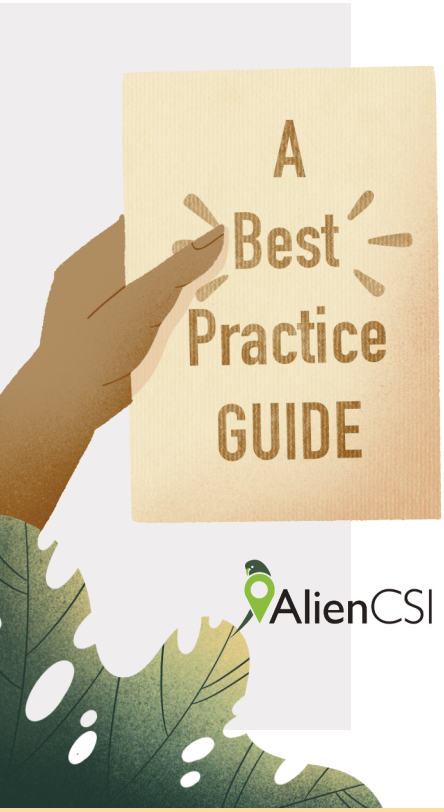


Using citizen science with alien species: a practical guide for project initiators

This guide is intended to help anyone set up an alien species citizen science project. Target people include NGO workers, researchers, policy makers, volunteer groups, government agency workers, project managers, invasive species managers, teachers and the general public.

Since there are already several published guides on citizen science, this guide summarises the most relevant topics, highlights topics that are more relevant in the context of (invasive) alien species, and refers to other sources of information.

What is this guide about?

This guide provides topics to consider when initiating or running a citizen science project on alien species or invasive alien species. It includes key recommendations on how to engage with your target audience, plan and design your project, handle data, perform analyses and evaluate your project outputs.

What is citizen science?

Citizen Science, also known as community/ participatory/ crowd-sourced science, actively **involves citizens in scientific research to generate new knowledge** or understanding. Citizens may act as contributors, collaborators, or project leaders. In all cases they have a meaningful role in the project.

For a summary of general best practice in citizen science, see the '**Ten principles of citizen science**'.

10 PRINCIPLES

What are alien species and invasive alien species?

Alien species, also referred to as non-native, non-indigenous or exotic species, are species that have been introduced outside of their natural ranges - whether intentionally or not - by people. A subset of alien species, termed **invasive alien species**, establish self-sustaining populations without human help, spread widely into the environment and have negative impacts on native biodiversity, ecosystems and on the way we live. Some alien species provide benefits. Others have neutral or minimal effects, but adverse impacts may occur, or be detected or only become evident later.

Why is citizen science on alien species valuable?

Alien species can be recorded either through existing nature recording platforms, such as **eBird**, **iNaturalist**, **Observation.org**, **EASIN Invasive Species in Europe App**, etc. or by setting up new projects. The benefits of involving citizens include:

Collecting observations of alien species that are valuable for science and species management.

Enabling collection of additional data beyond the presence or absence of an alien species including local abundance or evidence of negative impacts on native species.

Raising awareness of alien species and their impacts with the public or specific stakeholders.

Enabling “structured” (as opposed to “opportunistic”) approaches that target specific regions or employ a specific sampling protocol.

Supporting identification of alien species, e.g., with identification guides or automated identification (image recognition) built into smartphone apps.

Citizen science allows upscaling data collection by engaging large audiences over large spatial scales.

Best practice tips for alien species citizen science projects

To help you decide whether citizen science is the best option for your aims you may read the guide on **Choosing and Using Citizen Science**.

1

Define the aims of your project.
That way it will be clear for participants what actions may arise as a result of their participation.

E.g., will the project simply map a species' distribution, will it improve knowledge on impact or invasion dynamics, or will it lead to control actions?

2

Identify the funding, resources and project team.
This ensures that you can sustain your project throughout its lifetime.

3

Carefully consider who you are targeting
to contribute data to your project. Then design your project with the target audience in mind. E.g., the wording that you use in project materials must be suitable for the intended participants.

4

Consider a collaborative approach for your project and whether you can involve participants in the design and set-up of the project. Especially at an early stage, this may be effective in increasing engagement and ensures that the project is designed appropriately for the target audience.

5

Test your project with your target audience before making it live and refine it in response to feedback. This step avoids wasting effort and resources.

Target species

Water primrose, Harlequin ladybird and Spanish slug are only a few examples of alien species

Consider whether the target is one specific alien species or many species? A single-species project may be easier to set up and clearer for participants, but a multi-species project approach is likely to be more cost-effective.

Accurate identification of alien species records is crucial to ensure the quality of the dataset and inform good science and decision-making. Consider record **validation processes** from the beginning.

Consider whether reporting absence of an alien species would be useful. Details such as the time spent looking indicate the search effort and render your data more useful.

Use existing tools or platforms for data collection where possible. For example:

ZOONIVERSE

Zooniverse is a pre-existing platform where you can build your own project.

AGOUTI

Agouti is an existing platform for projects using wildlife cameras with built-in image analysis tools.

iNATURALIST EASIN

Tools such as **iNaturalist** and the **EASIN Invasive Species in Europe App** allow you to create new surveys and projects for reporting observations.

PLAN IN ADVANCE

how the project may be sustained in the long-term when the original funding runs out, i.e., try to make the project as sustainable as possible, so that it may continue with a minimum of ongoing updates and costs.

For example, bespoke smartphone apps are expensive to develop and become obsolete if not maintained and upgraded over time. Consider alternative approaches to avoid this.

CONSIDER USING TECHNOLOGIES

that can help increase data quality and validation.

For example, Artificial Intelligence & machine learning to support identifications, acoustic monitoring of animals such as birds or insects, analysing pond water with environmental DNA for presence of alien species, or ***remote sensing and modelling*** *to direct people to survey in specific places.*

Several existing platforms have such technologies available that you may use:

have automated **image identification**

have sound **identification tools**

iNATURALIST | ObsIdentify | PI@ntNet | BirdNET | Merlin app

Seek *and* ***ObsIdentify*** *include elements of gamification to stimulate recording.*

Tools and guidelines are available for citizen science on bats using acoustic recorders and sound analysis and projects exist on acoustic monitoring of amphibians. Laser vibrometry is used to detect wood-boring beetle larvae.

The PondNet project **uses eDNA** to involve the public in collecting water samples to find newts.

PondNet

Roadside monitoring with cameras and Google Street View technology track invasive plants.

Google Street View

NEW SKILLS FOR YOUR PARTICIPANTS

Train participants in species identification, the handling of technology or other skills needed for your project, e.g., extracting and storing samples. Web-based training materials, including identification tools, can be created efficiently and are often relevant in the long term.

species identification

handling of technology

storing samples

FEEDBACK

Provide **regular and timely feedback** to participants

(e.g., confirming receipt and identification of species records).

If possible, **personalise the feedback.** Feedback can be given in a semi-automated way whilst appearing to be personalised, for example through using natural language generation in drafting personalised emails or push notifications.

Ensure that participants are informed of what is going to happen when they report a species (e.g., management) and provide feedback on actions taken. This needs to be clear, as some contributors may expect species management (e.g., culling, plant removal) as a result of their report.

Manage the expectations of participants.

With your target audience in mind, ***communicate your project clearly!***

Consider the **motivations** of participants and what may be more rewarding for them, and design the citizen science project to maximise the value to everyone involved. If possible, work with an **interdisciplinary team**, including ecologists, data scientists, social scientists, etc. to better motivate and sustain volunteer involvement and to evaluate socio-economic impacts.

If volunteers are contributing to the **management** of invasive alien species, consider best practice guidelines, biosecurity (e.g., not spreading invasive alien species further), ethics and health and safety issues (e.g., for hazardous species such as alien snakes or giant hogweed), consider insurance cover of your volunteers.

Consider strategies for improving the **inclusiveness** of your project (e.g., provide opportunities for people to take part remotely or through taking on different roles, e.g., verification of photos).

KEEP IN TOUCH WITH PARTICIPANTS!

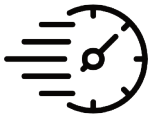
- Consider what are the **best methods of communicating** with your target audience - and what are the **best platforms to encourage data collection** from your audience.
- You may need a **variety of communication strategies and outreach materials** for different groups. Drafting a communications plan is always a good approach.
- Appropriateness of **technologies** you use to reach potential participants will vary. E.g., Tiktok may be better suited to a young audience than Facebook.

Use evaluation approaches either at the end of your project or, particularly for long running initiatives, at regular intervals, to see how impact changes over time. Inform participants of the ways in which the feedback will be used. Check information on impact evaluation metrics and indicators on the MICS: Measuring the impact of citizen science project

Evaluation can be used to inform the types of visualisation deployed to summarise the results, to review the feedback given, etc. Share impact summaries with participants, funders and other stakeholders.

MICS

Data management & standards



Speed is important in alien species citizen science, both in validation and data flows, especially when the data are used in early warning systems to develop rapid responses to newly detected species or invasive alien species with limited distributions.

Also consider any ethical concerns about making data public.

MAKE YOUR DATA FAIR

- **F** Findable
- **A** Accessible
- **I** Interoperable
- **R** Reusable

Data quality and validation

- ☑ Provide clear instructions for participants and participating experts.
- ☑ Choose a validation mechanism that is suited to your project aims and data (e.g., community validation, expert validation, artificial intelligence).
- ☑ Consider in the design phase the **trade-off between data quality and maximising participation** (data quantity) explicitly for your project's aim.

Share your data on an open, accessible data platform, such as the Global Biodiversity Information Facility (GBIF), iNaturalist or Zenodo.

Try to maximise the value of your data to others by using **accepted data and metadata standards, such as the Darwin Core standard.**

Be generous with metadata. Include information that might seem irrelevant to you, but could be relevant for others.

Choose the correct licence for your data. This specifies the conditions under which your data can be (re)used. Opt for a CC0, CC-BY or CC-BY-SA licence for your data.

- [x] Consider the **legacy of your data** (and the technology used to gather them): Where can participants go to access their data after your project has ended? Can you link with an established platform?

- [x] Consider ethically undesirable **side effects of releasing sensitive data**, such as quarantine species, locations in private properties, images of people.

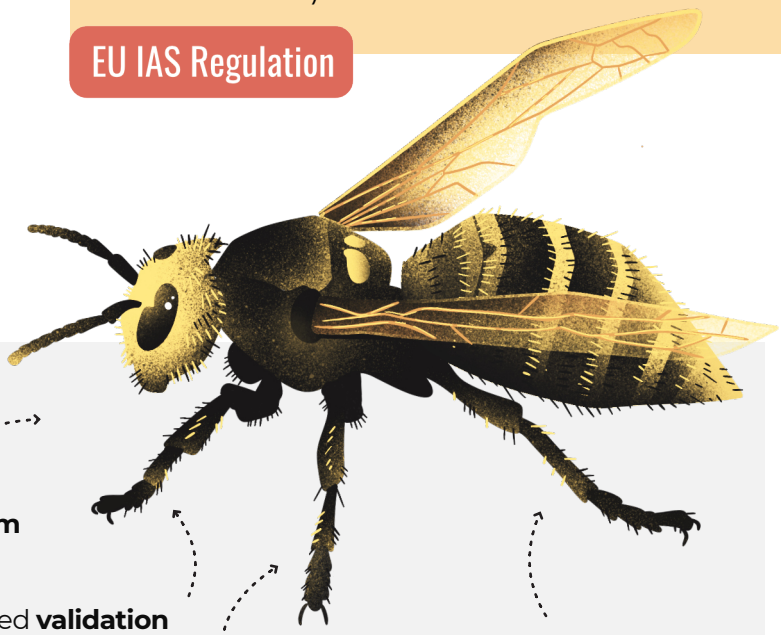
- [x] You can track scientific output of the data from your project by publishing them on platforms like **GBIF**.

- [x] **Some invasive alien species are 'regulated', so liaise with the competent authorities** so that you can collaborate on data flow (and subsequent management actions).

Data charter

FAIR data

EU IAS Regulation



CASE STUDY OF HOW TO MAKE IT HAPPEN

VespaWatch

built on an **existing platform**

unlimited **validation community**

it has a **data management plan**

uses **international data standards** and has **rapid dataflow** to GBIF

- [x] links to **primary motivation** of reducing species impact

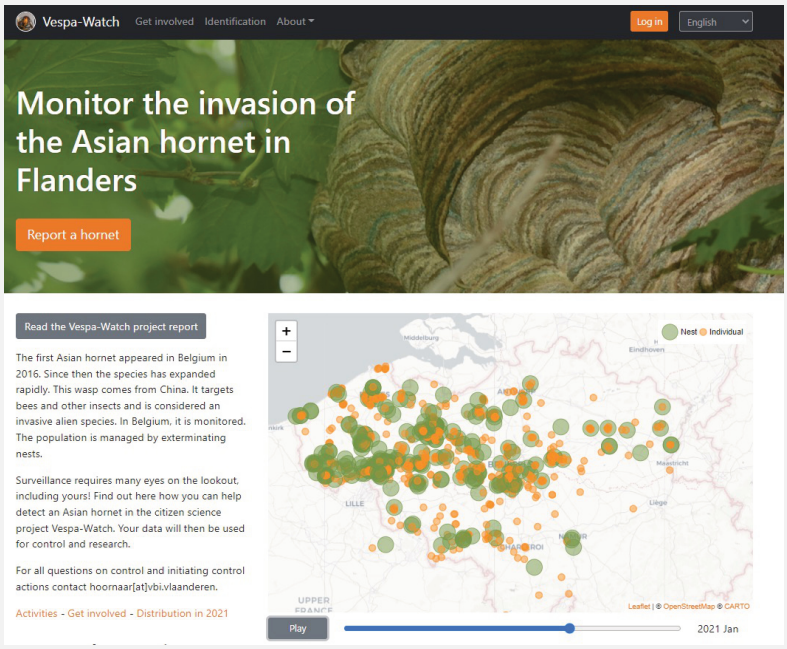
- [x] **provides data openly** through an api and downloadable CSV format

- [x] **shows visualisations** based on the data to support nest detection

- [x] provides **feedback** on participants' contributions

- [x] organises **guided bioblitzes** for nest detection

- [x] gathers data on management of **the species**



Analysis & visualisation

Work with a statistician or analyst from the start of the project. They will advise on how to make the data collection suitable for addressing your specific questions and the analysis approaches, ultimately maximising the value of the volunteer-contributed data.

What should you be aware of when analysing alien species citizen science data?

Simple descriptive statistics of the project results (e.g., number of observations) and maps of records can be useful in summarising the progress or outcomes of your project.

Observations may be **unevenly distributed** in space and/or time, e.g., with more records in towns and cities, or at weekends. Appropriate statistical analysis can be used to address unevenness of data.

Some aspects of project design can help to improve data quality and **reduce uncertainty** (e.g., recording in set locations), but might require more investment in recruitment and retention of volunteers.

Examples of how/what to analyse for research and management purposes:

- ☑ Habitat suitability/occupancy models for alien species
- ☑ Determining areas at risk of introduction
- ☑ Spread models
- ☑ Potential impacts
- ☑ Interactions with other species

WeObserve Toolkit

Visualisation of citizen science data can be an effective way of summarising information, communicating the outcomes of the project, and motivating volunteers. Bad visualisations can be confusing or misleading (e.g., distribution maps of *records* could be misinterpreted as the *complete* distribution of a species), so take care!

Good communication of results through maps can encourage recording in areas without observations.

DECIDE project

Different forms of visualisation include:

Maps of records from the project. There are many tools available (e.g., **OpenStreetMap**) to create maps that are interactive, e.g., so users can zoom and scroll within a map. In particular, seeing your own and others' records can be a powerful motivator.

Maps of change over time, e.g., showing the spread of an alien species. These can be created via interactive tools or **videos** that enable people to explore the data themselves, which can be inspiring for them. Videos or graphics enable project organisers to 'tell the narrative' about the data much more clearly and so reduce the risk of misinterpretation of the results.

Don't forget about **traditional ways of visualising data**, e.g., graphs or charts. They can be very effective at summarising the data, e.g., the numbers of records changing over -time, or the numbers of records in different habitats. An online dashboards, e.g., made with open source software **Rshiny**, can be a powerful tool to track and communicate project progress.

Maps of modelled data, e.g., predicted distribution of an alien species or areas of high risk of future spread.

COST Action Alien CSI

This publication is based upon work from COST Action CA17122: Alien CSI, supported by COST (European Cooperation in Science and Technology). COST is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation. The authors are from a range of countries and are experts in setting up and running alien species citizen science projects in Europe.

Contributors: *Peter Brown[1], Elizabete Marchante[2], Elena Tricarico[3], Tim Adriaens[4], Anna Gazda[5], Michael Pocock, Lien Reyserhove, Maarten De Groot, Paraskevi Karachle, Niki Chartosia, Jan Pergl, Angeliki Martinou, Annelies Duerinckx, Bernat Claramunt López, Bozena Mitic, Ioanna Angelidou, Ioannis Bazos, Jiří Skuhrovec, Marta Lopez Darias, Pavel Pipek, Siobhan Edney, Sven Schade, Vanessa Lozano, Helen Roy*

1: **peter.brown@aru.ac.uk**; 2: **emarchante@uc.pt**; 3: **elena.tricarico@unifi.it**; 4: **tim.adriaens@inbo.be**; 5: **rlgazda@cyf-kr.edu.pl**

Alien CSI (2023). Using citizen science with alien species: a practical guide for project initiators. Available under Creative Commons Zero Universal licence at **https://doi.org/10.5281/zenodo.7521429**

*Design by Nela Gloríková, **Landalomad.sk***

Funded by the European Union