protocols and plans*



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## Deliverable description.

Text

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<b>PU</b>	<b>Public</b>
<b>CO</b>	<b>Confidential, only for members of the consortium and AB (including the Commission Services)</b>
<b>CI</b>	<b>Classified, as referred to in Commission Decision 2001/844/EC</b>

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## Acronyms

Acronym	Description
APC	Article Processing Charges
AU	Aarhus Universitet
CS	Citizen Science
CSI(s)	Citizen Science Initiative(s)
D	Deliverable
EC	European Commission
ECSA	Verein Der Europäischen Bürgerwissenschaftler
EU	European Union
EUSEA	Europäische Gesellschaft Für Wissenschaftsveranstaltungen
GDPR	General Data Protection Regulation
K&I	Conoscenza e Innovazione Società a Responsabilità Limitata Semplificata
HAS	Lovska Zveza Slovenije (the Hunter Association of Slovenia)
M	Month
OA	OpenAccess
SfC	Science for Change
T	Task
UP	University of Primorska
WP	Work Package
ZSI	Zentrum Für Soziale Innovation GMBH



## Overview of WP2

### **Goals**

WP2 aims to improve existing platforms for data collection and analysis about wildlife presence, movements and behavior in Slovenia. These will include the development of an app for wildlife monitoring, combining inputs from hunters and non-hunters (e.g. outdoor enthusiast, amateur camera trappers, wildlife photographers, farmers, students). WP2 also aims to assess the capacity of CS to provide high-quality data about wildlife, by comparing data collected by citizen scientists with information collected through ecological sampling techniques, and by developing a procedure for verifying collected CS data. WP2 aims also to provide information for evidence-based wildlife conservation and management in Slovenia and raise public awareness about this topic.

### ***Research Team, WP advisors, stakeholders and extended participants***

The Research Team includes:

- Prof. Elena Bužan, University of Primorska (Leader of the CSI and Project Coordinator)
- Prof. Boštjan Pokorny, Faculty for Environmental protection and Hunting organization (Co-leader of the CSI)
- Dr. Laura Iacolina, University of Primorska (member of the Core Team)
- Dr. Jacopo Cerri, University of Primorska (member of the Core Team, data protection officer)
- Dr. Felicita Urzi, University of Primorska (member of the Core Team)
- Sandra Potušek, University of Primorska (member of the Core Team)
- Aja Bončina, University of Primorska (member of the Core Team)
- Prof. Hubert Potočnik, University of Ljubljana (member of the Extended Core Team)
- Prof. Aleksandra Perčin, University of Zagreb (ethical officer)

Relevant advisors for WP2 include:

- Dr. Francesca Cagnacci (Fondazione Edmund Mach, Member of the Advisory Board of Step Change)
- Dr. Luca Corlatti (ERSAF Regione Lombardia, external advisor for WP2 and co-author of D2.1)



Stakeholders and extended participants will include:

- Tilen Bartol (HAS), who will assist the Research Team in hunter recruitment and engagement
- Taja Pajmon Rak (Student Council of the University of Primorska), who will assist with student recruitment and engagement
- Lili Mahne (Notranjska Ecological Centre), who will assist the Research Team in CS (farmers) recruitment and engagement
- Irena Mrak (Alpine association of Slovenia), who will assist with the Research team in CS (nature lovers and photographers) recruitment and engagement
- Rok Haviček (Ministry of the Environment and Spatial Planning), who will represent the contact point with the Ministry
- Jure Čuš (Ministry of Agriculture, Forestry and Food), who will represent the contact point with the Ministry
- Mitja Stregar (Slovenian Forestry Service), who will be the contact point regarding the management policy

### ***Tasks, related deliverables and timeline***

WP2 will include six different Tasks:

- T2.1, the creation of the study design, protocols and plans, addressed by this Deliverable (D2.1). The development of D2.1 took place between October 2021 and February 2022.
- T2.1, the development of an app for Citizen Science. Currently, this task is being undergone by intensive collaboration between the core team and an external company with extensive experience with apps for CS in Slovenia. This task also focuses on the acquisition of complementary tools, namely camera traps, for the field campaign. This task is taking place between October 2021 and March 2022.
- T2.3, data collection through the field campaign and the CS initiative. This task will start in March 2022 and include four different activities, until December 2022:
  - Recruitment of minimum 100 hunters and 100 non-hunters, who will then collaborate as citizen scientists. The promotional campaign will be co-designed by the core team of WP2 and the offices for public relationships (PR) of HAS and UP





- Capacity building, where participants will be provided with information about Step Change, as well as about its goals, protocols for data collection and information about the use of the CS app
- Data collection through the citizen science app and through voluntary camera trapping
- Data collection through the deployment of camera traps over a systematic 10km lattice grid, made by members of UP and HAS
- T2.4, analysis of data collected during the field campaign, between December 2022 and April 2023. In this task, researchers will analyze data collected from: *i)* deployed camera traps, *ii)* SRNA, the citizen science app that hunters and non-hunters will use to upload their observations. A complete overview of data analysis is provided in the following chapters
- T2.5, data verification and feedback, between December 2023 and April 2023
- T2.6, engagement and communication activities



## Citizen science app

### **Overall structure**

In October 2021, UP, together with HAS subcontracted an external company to develop an app for collecting citizen science data. The chosen company was LOGOS (<https://www.logos.si>), which already developed the national platform for the game monitoring by HAS ([https://www.logos.si/Home/Produkti Lisjak](https://www.logos.si/Home/Produkti_Lisjak)).

The app was named SRNA, corresponding to the Slovenian word used for the female roe deer, one of the key species of the CS campaign. UP, together with extended core team members (dr. Pokorny and dr. Potočnik), prepared the app design in November 2021. A beta-version of SRNA was first presented in December 2021, received preliminary feedback from the core team and is currently undergoing some refinements, before its adoption. SRNA adopts two tailored layouts, for hunters and non-hunters. However, all data are centralized on a server, maintained by LOGOS, which already contains other data from monitoring programs for golden jackal and game species.

Data will follow a precise path, from collection to their archiving and re-usage:

- Citizen scientists will collect data with SRNA, from their desktop or mobile devices
- Data will flow to the server maintained by LOGOS, where they will be stored and curated
- On a daily basis, data will be transferred to two other servers, at the University of Primorska and HAS. This decentralization will be followed by quality checks and data analyses, following FAIR principles and data management roles established in the Data Management Plan (D11.2)

The centralization of observations into a single server will facilitate their curation and harmonization, while their subsequent de-centralization will safeguard Step Change against data losses.

Data collection in SRNA will involve 31 species of mammals and 8 species of birds. Mammals included are: wild boar (*Sus scrofa*), European roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*), Northern chamois (*Rupicapra rupicapra*), Alpine ibex (*Capra ibex*), Eurasian moufflon (*Ovis aries*), brown bear (*Ursus arctos*), gray wolf (*Canis lupus*), Eurasian lynx (*Lynx lynx*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), European wild cat (*Felis silvestris*), raccoon dog (*Nyctereutes procyonoides*), pine marten (*Martes martes*), stone marten



(*Martes foina*), European polecat (*Mustela putorius*), Eurasian badger (*Meles meles*), American raccoon (*Procyon lotor*), Eurasian otter (*Lutra lutra*), stoat (*Mustela erminea*), weasel (*Mustela nivalis*), domestic cat (*Felis catus*), European brown hare (*Lepus europaeus*), mountain hare (*Lepus timidus*), red squirrel (*Sciurus vulgaris*), Eurasian beaver (*Castor fiber*), coypu (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), European edible dormouse (*Glis glis*). Birds included are: capercaillie (*Tetrao urogallus*), black grouse (*Lyrurus tetrix*), ptarmigan (*Lagopus muta*), hazel grouse (*Tetrastes bonasia*), gray partridge (*Perdix perdix*), common quail (*Coturnix coturnix*), rock partridge (*Alectoris graeca*) and the common pheasant (*Phasianus colchicus*).

## App layout for hunters

Hunters will report two types of data (Fig. 1), through SRNA:

- wildlife observations, animals that they observed during their everyday activities (e.g. hunting, but also simply hiking or working in countryside/woodlands)
- characteristics of wildlife that has been harvested during their hunting activities.

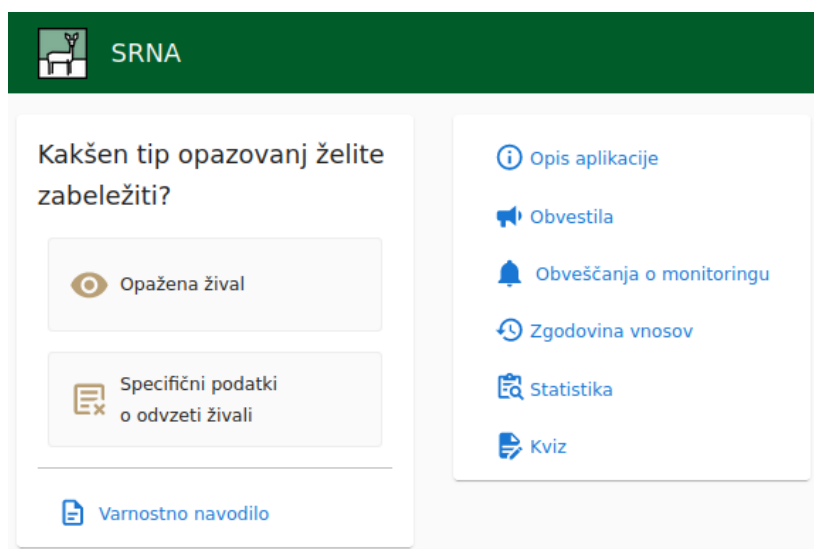


Fig. 1. Main menu for the hunters' portal on SRNA. From this page, hunters could access all the main functionalities from the app.

Compared to non-hunters, it is important to pinpoint that hunters will not collect any information regarding dead animals and roadkills. This because, they already record this information for other management purposes, and their data are already uploaded on the central server of HAS on a daily basis.



For wildlife observations, hunters included the observed species, the location of the record, the number of observed individuals and finally they also had the possibility to include extra indications through an open-ended menu. For each record, hunters can include the characteristics of each observed individual, such as the age class or sex. Moreover, it is possible for them to add a picture of each observation.

As for harvested wildlife, apart from sex and age, hunters must report the identification tag with which they had marked animals, once shot, along with sanitary-relevant details, such as injuries (fractures and wounds), traces of diseases (internal and external) and parasites found on individuals (Fig. 2).

SRNA

< Specifični podatki o odvzeti živali

< NAZAJ

11.02.2022 12:41 | Alpski kozorog | WGS: 45,5692828; 13,7536058

**Paraziti**

Nosni zolj

Stopnja zaparazitiranosti:

Ne  Blaga (do 5)  Srednja (do 15)  Večja (15+)

Podkožni zolj

Stopnja zaparazitiranosti:

Ne  Blaga (do 5)  Srednja (do 15)  Večja (15+)

Klop

Stopnja zaparazitiranosti:

Ne  Blaga (do 5)  Srednja (do 15)  Večja (15+)

Dlakožer

Fig. 2. Example of parasites and diseases, that could be reported from harvested animals. This information can be extremely precious for detecting outbreaks of infectious diseases.

## ***App layout for non-hunters***

Non-hunters will report three types of data:

- wildlife observations, animals observed during their outdoor activities
- animals that were found dead, including road-killed individuals
- pictures, taken directly from smartphone cameras



Wildlife observations include animals that non-hunters will observe during their outdoor activities. The structure of the data is similar to that of hunters, as non-hunters will have the chance to report the age and sex of individuals, altogether with their number (Fig. 3). Moreover, SRNA offers an open-ended menu for collecting information about any other relevant detail (e.g. behavior). To facilitate its usage by non-Slovenian people, such as foreign tourists, the interface of SRNA for non-hunters was also translated in English. This option can also facilitate the integration of SRNA in transboundary monitoring activities or its application in other European projects.

The screenshot shows the SRNA mobile application interface. At the top, there is a green header with the SRNA logo and the text "SRNA". Below the header, there is a navigation bar with a back arrow and the text "Opažena žival/osebek Wildlife (seen)". The main content area has a sub-header "OSTALO OTHER DETAILS" with a back arrow. Below this, there are two lines of text: "11.02.2022 15:57 | Gams (1: Neznani Neznani; ) | WGS: 45,6285006 ; 13,7836839 |" and "11.02.2022 15:57 | Alpine chamois (1: Unknown Unknown; | WGS: 45,6285006; 13,7836839 |". The main title is "Podrobnosti o opazovanju Sighting detail". Below the title, it says "Gams 1 Alpine chamois 1". There are two sections for classification: "Spol (Sex)" and "Starost (Age)". Each section has three buttons: "Moški Male", "Ženski Female", and "Neznani Unknown". The "Neznani Unknown" buttons are highlighted in green. At the bottom, there is a green arrow and the text "NAPREJ NEXT".

Fig. 3. An example of how non-hunters could classify the sex and age class of an Alpine chamois (*Rupicapra rupicapra*), spotted during an outdoor activity.

Currently, after an initial pilot phase on the beta version of SRNA, researchers from UP asked LOGOS company to allow non-hunters also to shoot pictures from the camera integrated in their mobile phones. This would allow, for example, to collect pictures of wildlife tracks and signs, which could subsequently be classified by researchers and practitioners, to increase available data about wildlife presence in Slovenia. Records of tracks and signs are particularly important for elusive species such as carnivores or the Eurasian beaver, which are seldom observed directly.



## Additional features of the app

SRNA also includes some additional functionalities, which are fundamental for engaging and evaluating citizen scientists (Fig. 4)

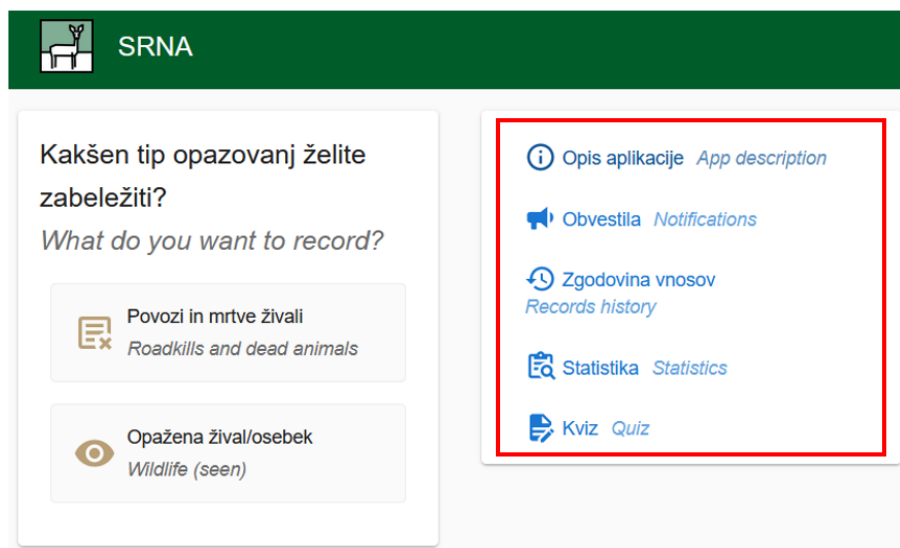


Fig. 4. The main menu of SRNA, for non-hunters. The menu allows users to access platforms for reporting observations (on the left) and to use additional features of the app (on the right, highlighted).

These functionalities include:

- a quick description of Step Change and SRNA, and about the role played by citizen scientists in wildlife monitoring and conservation in Slovenia
- a page where users could be notified from the core team of WP2 about project-related activities, as well as about news regarding wildlife in Slovenia. For hunters, a second option is available, to notify them about activities organized by HAS
- a section summarizing individual statistics. This section is currently undergoing some refinements, from the beta version, to provide participants with an overview of project records, as well as about their own observations
- an interactive quiz (Fig. 5), implemented through 1KA (<https://www.1ka.si/>), and compliant with requirements from the GDPR (<https://gdpr.eu/>), where citizen scientists could measure, and improve, their ability to recognize wildlife species. The identification quiz is one of the cornerstones of the data validation procedure. It will enable UP core team to understand more about the real capacity of citizen scientists to recognize



different species of wildlife. In the quiz, participants will be asked to evaluate 30 pictures of wildlife, randomly extracted by a pool of ~ 200 Images about large carnivores, mustelidae, rodents and ungulates. All these images have been downloaded from the internet and are under CCBY license. Thus, proper credit will be given at the end of the quiz for each picture that will be used.

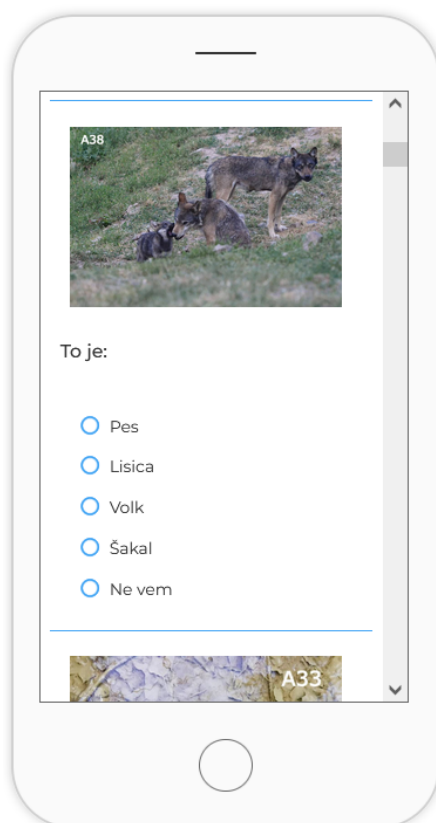


Fig. 5. A question from the quiz, where participants are asked to indicate the species portrayed in the picture, from a list of similar species: the domestic dog ("Pes" in Slovenian), the red fox ("Lisica"), the gray wolf ("Volk"), the golden jackal ("Šakal").



## Recruitment, capacity building, engagement

### ***Recruitment and capacity building***

In-presence activities for recruiting citizen scientists will be coupled with capacity building, whose main goal is to provide citizen scientists with information about Step Change, its goals, protocols for data collection and instructions on how to use SRNA.

Activities will be tailored for hunters and non-hunters and include:

- In-presence workshops for hunters (n = 2), carried out by HAS and UP. Workshops will occur at different areas of Slovenia, between April and December 2022, and they will combine the recruitment of participants and their capacity building. During these workshops, hunters will be trained on how to use SRNA for collecting data, even through on-site examples, and how to follow hygiene principles when taking parasites' photos. Moreover, those who want to contribute to wildlife monitoring through voluntary camera trapping, will receive adequate instructions on how to deploy camera traps in a way which is effective for recording wildlife (Palencia et al., 2021; Wearn and Glover-Kapfer, 2017) and for protecting individual privacy
- In-presence workshops for non-hunters (n. events = 4), co-organized with:
  - *i*) the student association from the University of Primorska (Studentska organizacija UP, <https://soup.si/si>) (n = 1)
  - *ii*) the association of young farmers in Slovenia (Zveza podeželske mladine, <https://zspm.si/>) (n = 1)
  - *iii*) the Alpine Association of Slovenia (Planinska Zveza Slovenije <https://www.pzs.si/>) (n = 1)
  - *iv*) associations for naturalistic photography, such as the Foto Klub Portrož (<http://www.fkp.si>) (n = 1)

During these workshops, non-hunters will be trained on how to install and use SRNA for collecting data, even through on-site practice sessions. Moreover, non-hunters will be trained on how to approach and record alive and dead animals, while complying with safety requirements. Workshops will occur at different areas of Slovenia, between April and December 2022

- workshops from remote (e.g. on Zoom), targeting both hunters and non-hunters. Remote workshops will have the same structure as in-presence ones and will target





citizen scientists who could not attend in-presence activities. They will also contribute to capacity building during autumn/winter 2022-2023, when in-presence activities could be constrained by further sanitary restrictions due to COVID-19. Workshops from remote will be organized from April 2022 until the end of the project. Thus, they will also contribute to maintain citizen scientists engaged until the end of project activities. For each group (hunters and non-hunters), 1 workshop from remote will be organized every six months, with the possibility of increasing their frequency if needed

Moreover, recruitment and capacity building activities for non-hunters will also be organized within the European Researchers' Night 2022-2023 in Koper. These will include a complete explanation about Step Change and the use of SRNA for collecting data about wildlife, coupled with a "treasure hunt" for wildlife in Koper and its surrounding area. This second activity will aim to reach non-hunters from the Primorska region, and it has already been proposed in October 2021 by UP. Actions from WP2 will also be presented at the national event for strengthening ties between high school/university students and universities (INFORMATIVA events - <https://www.informativa.si>).

Recruitment activities will also include promotional campaigns for encouraging non-hunters to download and use SRNA. As the app can be downloaded from a remote link, leaflets and stickers with a QR code will be left at multiple sites in Slovenia, at the time when these areas are interested by data collection through camera trapping. For example, leaflets and stickers can be left at the beginning of hiking trails, where people gather and set up their equipment, before hiking, mountain-biking or angling. The effectiveness of these campaigns at recruiting new participants will be evaluated through a treatment/control approach (see the "*Data verification and analysis*" section for further details). This quasi-experimental comparison will take place between April and December 2022, in parallel with the field campaign.

Recruitment, capacity-building and engagement activities for hunters will be spatially prioritized, to increase coverage of those areas covered by field sampling. Once researchers from UP and HAS identify areas where camera trapping will be carried out, recruitment and capacity building activities will try to reach hunters from those specific districts. This means that in-presence meetings will be organized in districts interested by data collection, and that the same hunting families will be actively targeted by HAS with direct communication. This will have the goal of maximizing the alignment between data collected by researchers and citizen scientists.



## **Engagement**

Engagement activities will be differentiated for hunters and non-hunters and they will include: *i)* in-presence workshops, *ii)* communication campaigns, *iii)* the "best CS of the month" award. In-presence meetings (n = 3) will be organized by UP and HAS, and they will aim to engage the most active local hunting families, in terms of data collection, and their neighbouring hunting districts. During these meeting, researchers from UP and HAS will visit hunting families and districts, and present preliminary findings from data collection, to keep them updated with on-going progress and to show them collected data, to better understand their importance. During these meetings, hunting families will be encouraged to talk about the reasons why they are participating to data collection, to promote participation of their neighbouring hunters as well. The same formula will be adopted for meetings with non-hunters (n = 4), co-organized with the student association from the University of Primorska, the association of young farmers, the Alpine Association of Slovenia and the Foto Klub Portrož. During these meetings, non-hunters who played a major role in data collection will be invited to share their experiences, while researchers from UP will present outputs from main data collection.

Communication campaigns will include:

- notifications via email and SMS, from HAS to hunters, focusing on updates from data collection within Step Change
- posts on the social media from UP (Twitter, LinkedIn, project webpage) and HAS (Facebook, TV channels, journal LOVEC, HAS webpage), focusing on updates about data collection within Step Change. Posts on social media will be uploaded every two weeks, to keep citizen scientists engaged
- participation to local and national radio and television shows, by partners from UP and HAS, where researchers will show the importance of data collected through SRNA and will emphasize the role played by citizen scientists

Engagement activities will also include a "CS of the month" award (n = 5). This initiative will be initially focused on hunters: members of hunting districts who collect the highest amount of data will release a short interview for Step Change, where they will talk about their experience. The interview will then be included in the monthly newsletter from Step Change and HAS webpage. Activities for engagement will be focused during the second-half of data collection,



once citizen scientists are recruited, as their main scope is to ensure their engagement, reducing drop-outs. Thus, they will be carried out between July and December 2022.

The CS of the month award will also aim to engage non-hunters, by focusing on hikers and students (n = 3). Interviews will be included in the monthly newsletters and the social media channels of StepChange, UP, the Alpine Association of Slovenia and association of young farmers in Slovenia

Engagement activities will also entail the participation of UP to the yearly conference organized by HAS, to present SRNA and introduce hunters to data collection within Step Change. The conference is expected to be organized between March and May 2022 and replicated in 2023.

### ***Retention activities***

While data collection from the field campaign will be officially closed in December 2022, WP2 will also include retention activities in 2023, aimed at encouraging data collection from CS. These activities will include:

- in-presence meetings with hunters (n = 2) and non-hunters (n = 4) during which outputs from CS and field activities during 2022, will be presented
- posts on the social media channels from UP (Twitter, LinkedIn) and HAS (Facebook), focusing on outputs from the field data collection through camera trapping carried out in 2022. Posts will be uploaded every two weeks, to sustain CS engagement
- the "CS of the month" award, those hunting families (n = 5) and non-hunters (n = 3), who engaged the most in data collection, will be interviewed for the Step Change newsletter. Interviews will then be shared on social media, to reach hunters

In March-April 2023, UP will also attend the yearly conference for hunting in Slovenia, organized by HAS. On that occasion, preliminary results from data campaign and CS will be highlighted.



## Field campaign for wildlife monitoring

### ***Overall structure***

The ultimate goal of WP2 is to test how well do CS data perform at monitoring some ecologically-relevant parameters, compared to conventional ecological census techniques (Sutherland, 2006).

Ecologically-relevant parameters will include:

- the spatial distribution of wildlife species, namely their occurrence over the entire territory of Slovenia. Measuring the distribution of species through space is important to identify key areas for their conservation, the role played by habitat connectivity and ecological barriers, as well as to design effective management policies ensuring the long-term viability of wildlife populations. Moreover, testing how well CS can measure the distribution of a certain species can be important to design rapid CS-based monitoring campaigns, whose implementation can be faster than that of conventional census techniques
- the richness of mammal and bird species that will be monitored through SRNA. Species richness can be calculated as the number of species in a certain area, and this information can identify hotspots of wildlife diversity in Slovenia, where conservation actions can be prioritized
- activity rhythms of wildlife, calculated by examining the temporal distribution of wildlife records, obtained through camera trapping. Quantifying activity rhythms of wildlife assemblages can shed light over interspecific interactions (e.g. predation, competition) as well as on the role played by human disturbance

In WP2, these parameters will be collected through three different approaches (Table. 1):

- staff from the core team will place camera traps over the national surface of Slovenia, helped by HAS and involving university MSc students. Camera traps will be put at random in a series of cells, extracted from a 1 km lattice grid. Camera trapping will be the "gold standard" to measure species distribution and richness, alongside with activity rhythms of wildlife
- Citizen scientists will use SRNA to collect data about wildlife presence across Slovenia.



Non-hunters will collect data about: *i*) wildlife observations, *ii*) animals found dead.  
 Hunters will collect data about: *i*) wildlife observations, *ii*) animals shot during the hunting season and culling plans

Data collection will be opportunistic and thus, data obtained from SRNA will be used only to measure species distribution and alpha-diversity. They will not be used to measure activity rhythms of wildlife, as this measure will almost certainly be biased by patterns in the outdoor activity of citizen scientists

- Citizen scientists, both hunters and non-hunters, will also upload data obtained from voluntary camera trapping on SRNA. As camera traps record wildlife continuously in time, these data will be used to measure the spatial distribution of species and alpha-diversity, as well as to measure activity rhythms of wildlife

Data collection method	Actors involved	Ecological parameters
Camera trapping (systematic)	Core team Members of HAS MSc students	Spatial distribution Alpha diversity Activity rhythms
Camera trapping (voluntary)	Citizen scientists (hunters and non-hunters)	Spatial distribution Alpha diversity Activity rhythms
Wildlife observations	Citizen scientists (hunters and non-hunters)	Spatial distribution Alpha diversity
Dead animals and roadkills	Citizen scientists (non-hunters)	Spatial distribution Alpha diversity
Harvested animals	Citizen scientists (hunters)	Spatial distribution

Table 1. Overview of data collection method, subjects involved and ecological parameters that will be estimated.

Systematic camera trapping will be based on an initial pool of 40 camera traps, which will be eventually extended by supplementary devices, in case these become available to UP or HAS from other research activities. Currently, UP is collecting quotations for camera traps from major suppliers of wildlife research equipment.

Moreover, WP2 will allow to quantify the extent to which in-presence and remote activities for the recruitment and engagement of citizen scientists can work in practice, by increasing both the adoption of CS apps and their continuative usage by citizen scientists. Although this second information might look trivial, actually little empirical evidence about the effectiveness of recruitment/engagement initiatives, collected through rigorous approaches, is available.



## ***Sampling strategy***

Systematic camera trapping, carried out by UP and members of HAS, will be based on the random placement of camera traps, with a twofold approach.

First, the random extraction of squared cells, from a lattice grid with a 10km cell structure, covering an area around 5 hunting districts in Slovenia (Kočevje, Škale, Oljka, Velenje and Senožeče) characterized by the presence of the most heterogeneous wildlife assemblages in the country. Then, the extraction of 12 random points in each cell, where camera traps will be positioned for a timespan of 30 days, the minimum amount of time suggested for faunal inventories. To increase spatial coverage, and minimize the re-capture of the same individuals of territorial species, the position of camera traps will be changed every 15 days (Rovero et al., 2013; Fig. 6).

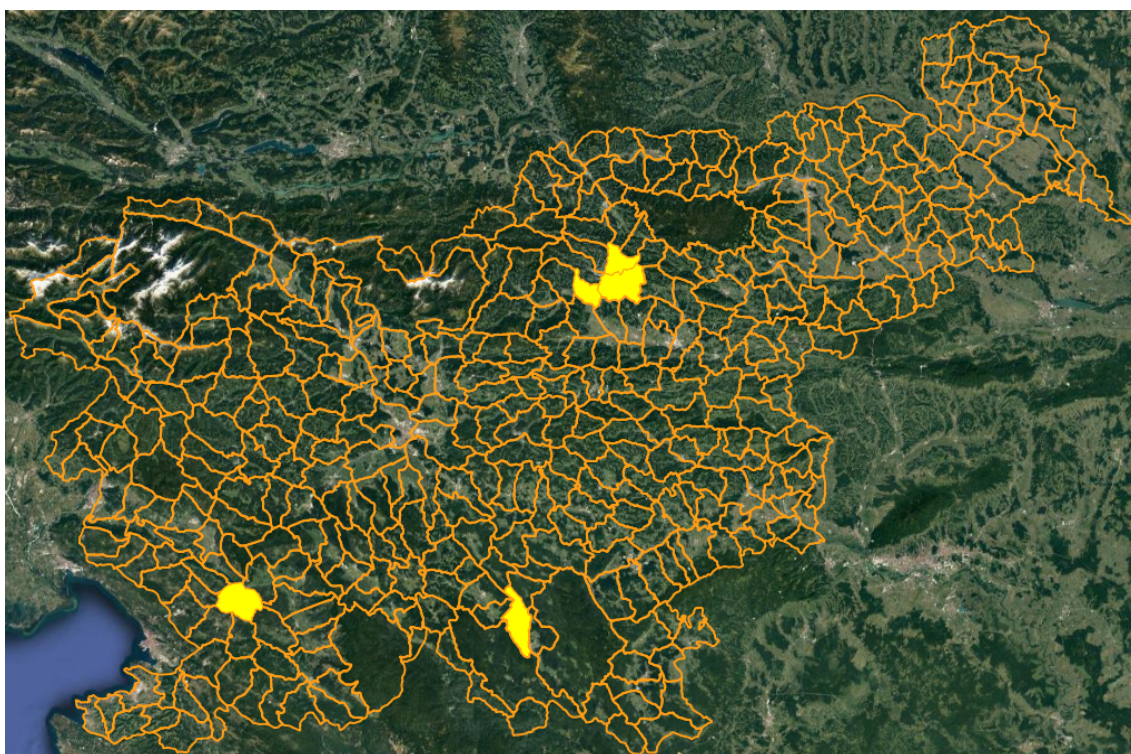


Fig. 6. an example of the five hunting districts In Slovenia, around which the squared grid will be designed.

Therefore, every 30 days, 3 cells from the lattice grid will be covered at the same time with camera trapping. This will ensure a rapid rotation of cells from the national grid, from April to December 2022.





The extraction of squared cells will be without replacement, so that each cell cannot be selected multiple times from the overall sampling frame. The extraction of sampling points for camera traps will be at random. However, before generating random sample points with a GIS software, ineligible land covers will be excluded: these will include large water bodies (e.g. lakes) as well as urbanized areas, to minimize biases. Urbanized areas will be identified based on the 2018 version of the Corine Land Cover (<https://land.copernicus.eu/pan-european/corine-land-cover/clc2018>). Simple random sampling will be adopted, without any particular strata.

During field sampling, at each one of the extracted cells from the grid, UP will also focus on administering brochures and stickers to hikers, at hiking points and trails, to encourage them downloading SRNA and collecting data about wildlife. On each one of these occasions, 3 control grids from the cells, among those that had not been selected from field sampling, nor sampled in the past, will be extracted. Brochures and stickers will be administered at hiking trails on these cells. A comparison in downloads of SRNA between control and treatment areas will be used to evaluate the effectiveness of these communication campaigns.

### ***Data acquisition from camera trapping***

Camera traps will be placed at 12 randomly chosen points in each cell. Each camera trap will have the following settings:

- wildlife records will be acquired through videos, not pictures. The use of videos will maximise species recognition, while also providing researchers with information about wildlife behavior. Each video will have a maximum duration of 1 minute
- each camera trap will have an activation time of 0.2 - 0.3 seconds
- videos will have a resolution of 10 - 16 Mp
- a minimum interval of 1 minute between consecutive videos will be set up. This will reduce the number of times that camera traps record the same individual on consecutive videos
- camera traps will be positioned according to best practices for camera trap deployment, while minimizing disturbances and reducing the risk of being stolen (Palencia et al., 2021; Wearn and Glover-Kapfer, 2017). Their positioning will however be evaluated based on the characteristics of each sampling point
- each camera trap will have a small sticker, on its cover, with the logo of the Step Change project, and a QR code redirecting to a webpage with quick overview of ongoing



research activities, relevant contacts from the project for any communication and its legal authorization from competent authorities. This practice will provide people, who will eventually notice the camera traps, with adequate instructions about ongoing sampling activities

- In case the location of camera traps is different from the one generated by the GIS code, for practical reasons (e.g. excessive visibility), the coordinates of its new positioning will be recorded through a GPS

Camera traps will be checked every 15 days, when they will be positioned at a second location, randomly generated by a GIS software. This practice will avoid the repeated sampling of the same subset of individuals, because some wildlife species are territorial. Moreover, it will also increase the probability of detecting new species. Every time that camera traps are checked, their SD cards (32Gb) will be replaced with empty ones, and their batteries will be checked and in case replaced with new ones. While this operation could be assisted by voluntary members of HAS, videos will be downloaded from SD cards only by members of UP and HAS included in Step Change. This will be fundamental for ensuring an adequate level of data protection. Before their engagement in project activities, volunteers from HAS who want to collaborate with camera trapping placement and checking, will need to attend a mandatory training workshop of 2 hours, where they will be instructed about data collection and basic safety procedures (e.g., they should hand retrieved SD cards as soon as possible to UP of HAS researchers). In April 2022, the duration of camera trap batteries and SD cards will be evaluated with a pilot sampling, and times for replacing them will be adjusted accordingly, in case.

SD cards will be checked at UP, and pictures will be immediately stored on servers. Videos containing human beings will be immediately removed, although their metadata (e.g. time, date, number of persons and human behavior) will be recorded separately for further analyses. Images and videos from camera traps will be stored with dedicated softwares (e.g. camtrapR, Niedballa et al., 2016). The use of open-source software will allow to create a harmonized workflow, to collect, process, and analyze camera trapping data in a way which is reproducible and with a data structure which can be easily integrated with that of other large-scale data collection initiatives, such as EuroMammals (<https://euromammals.org/>) or Snapshot Europe (<https://www.ab.mpg.de/358074/snapshot-europe>).





## ***Acquisition of CS data through SRNA***

As explained previously, SRNA will allow both hunters and non-hunters to collect data about wildlife presence. Moreover, SRNA will allow users to update observations done through amateur camera trapping.

Records will be automatically generated by the software, and they will be centralized into a server managed by Logos, where they will be curated and afterwards transferred to servers at UP and HAS on a daily basis. For each record, the following attributes will be recorded:

- Date and hour
- Anonymized ID of the user
- A dichotomous variable indicating if citizen scientists are hunters or non-hunters
- Coordinates of the location
- A categorical variable indicating if observations have been obtained through direct observations, or the deployment of camera traps
- An ID variable associating a specific recoding from the server to the spreadsheet, to retrieve uploaded entries and associate them to records. Thus, in case that multiple individuals are observed from the same records, some data will be nested.
- A variable indicating the type of data for hunters (harvested wildlife, observations) and non-hunters (observations, animals that were found dead)
- Information about each record:
  - Species
  - Number of individuals
  - Characteristics of each individuals (e.g., age, sex, behavior, diseases, injuries, tags of harvested individuals), which in SRNA should be included for each individual that was observed.
  - Other relevant information about the record

Collected data will be integrated with data from camera trapping by spatial overlapping between coordinates of observations and the spatial location of cells within the 10 km lattice grid.



## Data verification and analysis

### *Quality checks*

The overall reliability of data collected by citizen scientists through SRNA will be evaluated in three different ways.

First, data will be compared to the national database collected by HAS, about harvested animals and roadkills. HAS established the dataset in 2006, through an on-line information system for the systematic monitoring and archiving of data. Hunters are obliged to record roadkills throughout the entire country, and to upload harvested individuals of game species. Collected data are uploaded on a daily basis to the Central Slovene Hunting Information System and they are particularly reliable as hunters have to exactly report roadkill and harvested animals, to meet harvest plans. Harvest plans include total “elimination quotas” (i.e., hunting bags, plus all registered mortality regardless the causes), and hunting ground managers can be fined by 4,200 up to 125,000€ when these quotas are not fulfilled. Therefore, hunters are highly motivated to report harvested individuals as well as to report all roadkills and dead wildlife they find, as this helps them meeting their management objectives and avoiding fines. On the other hand, over-reporting is prevented by the fact that hunters have to collect, prepare and hand over relevant proofs on individuals that are found dead (e.g. left hemimandibles for all ungulates). This approach will allow to identify, and eventually remove, anomalous records of wildlife from areas where species are extremely unlikely to occur, and duplicated observations of the same individuals. This practice can be particularly helpful for data collected through voluntary camera trapping, as it will not possible for citizens to upload their videos on SRNA.

Moreover, the use of the quiz functionality, embedded in SRNA, will allow to have an overall perspective about the proficiency at wildlife recognition from hunters and non-hunters, and to assess the role played by their professional qualifications and level of educations.

Finally, data quality will also be assessed by asking citizen scientists to provide their feedback about data collection and the use of SRNA. This self-assessment activity will provide the core team with insights from citizen scientists' perspectives about the experimental campaign and the best survey areas and field conditions that influenced their data collection. Feedback will be obtained by means of interviews during in-presence activities, as well as by on-line polls on social media, mailing lists and SRNA itself. Feedback will be collected at the end of the field activities during 2022. Its outputs will be useful for calibrating further engagement activities for 2023 and the aftermath of the project.



### ***Data analysis: spatial distribution of records and species richness***

The spatial distribution of wildlife reports will be compared through the Cohen's Kappa, a measure of agreement, frequently adopted to compare evaluations of a series of objects between different raters, and which can then be used to measure the level of spatial agreement between two maps (Tattoni et al., 2019).

For each species:

- Records from SRNA, collected by citizen scientists, will be associated to each 10km cell of the grid used for field sampling with camera trapping. Records will be distinguished between those of hunters and non-hunters, and between those arising from wildlife observations and voluntary camera trapping
- Records from the camera trapping survey, carried out by UP and HAS, will be used to classify each species as present or absent from a 10 km cell
- Supplementary Information from other CS apps, such as iNaturalist (<https://www.inaturalist.org/>) or iMammalia (<https://mammalnet.net/it/imammalia>), will be downloaded and used to record species in each cell. This will constitute another baseline of data, collected from prolonged CS-based surveys, to which data from Step Change will be compared

Then Cohen's Kappa will be used to measure the spatial overlap between these three types of data. Particular attention will be paid at comparing spatial overlap in CS data collected by hunters and non-hunters, to highlight differences in the species-specific data provided by these two groups of people. Agreement between different maps will be reached for values of the Cohen's Kappa higher than 0.70.

In case that species-specific data are spatially unbalanced, species distribution models (Guisan et al., 2017), combining species-specific records from SRNA with information from relevant environmental covariates, will be used to predict probabilities of occurrence for each species, and also to adjust for spatial heterogeneities in sampling effort (e.g., Stolar & Nielsen, 2015).

Species richness at sites interested by both systematic camera trapping and data collection by citizen scientists will be compared by means of species accumulation curves (Gotelli and Colwell, 2001). Species accumulation curve estimates the amount of species diversity at a certain site by modelling the total number of species that are found for increasing sampling effort. In WP2 there will be a comparison between data collected through *i*) camera trapping from UP/ HAS, *ii*)



voluntary camera trapping from hunters and non-hunters, *iii*) wildlife observations from hunters and non-hunters. These groups of data will be compared:

- in their predicted number of species, through the Spearman's correlation Index
- in the shape of their accumulation curves, to reveal the efficiency through which sampling effort could progressively reveal wildlife assemblages (Kelling et al., 2015)

### ***Data analysis: rhythms of activity***

The rhythm of activity of different wildlife species will be compared between observations collected through: *i*) systematic camera trapping, performed by UP and HAS, *ii*) voluntary camera trapping, performed by CS.

Kernel density estimates (Ridout and Linkie, 2009) will be used to measure the overlap in the activity patterns of each species between the two sources of data, if observations from voluntary camera trapping are collected from sites with comparable environmental characteristics. In case that the two sources of data are collected at sites that differ in some relevant environmental attribute, affecting the rhythms of activity of wildlife (e.g., human activity, Oberosler et al., 2017; measured through the Human Footprint Index, Venter et al., 2016), we will use Generalized Additive Models based on cyclic regression splines (Cunningham et al., 2019) or Bayesian Generalized Linear Models based on a von-Mises distribution (Cremers and Klugkist, 2018) to compare these two groups of data, while adjusting for differences in environmental conditions.

### ***Data analysis: evaluation of recruitment campaigns based on flyers and stickers with the QR code***

As explained previously, recruitment of new citizen-scientists, especially non-hunters, will also be based on communication campaigns based on flyers and stickers containing:

- a short Introduction to Step Change and activities within WP2
- a brief overview of SRNA and its potential use for wildlife monitoring
- a QR code for downloading and installing SRNA on mobile devices

Leaflets and stickers will be left on hiking trails and at mountain huts or other facilities where hikers and other people practicing outdoor activities (e.g., mountain bike, photography, angling) aggregate. Therefore, they can be useful for recruiting new participants in those areas covered by systematic data collection through camera trapping, at a minimum cost. Once a sticker is



sticked to the pole of a hiking trail panel, or to the door of a mountain hut, it can be noticed by hikers and therefore drive them to download and use SRNA.

To date, few studies evaluated the effectiveness of on-site communication campaigns (e.g., panels, Abrams et al., 2019), but this goal can be achieved by measuring the amount of extra records produced in areas interested by communication campaigns, and by comparing them to records from uncovered areas. Therefore, they can be evaluated through a "treatment-vs-control" approach, namely:

- when a certain square of the 10km lattice grid is sampled by camera trapping activities, members of the core team will administer leaflets and stickers at hiking facilities. These facilities will be identified based on digital maps of hiking trails or from OpenStreetMap. These units will constitute the "treatment group"
- other units of the lattice grid, unaffected by communication activities, will be the control units.
- CS records will be obtained through SRNA on a 24/7 basis
- Causal Impact analysis, through Bayesian Structural Time Series will be used to quantify the effect of communication campaigns, over CS records, compared to the control group (Brodersen et al., 2015)

### ***Data analysis: evaluation of in-presence and remote recruitment and engagement activities***

As mentioned in the previous section, WP2 will also include recruitment and engagement activities, through in-presence meeting and remote activities, with both hunters and non-hunters. These two activities have different scopes and thus they should be evaluated separately:

- Recruitment activities aim to encourage people to join Step Change, so they aim to increase the total number of app downloads and, subsequently, the total number of records.
- Engagement activities aim to encourage citizen scientists to keep recording wildlife on SRNA, counteracting the natural decrease in participation that might happen through time.



The biggest issue in their evaluation is the lack of clearly identifiable control units: recruitment/engagement activities from remote target hunters and non-hunters throughout the country and therefore it is not possible to establish treatment and control group, as every citizen is potentially exposed to communication activities on the Internet. Moreover, even if it is possible to assess the location of records on SRNA, it might not be possible to have the geographic location of users downloading SRNA. These two elements prevent the classic calculation of the average treatment effect (Cunningham, 2021).

However, it is still possible to see if these activities spark an anomalous increase in the total number of records and SRNA downloads, in the time soon after their implementation. These differences will be detected through anomaly detection techniques (Fernandéz-Bellon and Kane, 2019). Moreover, as we expect engagement activities to trigger the interest of citizen scientists towards data collection within Step Change, we will assess if they also produce some change in the evenness of records across wildlife species (e.g., through the Gini coefficient). In case they are successful, in their aftermath records should become more balanced across different species, as people should become more motivated at recording a wider range of species, including those they are not normally interested in.

We will also see if recruitment and engagement activities are capable of producing wider changes in the overall interest of the Slovenian society towards wildlife, biodiversity and nature, by analyzing changes in internet searches about the various species, soon after recruitment and engagement events. Namely, we will focus on GoogleTrends and Wikipedia, as these two sources represent the most available sources of information for laypersons about wildlife. ChangePoint and anomaly detection methods will be used for detecting changes in the overall volume of internet searches.



## Expected outputs

### ***Deliverables***

Apart from these research protocols (D2.1), WP2 will produce three other deliverables:

- SRNA, the data collection software (D2.2). The software is currently being completed by Logos, in line with its expected deadline (March 2022) and a beta version is already available. SRNA will be used for the entire duration of Step Change and it will remain available even after the conclusion of project activities, when it could be used for further data collection initiatives.
- An experimental campaign report and policy brief about the use of CS for wildlife monitoring in Slovenia (D2.3). The campaign report will include findings from systematic camera trapping, as well as from the main outputs of data collection by citizen scientists. These two documents will be prepared by February 2023.
- A validation approach for CS data in wildlife monitoring (D2.3). This protocol will show how it is possible to triangulate between different sources of data, including ecological sampling techniques, hunting bags data and datasets about roadkills, to assess the quality of citizen science data. Moreover, they will show how to design survey inquiries and interviews to measure feedback about CS data collection, by using activities from WP2 as a blueprint. The validation approach will be available in June 2023.

### ***Scientific publications on peer-reviewed journals***

Outputs of data analysis will be published through at least three scientific publications on peer-reviewed journals. These will be:

- A study comparing data collected by citizen scientists through SRNA and by the core team through professional camera trapping, in terms of the presence/absence of wildlife species, species richness and rhythms of activity of wildlife. This paper will summarize findings about the evaluation of CS data collection. Potential journals include Scientific Reports, Biological Conservation, PlosOne, PeerJ or the Journal for Nature Conservation.
- A study comparing the evaluation of recruitment and engagement activities, both in presence and from remote, on CS data collection by hunters and non-hunters, as well as on the total volume of internet searches on Google and Wikipedia. This paper will



summarize findings about the effectiveness of these activities over CS recruitment and engagement, as well as over the broader public interest in Slovenia towards wildlife. Potential journals could be People and Nature, Environmental Communication, Biological Conservation, the Journal for Nature Conservation or Human Dimensions of Wildlife.

- A study showing how visual-based quiz can be used to measure the extent to which citizen scientists could accurately distinguish between different species of wildlife, and how the availability of integrated field guides can increase their classification accuracy. Potential journals could be People and Nature, Biological Conservation, the Journal for Nature Conservation, Hystrix the Italian Journal of Mammalogy or Human Dimensions of Wildlife.

Considering that average publication times range between 12 and 18 months, data analysis will be carried out in the semester after the end of data collection from the field, between January and June 2023. This will maximize the chances of publishing scientific findings on journals within the expected end of Step Change, in March 2024, and to disseminate scientific findings on dedicated social media channels.

Gold Open Access will be used for at least one scientific paper, as available funding has been dedicated within Step Change. Anyway, Green Open Access will be granted for each scientific publication, by archiving preprints, altogether with reproducible datasets and software codes.





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