InsectsCount: a pollinator monitoring app with gamification tool.

Deliverable D4.3

2 May 2024

Michiel Wallis de Vries[1], Bas Oteman[1], Nora Thierry[1], Ineke Radstaat[1], Clara Pietro[2], Elena Contel[2], Kira Keini[2], Suresh Chithathur[2], Alice Mauchline[3], Amelia Hood[3], Erik Öckinger[4], René van der Wal[5], Ignasi Bartomeus[5]

[1]De Vlinderstichting (DVS), [2]Scienseed
[3]University of Reading (UREAD), [4]Sveriges lantbruksuniversitet (SLU)
[5]Estación Biológica de Doñana (EBD-CSIC)

SHOWCASE

SHOWCASing synergies between agriculture, biodiversity and Ecosystem services to help farmers capitalising on native biodiversity

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862480.

Prepared under contract from the European Commission

Grant agreement No. 862480
EU Horizon 2020 Research and Innovation action

Project acronym:	**SHOWCASE**
Project full title:	**SHOWCASing synergies between agriculture, biodiversity and Ecosystem services to help farmers capitalising on native biodiversity**
Start of the project:	November 2020
Duration:	60 months
Project coordinator:	Prof. David Kleijn Wageningen University
Deliverable title:	Gamified visualization tool integrated with the monitoring app.
Deliverable n°:	D4.3
Nature of the deliverable:	Demonstrator
Dissemination level:	Public
WP responsible:	WP4
Lead beneficiary:	DVS
Citation:	Wallis de Vries, M.F. Oteman, B., Thierry, N. Pietro, C., Contel, E., Keini, K., Chithathur, S., Mauchline, A.L., Hood, A.S., Öckinger, E. & Bartomeus, I. (2024). *InsectsCount: a pollinator monitoring app with gamification tool*. Deliverable D4.3 EU Horizon 2020 SHOWCASE Project, Grant agreement No 862480.
Due date of deliverable:	Month n° 36
Actual submission date:	Month n° 36
Submission version 2:	Month n° 41
Submission version 3:	Month n° 43

Deliverable status:

Version	Status	Date	Author(s)
1.0	Final/Draft	27 October 2023	DVS, Scienseed, UREAD, SLU, CSIC
2.0	Revision	25 March 2024	DVS, Scienseed, UREAD, SLU, CSIC
3.0	Revision	2 May 2024	DVS, Scienseed, UREAD, SLU, CSIC

Table of contents

Preface

To ensure engagement of farmers, conservationists, and citizens in promoting biodiversity, the project SHOWCASE emphasizes that we should establish a bidirectional communication between scientists and citizens. Collecting data on biodiversity can help this dialogue by getting people involved in recording and identifying species and, ultimately, in monitoring and evaluating the impact of management practices on biodiversity. To that end, we have developed a monitoring app for recording and counting pollinators in the context of management practices and the availability of flower resources. The potential use of this mobile app is being explored and tested in Sweden, United Kingdom and Spain. To encourage the use of the app, gamification elements have been added, which challenge users with various recording targets and reward them with specific badges.

Summary

Pollinator monitoring is on the rise, but besides its contribution to the knowledge on status and trends of pollinators, it can also be an instrument to raise awareness about farmland biodiversity and engage farmers and citizens in caring for and promoting biodiversity. To this end, we developed the monitoring app *InsectsCount* to record and count flower-visiting insects. The app was furnished with gamification elements to stimulate recorders to collect further data. As far as we know, this app is the first to combine pollinator monitoring and gamification.

The mobile app was developed as a progressive web application (PWA) for field use in combination with online access to a website for data visualisation and further information. Users can choose from three different observation methods: 15-minute counts, flower patch counts and transect walks as well as record special observations. For beginners, the app can be used to count at the level of easily identifiable species groups, such as butterflies, bumblebees and hoverflies. For more advanced recorders, counts can also be carried out at species level. Species and flowers can be tailored to the set of species potentially present in individual regions, i.e. the Experimental Biodiversity Areas (EBAs) in the context of SHOWCASE, and in the local language. Users can view their observations online on accompanying webpages and compare their results to those of others in the same region.

Feedback on the observations is accompanied by gamification in the form of badges that reward different recording efforts. Also, competitive challenges can be actively launched by regional administrators.

The app is freely available, and the source code is accessible for further use.

1 Introduction

The EU project SHOWCASE is dedicated to the integration of biodiversity into farming practices. However, to ensure engagement of farmers, conservationists, and citizens in monitoring biodiversity, Task 4.3 aimed to establish a bidirectional communication between scientists and citizens and foster healthy communities of practitioners.

We intended to cooperate with and build on the existing *Vlindermee* app. This app focused on citizen science through standardised butterfly counts in gardens and on people's holiday destinations. The app had 2460 active users in 2017 and this increased to 3535 in 2021. Soon after the start of the SHOWCASE project, however, we had to conclude that we needed to find an alternative. First, the developer of *Vlindermee* did not want to continue its maintenance and further development. Second, even if the developer would have made the source code fully available, the long-term stability of the *Vlindermee* app could not be guaranteed anymore, because of the rapidly increasing cybersecurity demands. As a consequence, *Vlindermee* is not functional anymore. Hence, we decided to engage in an extensive mitigation effort to develop a new system, which finally resulting in the *InsectsCount* app.

Before engaging on the development of a new app, we explored alternative apps that might cover the requirements we needed by carrying out a market analysis. The main functionalities for the citizen science that we aim at in SHOWCASE are: 1) a capacity to accommodate multiple languages allowing a Europe-wide cover, 2) standardised counts allowing evidence-based assessments of biodiversity, 3) capacity to record information on land use and management to enable learning from experience, 4) gamification challenges to engage users, 5) regional community building to promote a bi-directional communication between farmers and citizen scientists.

2 Market analysis

The key question behind the market analysis was: which apps are currently available that meet all the above criteria that we need in SHOWCASE. In doing so, we chose to focus on flower-visiting insects as indicators of farmland biodiversity, both because of their functional role in pollination of crops and wild flowers and because of their appeal to citizen scientists, which has been especially well developed in recording and monitoring butterflies.

We thus carried out a market analysis of potential competition for a new SHOWCASE app by comparing the number of users of existing apps and their strengths, weaknesses and strategies. We focused specifically on the app functionalities as outlined above against existing apps available from Google Playstore that also allow counts of flower-visiting insects in Europe. In dealing with the capacity for standardised counts, we distinguished three types of counts: time-effort counts with location tracking, flower-visit counts and fixed transect counts.

We found nine potentially competing apps, listed in Table 1. It can be readily seen from the table that none of these apps fulfil all the critical criteria that we identified as important for the desired SHOWCASE app. With respect to the individual criteria, the outcomes were as follows:

- Multiple languages and Europe-wide cover: not available in Spipoll, FIT count, IRecord and Naturbasen;
- Time-effort counts with track recording: not available in iNaturalist, ObsIdentify, IRecord, Spipoll, FIT count and Naturbasen;
- Flowerpatch or Flower-Insect timed (FIT) counts: only available in Spipoll and FIT count;
- Fixed transect counts represent a third type of standardised counts and are currently only made available for the European Butterfly Monitoring Scheme (EBMS) and can be accommodated only by the ButterflyCount app;

- Recording information on land use and management: not available in any of the nine apps;
- Gamification challenges: only available in iNaturalist and ObsIdentify;
- Regional community building: only available in iNaturalist and ObsMapp

In conclusion, we decided that there was an open niche for the development of a new app to meet the desired objectives outlined in the SHOWCASE project. The number of actual users varies widely between apps, from >1000 to several million. The focus on standardised counts and regional user communities can be expected to set a limit to the number of users. On the basis of the experience with the *Vlindermee,* we envisage an estimate of a potential of 1000-5000 users as realistic.

Table 1: Comparison of app functionalities between potential competitors for the desired SHOWCASE app to record flower-visiting insects in Europe; listed in decreasing order of the number of criteria fulfilled by the app.

App name	Region	By	Flower-visiting insect groups	Number of downloads	Criteria fulfilled	Multiple languages	Time-effort count with tracking	Flower-patch count	Fixed transect counts	Regional communities	Meta-data on land use	Feedback to users	Gamification
iNaturalist/Seek	Worldwide	California Academy of Sciences	All	1 mio+	4	yes	no	no	no	yes	no	yes	yes
ObsMapp	Europe	Stichting Observation International	All	100K+	4	yes	yes	no	no	yes	no	yes	no
ObsIdentify	Europe	Stichting Observation International	All	500K+	3	yes	no	no	no	no	no	yes	yes
NaturaList	Europe	Biolovision Sàrl	All	100K+	3	yes	yes	no	no	no	no	yes	no
Butterfly Count	Europe + other countries	Centre for ecology and hydrology	butterflies moths, bumble-bees	5K+	3	yes	yes	no	yes	no	no	no	no
Spipoll	France	OPIE, Museum Nat. Hist. Naturelle	All	5K+	2	no	no	yes	no	no	no	yes	no
Fit count	British Isles	Centre for ecology and hydrology	Not at species level	1K+	2	no	no	yes	no	no	no	yes	no
IRecord	UK	Centre for ecology and hydrology	All	10K+	1	no	no	no	no	no	no	yes	no
Naturbasen	Denmark	Naturbasen.dk	All	10K+	1	no	no	no	no	no	no	yes	no

3 App development

On the basis of the market analysis, we set out to develop a new app, *InsectsCount*, with several unique selling points*:*

1. accommodating all three of the standardised counts that are required for monitoring insect richness and abundance.
2. allowing to record information on land use and management, which is key to gain understanding about beneficial management types for flower-visiting insects.
3. permitting flower-Insect timed counts throughout Europe.
4. Another strong point is the emphasis on building regional communities of practice, which is possible in iNaturalist and ObsMapp, but we have aimed to encourage

learning-by-doing more prominently and facilitating this approach through the option to record land use and management.

Thus, *InsectsCount* should be offering an added value in comparison to other biodiversity recording apps. The aim is not to outcompete current apps, but to complement them by offering a more complete app for power users that require specific features not found in generalist observation recording apps.

It should be noted that in order to compensate for the setback that building on the *Vlindermee* proved impossible, De Vlinderstichting had invested more than 1 person month work for the development of *InsectsCount* in addition to the available funding from the SHOWCASE project.

The focus of *InsectsCount* is to record standardised information on flower-visiting insects in the context of citizen science engagement, with opportunities for collaborative gaming, where participants within a regional user group (i.e. a so-called EBA or experimental biodiversity area) are stimulated to record biodiversity by receiving feedback on their observations and participating in competitive challenges (e.g. rewarded by scores or badges). This offers potential to broaden the outreach of the project to supporters of biodiversity conservation by increasing their engagement with farming communities in citizen-science projects. Farmers will be able to collect their own biodiversity data and/or use the recorded information to take specific actions in their farm.

In the following chapters we first give a description of the app, we outline the accompanying guidelines for users and admins and in reflect on its implementation and future perspectives, which have been outlined in more detail in the business plan. Finally, we refer to the repository, where the source code of the app can be accessed.

4 App description

The focus of the mobile app *InsectsCount* is on recording flower-visiting insects as biodiversity targets. Flower-visiting insects provide a link to local insect diversity as well as the provision of ecosystem services through pollination. Moreover, this focus allowed us to benefit from extensive experience on the use of citizen science in recording and monitoring butterflies, as a popular group of flower-visiting insects.

The app offers different options for counting flower-visiting insects. It can be tailored to the set of species potentially present in individual EBA regions and in the local language. The accompanying website offers an environment to view and edit observations, to seek further help for identification and it provides gamification opportunities. These will be described in more detail in the following paragraphs.

4.1 Monitoring app

The app was designed as a progressive web application (PWA) to develop the app. This overcomes the problem that the ever-increasing technical requirements following continued updates for both Android and Apple smartphones might not be met in the absence of structural funding for maintenance. Hence, the app should be able to continue running after the completion of the SHOWCASE project. Additionally, using a PWA allows a broader spectrum of phones to be used, as even relatively old devices can use PWAs.

A PWA is designed to work on any browser that is compliant with the appropriate web standards. This avoids considerable efforts for updating and ensures that it can be used on most smartphone types. It uses the browser cache and can therefore function offline. It can be included in regular App stores. Data from observations can be uploaded to a central

database when a user is online. The main limitation is that the size of the app should be limited to allow storage in cache memory. This should not pose any problem for data collection, except that the app needs an online connection, should a user want to consult background information on, for example, species identification, as this information is not stored in the app itself. Access to the app and the supporting website is gained through https://insectscount.eu/.

4.1.1 Regional use

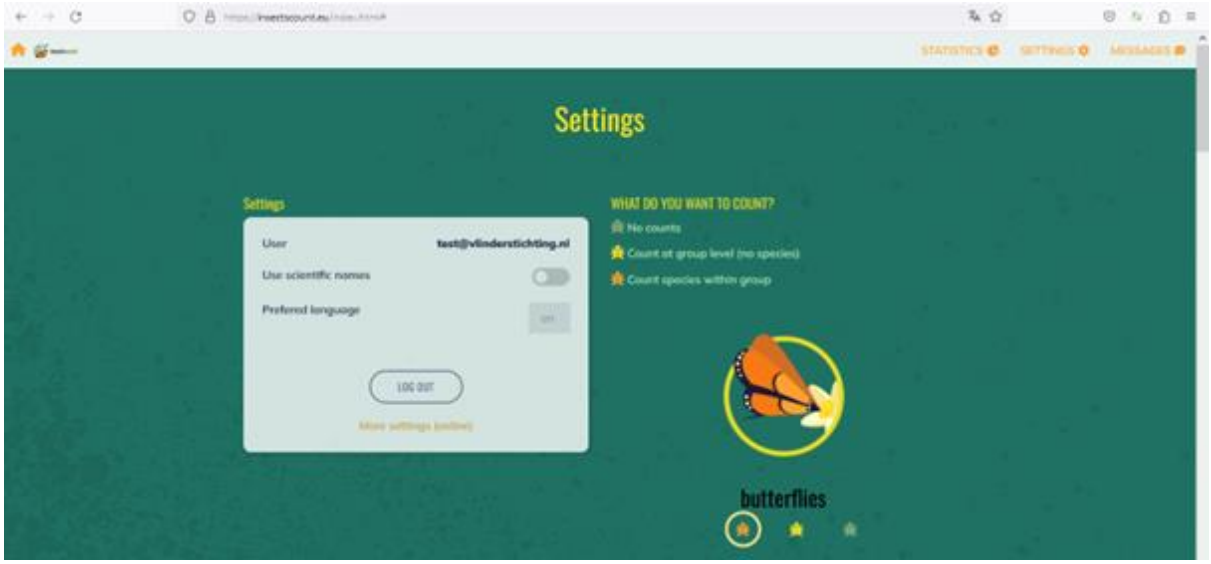
Bi-directional communication is facilitated by regional admins who coordinate the user community in a specified region. Admins are able to define the geographical scope of the region, the management options and habitats available to record, translate standard app texts, manage user accounts, have access to recorded data and post push messages to regional users (e.g. about gamification challenges, upcoming events, interesting species to be observed or that have been recorded by others) to engage users in using the app.

Species lists within insect groups and flower taxa can be made region-specific and edited by the admins. Rare and 'difficult' species will be typically excluded or grouped to facilitate identification.

4.1.2 User settings

Users are able to set up their personal account and indicate their preferences: to join a regional group, to share their data, to choose their language, to specify what they want to count and if they want to use common or scientific names of species (groups) and, finally, if they want to share their data with other users.

It is possible to record the abundance of flower-visiting insects at the level of species groups, i.e. for butterflies, moths, bumblebees, solitary bees, honeybees, hoverflies, other flies (Diptera), beetles, bugs and wasps. Optionally, butterflies and bees can also be recorded at species level; for other flower-visiting insects identification at species level is beyond the capacity of most citizen scientists and has therefore not been made available at present, but this can be easily extended in the future if needed.

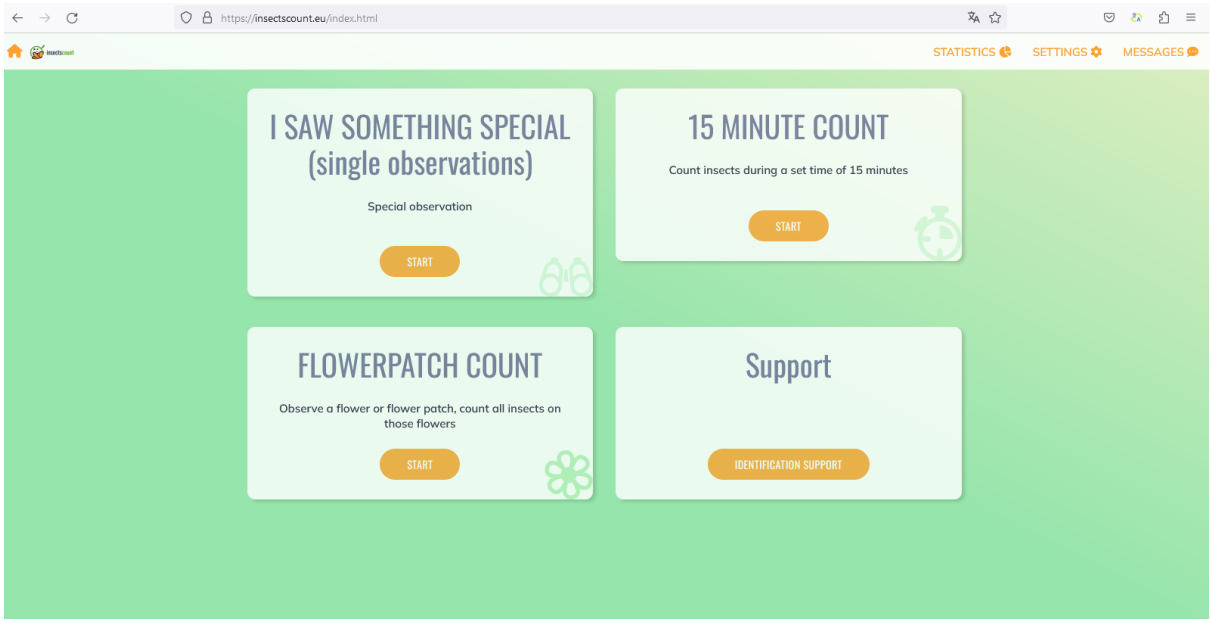


4.1.3 Recording options

We decided to offer four types of recording flower-visiting insects to the users. The focus lies on recording by following standardised counting protocols in order to facilitate statistical processing of the data for monitoring purposes. In addition, however, we felt that there is a need for observers to record special incidental observations outside these standardised count events.

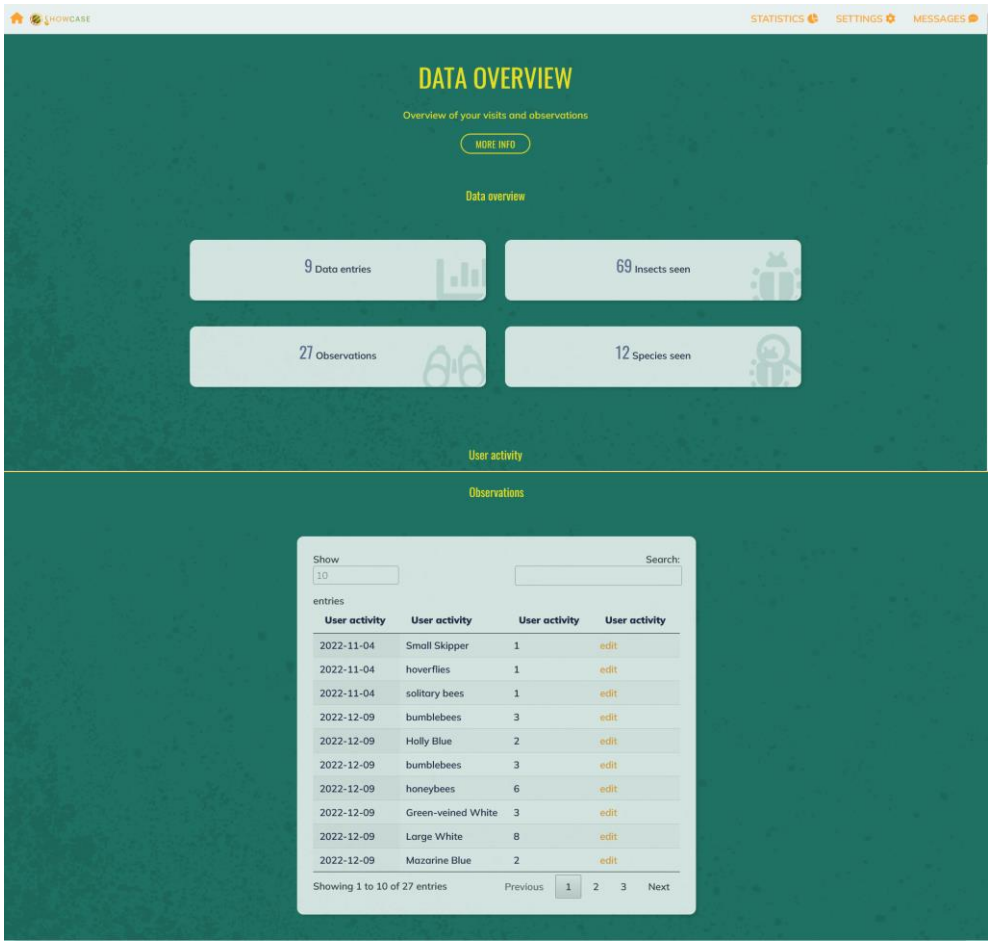
1. Time-effort count: 15-minute counts of all observed individuals of butterflies, hoverflies, bumblebees, honeybees and other wild bees (butterflies may be recorded at species level). Additional information can be provided on weather conditions, land use type and management intervention.
2. Flower patch count: 10-minute count of all flower-visiting insects on a flower patch of 50x50 cm, together with a count of available flowers of specified species or species groups. Besides the flower-visiting insects mentioned above, the number of insect species groups may be extended to include e.g. beetles, bugs, flies, moths and wasps. Additional information can again be provided on weather conditions, land use type and management intervention.
3. Transect count: users who are already engaged in the European Butterfly Monitoring Scheme (eBMS) can also use the app to count their existing transect after mediation by the regional admin. Additional information is limited to entering weather conditions.
4. Incidental observation: users encountering special insects outside the standardised counts can enter them through this option. No additional information required.

Date, time and location (or track) are automatically recorded. The option to upload photos has been considered, but has not been implemented at this stage, because it requires substantial effort to expand the surrounding infrastructure, address safety issues and storage capabilities.



4.1.4 Feedback to users

Feedback to the observer consists of a summary of number of observations, species seen and recording activity over time. Communication with users is also possible through messaging from the regional admin. More elaborate information can be obtained from the website.



4.2 Supporting website with gamification tool

App users can use an accompanying website for a) information about the SHOWCASE project, b) help on recording methods, c) help for species identification, d) accessing, editing and downloading their own data, e) sharing data and experiences in the regional community, f) gamification activities.

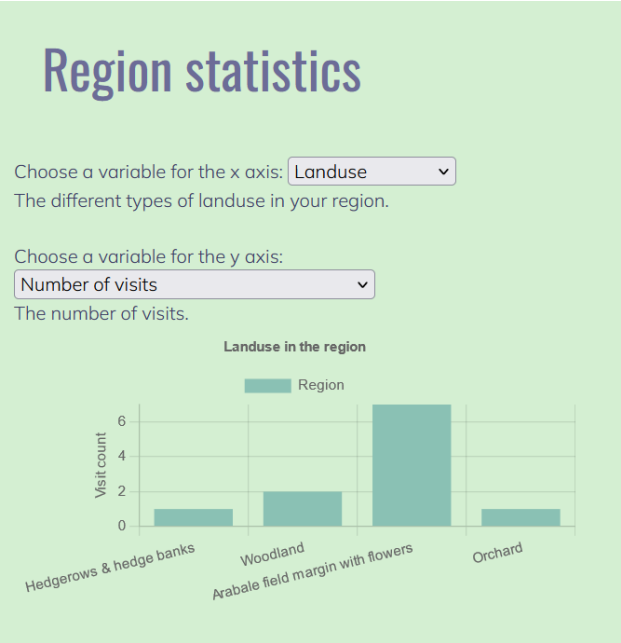
The feed-back by potential users received during the beta-test in the three EBAs indicated that the information that users want to see needs to be simple and comparable. Hence, rather than more complex graph-oriented visualizations, we opted for a combination of customizable graphs that allow for multiple comparisons and a badge recognition system.

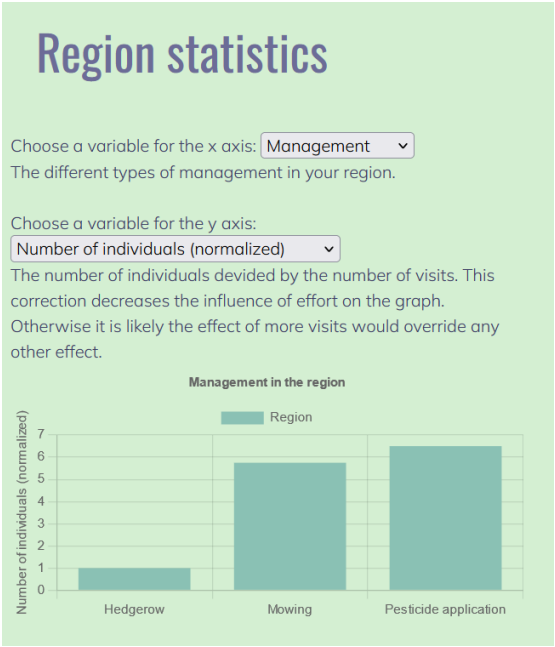
The gamification consists of various elements that encourage users to engage in insect counts by collaborative gaming, where all participants within a group (e.g. an EBA region):

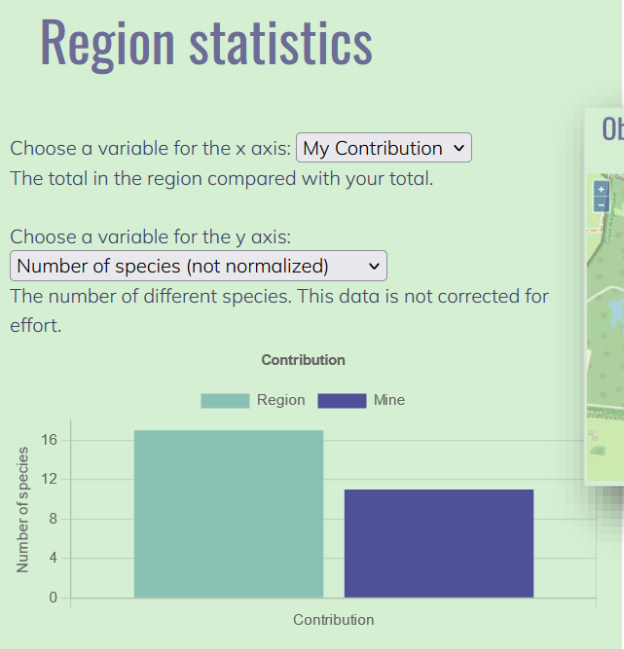
- Badges that can be obtained with a certain observation effort for: number of species seen, number of visits, number of single observations, number of recording types, number of flower visit counts, and number of timed counts. These badges are of bronze, silver or gold level, depending on the observer effort. These achievements can be shared with other users on social media.
- Feedback on the observations by the user offering comparisons against those in the region, comparisons among management options or habitat types, as well as among different years.
- Messages by the regional admin to promote recording, e.g. in the flight period of certain species
- Active challenges to achieve a common goal through push-messages from regional coordinators (e.g. a common observation effort, such as a total number of observations

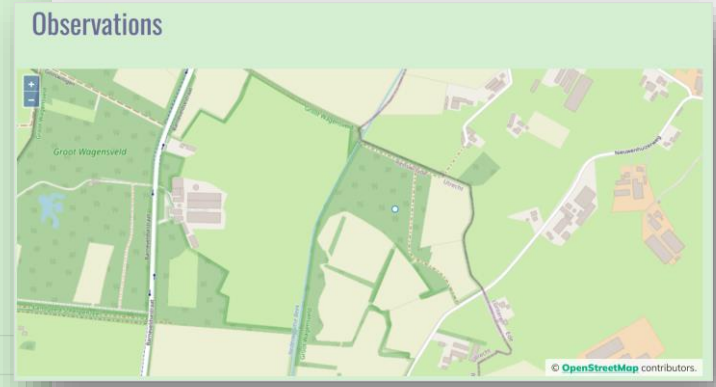
or a focus on particular species that may be observed during the field season, has only rarely been seen or still remains to be seen in the region)

With the addition of the gamification, we aim to not only enhance the exploitation of the results gathered by the biodiversity recording app, but also broaden the outreach of the project to supporters of the conservation movement by increasing their engagement with farming communities in citizen-science projects.

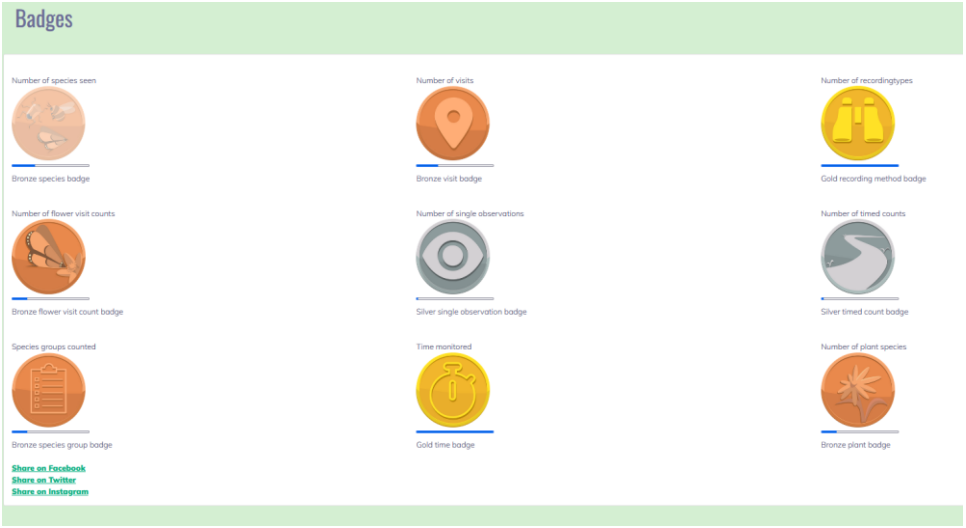








We offer small rewards continuously. Especially early badges are easy to collect. The badges are designed to challenge users to also try other recording methods, or also record other species groups. We allow users full access to their own data, and the data of other (who made their data public). We also make some small analyses available. Users can directly see the effect of different types of land use and management in the EBA. And they can also see their own contribution to these data. This reinforces the idea that the data were collected as part of a scientific study, and will be used for important analyses. Finally we offer the possibility to local coordinators to organize events. For example, a local coordinator can challenge users to come together and record x of species y. Or the coordinator can publish a list of the most valuable recorders. We hope this will form a community of people that keep each other motivated.



NOTE: We did explore an alternative gaming strategy to use local site information as input to reflect local diversity of flower-visiting insects. Its concept was that the user can select an option to change the landscape by means of an evidence-based management option that benefits flower-visiting insects (e.g. adding a hedgerow). This modifies the landscape and the associated flower-visiting insect community and the user can obtain a score from all consecutive actions benefiting biodiversity. The game could thus help to bring the central SHOWCASE message across that evidence-based improvements to biodiversity are worthwhile and feasible. However, this exploration, although promising as a stand-alone game, was abandoned because it could not be effectively linked to the observations collected in the app in a regional collaborative effort. This would likely decrease the effectiveness of the feedback loop we hope to create (record, see results, increase enthusiasm, record again).

4.3 Technical specifications

Developing an app of this magnitude is a complex process. Largely because this type of app cannot function alone, it requires a supporting infrastructure. This infrastructure stores and provides supporting data (such as species lists and translations), but also allows local administrators to adjust these data. To keep the app operational the entire infrastructure has to be maintained. In this section we explain how the components were developed, and the expected maintenance to keep them operational.

The infrastructure for the *InsectsCount* project consists of eight major components:

1) A virtual private server (VPS) to host the different components
2) A test server, where the project can be deployed for extensive testing prior to release
3) A secure database, to store reference data, user data and collected biodiversity data
4) The app itself

5) An application programming interface (API) to facilitate the communication between the app and the database
6) A website where users can download/edit their data, see and share their badges through social media and adjust their settings (language etc)
7) An admin portal that allows administrators to help users with problems with their accounts, create and manage EBAs, send out messages, and add or edit translations (both the app and the user-website are entirely translatable by an admin)
8) An API that allows admins access to the collected data for analysis in R.

1) VPS
The VPS is hosted by TransIP, a large company that offers highly stable VPS systems. The VPS has a performance rating of >99,9% online. This VPS also includes a snapshot-based backup system, this means that the entire server is backed up regularly. The costs of hosting of the app will be covered by De Vlinderstichting for at least the coming 3 years. After that continuation will depend on app use and available funding.

2) Test server
For this project we used several test servers, most testing was done on a local test server. Several components were tested on a test VPS system. Both have been dismantled after the completion of the development to reduce costs. Although the local test server can be restored relatively quickly.

3) Database
A PostgresQL database was developed, all relevant security standards were followed. The database was created using a migration system. This means that instead of creating a database, a script was created that builds the required database. This allows anyone who wishes to continue development to run this migration script and instantly have an (empty) copy of the database.
The database includes the PostGis extension to allow storage and processing spatial data. At the time of development the last stable PostgresQL is Postgresql 14. Which is expected to be supported until November 2026. We expect little maintenance until then.

4) App
The app consists of two components. A Javascript package and a service worker. The Javascript component renders the graphical user interface (GUI) and handles all the interaction with the user. The service worker maintains contact with the server. If an internet connection is available, the service worker component ensures the app is updated to the newest version and the collected data is uploaded.
If these components are properly defined, they are recognized by modern browsers, allowing users to place the components in their browser cache. This installs the PWA on the user's device and makes the app available without internet. This approach decreases the chance of a local version of the app being outdated. Because the app is installed in the browser cache, the app does not require an update after a new Android or Mac update is released. The Javascript components are expected to require minimal maintenance the coming years, any unexpected maintenance will be done by De Vlinderstichting.

5) Communication between app and server
The communication between the app and the server is facilitated by an API. The API handles communication between the app and the user's device. The connection through this API has to be secure, therefore the development of this API was largely focused on security and data validation. No large maintenance is expected on this component, any unexpected maintenance will be done by De Vlinderstichting for the at least four years after the end of the SHOWCASE project.

6) User web environment
A web environment was developed where users can see/edit/download their own data, and the data of others (who shared their data) in their region. See the user manual for a full overview. This website was developed in PHP. When development was completed PHP version 8.1.4 was used, using the Laravel 9 framework. This framework is widely used and actively developed. See next section for maintenance.

7) Admin web environment
Similar to the user web environment, the admin web environment was developed using PHP+Laravel. The aim of this component was to allow administrators secure and full access to the user and EBA data, to allow them to assist users with support requests, and allow them to create new messages to keep volunteers in the EBA engaged. See the administrators manual for a full overview.
This component and the previous one need regular updating. Laravel is continuously developed and, as with any web-based component, security issues are a continuous concern. Laravel develops quickly and is generally supported for relatively short periods of time (1-1.5 years). The continued maintenance of this component is crucial. De Vlinderstichting will keep this component up to date for at least four years after the end of SHOWCASE, possibly longer depending on the budget availability.

8) Admin data access
To allow administrators access to the collected data, an API was developed to allow direct access to this data from R (through the Curl library). All relevant data is accessible through this API, some non-relevant system data and user security data are omitted. The API is only accessible using a 60-character access token. This component is not expected to require large maintenance.

5 User guide

A user guide is available. Although the app should, in principle, be self-explanatory and not require a user guide, we have considered it helpful to elaborate on it just in case. The user guide can also serve as an introductory overview for new admins and help them to answer questions from users. The Spanish EBA has also realized an informal outreach video explaining its use.

The user guide explains how to get started and sign in, shows the homepage lay-out and elaborates on the recording options, the settings, observation feedback and furthermore which information can be accessed on the website. The user guide is available on the website as PDF.

6 Administrator guide

The admin guide provides some background information on the app and offers help on the admin management panel, which covers the setting up of a new region, managing users, composing and sending messages and news items. It also allows translating all app and website texts in other languages; this includes common species names (so far, translations have been made available in Spanish, Swedish and Dutch).

The set-up of a new region includes a geographic delimitation within a specified polygon. It also involves the selection of relevant species of butterflies, bees and plants to be made accessible to the users.

Transect monitoring can only be done when there is an existing eBMS transect within an EBA. An admin can then enable the “walking a transect” function for the app user who is responsible for monitoring. Admins have the option to create new admins and EBAs. Therefore, to start a new EBA an existing admin has to appoint a new local admin. And s/he can get started.

The guide also offers a R-script to view and export user observations. Data can be accessed by admins through a secure API.

7 Implementation and future perspectives

The comprehensive review reported in T3.8 (also see our recent Ambio paper), described the different types of citizen science approaches that are currently available for biodiversity monitoring on farmland, and set out a typology of eight programme types. The overall potential of citizen science to expand farmland biodiversity monitoring was also explored in terms of additional data collection and volunteer (especially farmer) engagement. Recommendations from this review that were pertinent to the app development in T4.3 included creating opportunities for farmers to partake in monitoring, ensuring engaging feedback to participants, enhancing opportunities for learning, develop more farmland-specific entry platforms that enable opportunistic submission of species observations, bridge gaps between communities of practice (e.g. farmers and scientists).

The app has been tested and implemented for use in Sweden, UK and Spain, where its potential to collect biodiversity data was explored by involving farmers on their own farm and by reaching out to volunteer citizen scientists to engage in monitoring flower-visiting insects in the context of developing pollinator-friendly farming practices (Task 2.6). Feed-back from farmers and volunteers was pivotal to develop the gamification part presented here. Its use will be studied more extensively in Sweden in the context of the SHOWCASE project during spring and summer 2024. The app will be made available for public use and hopefully encourage further development of its potential, as a further tool in the toolbox of citizen science approaches to monitor farmland biodiversity (Task 3.8).

As part of Task 2.6, farmers in Spain, UK and Sweden were engaged in biodiversity monitoring activities. In Sweden the farmers were encouraged to record butterflies on their farm using I*nsectsCount*. In Spain the farmers were trained and supported to record the data using *InsectsCount*. In the UK, the farmers and recorders already had an app and recording scheme that they wished to use, so the researchers only inputted some biodiversity data into *InsectsCount* in order to test the functionality. In Sweden further experience will be acquired in 2024 about the added value of the gamification component.

Region	Users*	Visits	Observations
Spain	49	34	78
Sweden	47	18	348
UK	15	10	15

*excluding 8 test users in the Netherlands

Recording method	%Visits
Flower visit	18
15-minute count	30
Single observation	42

As far as we know (see 2 Market analysis), this app is the first biodiversity recording app that combines a focus on standardised counts with gamification options. The *InsectsCount* app

provides an interactive, visual platform for displaying and sharing biodiversity data that is recorded within a community of practitioners. The app was designed to create geographically bounded communities of practices (EBAs) that could share biodiversity data. A local 'admin' can send messages to communicate between the members and the gamification element encourages further recording. Hence, the app is designed to achieve high quality interactions with engaged users, rather than maximize the number of users with a low engagement,

The success of its implementation in the future will strongly depend on the availability and use of already existing biodiversity recording apps on the one hand and the willingness of farmers and citizens to engage in pollinator monitoring on the other. We expect that *InsectsCount* will be most readily adopted in regions where the competition from existing, more generalistic apps is low and where there is a widespread interest and concern to preserve biodiversity.

By including gamification, we hope that people will feel challenged to keep recording. Aside from making it as easy as possible to record and enter data, there are three main components designed to keep people involved:

1) Small rewards
2) Rapid feedback, accessible data
3) Community involvement

8 Business plan

The current app has been developed for use in the context of the SHOWCASE project, but with the intention for a broader use. To this end we are carrying out the following promotion activities:

- sending out a press release in 2024 to promote the app and encourage coordinators of especially farmer collectives and green organisations to start their own EBA and build a user community around *InsectsCount.*
- communicate the app from all SHOWCASE partners to their network to adopt *InsectsCounts* in future projects on farmland biodiversity. Thus, in the Netherlands we already found the farmer collective of Natuurrijk Limburg willing to do so. Also, the emerging policy of 'Basiskwaliteit Natuur' (i.e. achieving a baseline quality for nature in farmland and other multifunctional landscapes) offers good potential for exploitation of *InsectsCount.* In Spain, the NGO AbejasSilvestres.es is promoting the app in its project ZUMBIDOS, a project to take pollinator conservation measures and monitoring its success.
- Finally, within the WP4 group, we will consider the options of further promotion activities, such as launching an instruction video to highlight the attractive possibilities of *InsectsCount.*

We have not involved the support of the Horizon Results Booster Business Plan Development, because of the niche market that *InsectsCount* is targeting and which is adequately covered by our professional network.

As stated in par. 4.3, the costs of hosting of the app will be covered by De Vlinderstichting for at least 4 years after the end of the SHOWCASE project. After that continuation will depend on app use and available funding. Below, we have explored the costs and benefits of its exploitation.

The monthly hosting costs currently are € 31.45 with an additional € 6.29 to securely back-up the server (both website and database). The annual hosting costs, not including price changes, are therefore € 453 (€37.74 x 12). To apply security updates, maintain the system and respond to user inquiries we allocated 16 hours annually (which costs €2,256 annually). The estimated annual cost of hosting the *InsectsCount* system therefore is €2,709.

The *InsectsCount* system was developed to be free to users, we do not plan to charge users for use of the system or use commercials. Instead, we aim to collect biodiversity data. As explained above, the *InsectsCount* systems allows participants to collect data in a structured format. This reduces the number of potential users, but increases the value of the collected data.

To estimate the value of these data we used estimates from the European Pollinator Monitoring System (EUPoMS 2020). This report looked at costs of different monitoring techniques in great detail, including costs of personnel and travel expenses in different countries. In this report a transect walk is estimated to takes c. 45 minutes, a fit or timed count takes c.10 minutes. We assume an average travel time of 30 minutes per location and 50km travelled (both one way). For these cost calculations we used the average hourly costs of a professional ecologist based on EUPoMS estimates for The Netherlands, Sweden, Spain and the United Kingdom, which is: € 50.69. The average fuel cost in these countries is: € 0.28 per km. The cost estimates are shown in Table 2. This table shows that the costs for fit/timed counts and transects are estimated at € 87.14 and € 116.71 respectively. Therefore the hosting and maintenance costs are roughly equal to 31 timed- or flower visitation counts or 23 transect counts.

This calculation does not include the difference in data quality between a volunteer and an expert. Additionally, it is easier to ensure a proper spatial distribution when monitoring with experts. However, when using expert monitoring there is no public engagement at all, public involvement has to be facilitated in another way. Thus far, in the testing period of SHOWCASE, we have collected 37 flower visits counts and 63 timed counts, if these data had been collected by experts, its collection would have cost € 8.714. This underlines the huge benefit of citizen science, especially in the context of specific scientific questions. The effect of management can only be analyzed when relevant data is available, collecting these data without citizen science is expensive. Therefore, the *InsectsCount* system seems an excellent tool to collect targeted data to answer scientific questions, and is a highly efficient way to collect data. The system is likely to be picked up and expanded upon by future projects. To support this, the source code of the app, website, administration tools and database have been made publicly available. This should ensure the potential for its exploitation over a longer term in the future.

Table 2. The estimated costs of data collection using *InsectsCount* when carried out by professionals instead of volunteers.

Method	**Time (minutes)**	**Measurement costs**	**Travel costs**	**Total costs per visit**
Timed count	10	€ 8.45	€ 78.69	€ 87.14
Flower visitation count	10	€ 8.45	€ 78.69	€ 87.14
Transect walk	45	€ 38.02	€ 78.69	€ 116.71

There inevitably are weaknesses associated with the app. The following three seem most relevant. First, the app depends to a large degree on the active involvement of coordinators. Without this, volunteers can still collect data, but the interaction between the farming practice and data collection is lost. Still, this is the main focus of *InsectsCount,* so recruiting active coordinators is key to its success. Second, the design and additional features of the app are rather basic in comparison to more popular apps. The available budget did not allow these, but they were also not essential to achieve the central functionalities within SHOWCASE of data collection and the ensuing bi-directional communication through gamification and challenges that can be initiated by regional coordinators. However, further elaborations on the

design and functionalities such as species identification could very well be accommodated in future projects; the public availability of the source code also enables other parties to continue on further developments. Finally, the app gives users the possibility to record either at species level or at the level of species groups, which could be somewhat confusing. But this is also a strength in that it allows both beginners and more advanced insect observers to participate; also, the confusion can readily be cleared by messages from the regional coordinator (as we have learned from the bumblebee monitoring scheme in the Netherlands).

The number of active users of *InsectsCount* in 2023 (c. 120) is not a good indicator of its potential, because these were only test users. The largest existing user community by far is iNaturalist (1 mio+ downloads), followed by ObsIdentify (500 K+ downloads). However, both these apps have a strong focus on opportunistic data collection, but do not allow the standardised counts necessary to promote learning-by-doing on the basis of insect counts.

ObsMapp (100 k+ downloads) might be considered as the closest competitor to *InsectsCount:* it does allow one type of standardised counts and offers the option to develop regional communities. However, it does not provide for gamification nor for the possibility to include metadata on land use and management, which is important for the learning-by-doing objective.

The essence of the *InsectsCount* app is to promote farmland biodiversity by encouraging farmers and volunteers to engage in standardised counts of flower-visiting insects. The engagement is enhanced by building regional communities around experimental biodiversity areas, with gamification challenges and messages from regional coordinators giving the incentive for users to become active counters. The standardised counts in various settings of land use and land management are essential to arrive at the desired learning-by-doing to benefit farmland biodiversity in practice. This combination of objectives clearly defines *InsectsCount* as an app for a niche market and this definitely limits the potential number of users. However, in line with the overall objectives of the SHOWCASE project and with the open challenges to implement citizen science to promote farmland biodiversity (see our recent Ambio paper), we chose to give priority to evidence-based biodiversity recording over a more commercial target of a large user market. In other words, InsectsCount prioritizes quality over quantity.

The two user groups targeted by *InsectsCount* are citizen scientists and farmers engaging in standardised insect counts on farmland. We should, therefore, be cautious about overoptimistic expectations of *InsectsCount* to conquer a substantial share of the citizen science observer market. User numbers of >100.000 are only to be expected for apps focusing on opportunistic observations, as most observers are not likely to find standardised recording attractive. Indeed, a more realistic estimate would rather lie in the order of 1000-5000 users; the Vlindermee app that we intended to build on had a maximum number of 3700 users in the Netherlands. Reaching such targets falls beyond the time limits of the SHOWCASE project, but the present deliverable does provide the basis to achieve these in the future.

9 Repository

The source code behind the app and the supporting website is freely available to use for further development. The code is shared through GitHub and can be found here: https://github.com/DeVlinderstichting/Showcase
Anyone can create a branch and continue development. It is also possible to contact the developers through GitHub to request further information or assistance. We will be happy to help anyone wanting to continue development.

10 Acknowledgements

During the technical development the help of Sil Nieuwhof and Emma Vriezen was crucial to the timely delivery of this large system.