

# White paper Best practices on environmental citizen science

The experience  
of the CSMON LIFE Project



CSMON-LIFE

White Paper

**Best practices on environmental citizen science**

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# Introduction

## Scope of this White Paper

An active and voluntary involvement of citizens will play an increasingly decisive role in the implementation of EU environmental directives, not only in terms of data collection and monitoring but also in stimulating innovative approaches in research and decision making.

A project carried out in Italy, CSMON LIFE, has offered a significant contribution to the involvement citizens in validated biodiversity data, accelerating the progress towards the objectives of the European 2020 biodiversity strategy.

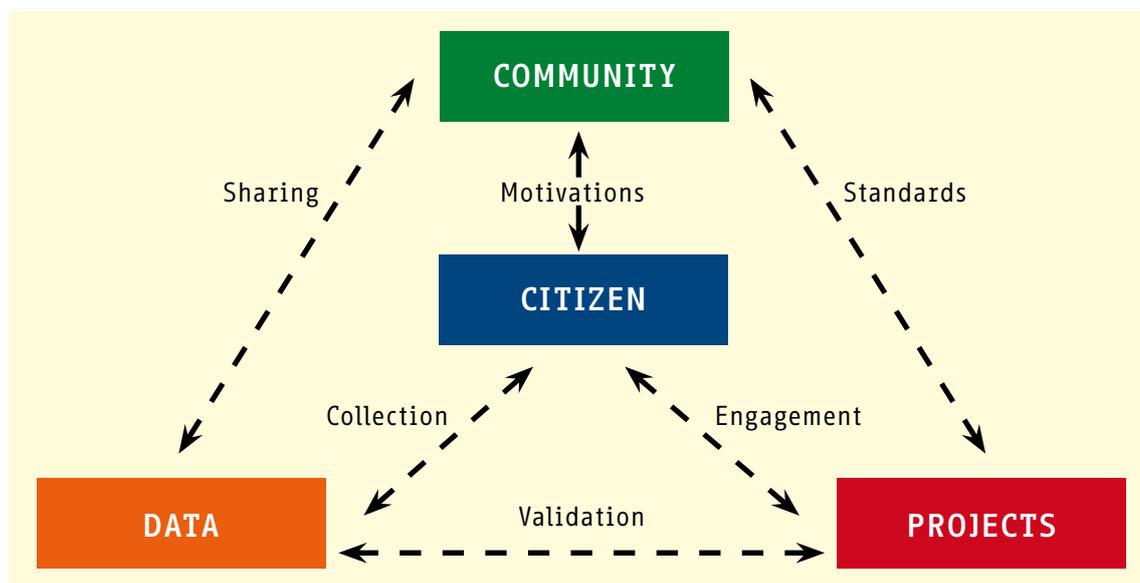
CSMON-LIFE is the acronym of a project dealing with biodiversity monitoring by citizens: “Un approccio di Citizen Science al monitoraggio della biodiversità per la soluzione delle problematiche Ambientali” (A Citizen Science approach to biodiversity monitoring for environmental problem solving). The project, co-financed by the European Commission through the LIFE+ financial instrument, was started in 2014 and concluded in 2017.

During the course of the project (<http://www.csmon-life.eu>) the members of the coordinating team came across a number of other similar experiences and were able to share challenges, opportunities and best practices.

The pages that follow represent a summary of the main acquisitions obtained during the implementation of the project and the encounters with team members of other European citizen science initiatives.

The document is divided into the four main actors which can influence the success of citizen science: the data (the hook and ultimate goal), the citizen (soul and core actor), the projects (precious tools when well structured) and the community (breeding environment).

Each chapter will illustrate the issue, showcase best practises and highlight the experience gained by CSMON LIFE.



# Data

## Data type and protocols

Citizen science plays an important role in collecting environmental data. It is becoming increasingly significant in the biodiversity monitoring at local and national scales, and can form the basis of scientific research, as well as evidence for policy and management.

However it is important to consider that citizen science lends itself better to certain types of data gathering and analysis than to others.

In the first place it is necessary to distinguish the various citizen science initiatives and associate the type of data requested.

The 'mass participation' citizen science are the most frequent initiatives. The media promote a project for anyone to take part anywhere. In these cases, the observation and crowd sourcing are the contribution of the citizen scientists.

There are other types of citizen science that could be considered, not being restricted to considering observations that people can make directly; many sensors exist for people to record things that they otherwise cannot directly observe (e.g. radiation) or cannot otherwise quantify (e.g. temperature or noise).

In other cases people have a vested interest in the results and are even willing to pay for analysis of the samples.

In all cases citizen science is at its best when it is

specific, i.e. when the question being addressed is precise. For citizen science to be effective the data need to be fit for purpose, therefore the purpose needs to be clearly defined.

The simplicity of the protocol is the key to the success especially in mass participation citizen science projects. An initiative that does not demand much time or expertise can potentially involve a large number of people. If the complexity of the protocol increases then the number of participants is likely to decrease, even though the value of the data may increase. If there is the need of a complex protocol then the citizen science initiative has to provide sufficient support for participants and the protocol must be thoroughly tested. A complex protocol is likely to result in fewer people participating, but there may still be sufficient to provide enough data.

Citizen science could potentially work extremely well for both extensive large scale and intensive small scale studies. It has proved to be particularly effective at addressing questions that require a large spatial scale approach, resulting in the engaging many volunteers simultaneously. The citizens can help to investigate present global issues - such as the impacts of climate change or biodiversity loss – in a way that is locally relevant and meaningful. However, where there is a need for data across a large spatial scale it is important to consider whether information is needed from particular sites, the location of the sites and their remoteness.

### In short

- ▶ Citizen science can form the basis of scientific research, policy and management and can help investigate present global issues.
- ▶ Citizen science lends itself better for certain type of data.
- ▶ Citizen science is at its best when it is specific but it is effective when address large spatial scale approach.
- ▶ The purpose needs to be clearly defined.
- ▶ The simplicity of the protocol is the key of success.

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*Case study*  
**Wakame Watch,  
an example  
of mass participation**

Wakame (*Undaria pinnatifida*) is a large species of seaweed considered to be one of the 100 'world's worst' invasive species, due to its potential to impact ecological and economic interests. Wakame Watch is a citizen science initiative that has been established in Britain in order to generate an up-to-date picture of

the distribution of the species. Scientists do not currently believe that the true spread of the species is known for Great Britain and North West Europe and producing an accurate distribution of this species is important in terms of managing and controlling spread. The Wakame Watch project involves citizens in the definition of the real distribution of the species. The citizens are routed towards a correct identification of Wakame with key identification features.

Similar species are described pointing out the similarities and the differences. The volunteers can contribute sending a photograph and data (date, location, etc...) by telephone or pc. Wakame has been selected as the target of the project because it is relatively easy to identify even with limited knowledge of its key features.

<http://wakamewatch.org.uk/>

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*Case study*  
**State of the oyster,  
an example of monetary  
contribution from citizens**

The State of Washington is the US lead producer of farmed clams, oysters, and geoducks, with an estimated annual harvest worth more than \$107 million. Shellfish have been a subsistence and ceremonial food for Native Americans in the Pacific Northwest for millennia and commercial shellfish farming has been active in Washington waters for more than 160 years. Washington Sea Grant (WSG) works closely with National Oceanic and Atmospheric Administration, West Coast

shellfish farmers, state agencies, and tribes to support sustainable Northwest aquaculture and wild fisheries.

Pollutants can destroy the shellfish's beds, and bacteria taken up by shellfish can lead to diseases to people who eat them. WSG's State of the Oyster Study is a citizen science monitoring program that trains waterfront property owners to test the safety of their shellfish before consumption. Four times a year, residents gather clams and oysters at low tide and bring them to WSG to be tested for *Vibrio parahaemolyticus* and bacterial indicators of faecal contamination.

WSG then helps participants interpret the test results and, if necessary, works closely with them to identify and remedy sources of contamination.

The project participants collect shellfish samples and pay for laboratory sampling for harmful bacteria in order to receive information on their shellfish, while the results contribute to an overall understanding of faecal contamination of the sea water. The results of the project are considered in research to address the concerns of the shellfish industry, regulators, policy makers and consumers.

<https://wsg.washington.edu/our-northwest/shellfish/>

<https://wsg.washington.edu/wordpress/wp-content/uploads/outreach/State-of-your-oyster-2015-form.pdf>

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## **Data quality and the importance of feedback**

Data collected by citizens needs to be investigated and validated. The quality of data collected by volunteers is obviously influenced by the survey design, the training materials and the support provided. It is important to minimise the opportunities for errors and validate the data before considering it in the analysis of results. Validation and verification are particularly important when the results are to be published in scientific literature, or used in national data infrastructures.

Verification is easier when participants provide photos. Another procedure is to verify a subset of the data, e.g. by requesting samples to be sent in or by accompanying participants and observing the measurements that they take<sup>10</sup>.

It is really important to provide feedback to participants. Methodology and timing depends on the target audience, on the budget available and on the way data is dispatched. In general it is possible distinguish three broad categories of target.

### **1. Citizens**

Thanking citizens for taking part in citizen science project shows that they are taken into consideration, encourages their continued involvement and gives them a sense of achievement. Rapid feedback to citizens, by email or short message on phone is a powerful way of motivating participants.

#### **In short**

- ▶ Data quality is influenced by the kind of survey, training and support.
- ▶ Validation and verification are important.
- ▶ It is important to provide feedback to participants.

A brief summary of results can be published on a regular basis via a newsletter, blog, social media or email and it is useful to analyse and report with an end of the year or end of the project paper the results obtained.

Real time maps are a good way to show that data furnished have been incorporated in the dataset. Different levels of detail and different types of visual representation of the data will be required.

### **2. Scientists and policy makers**

Citizen science can be an important tool in helping to meet the need for environmental monitoring and to address the challenges outlined within the emerging governmental biodiversity and environment strategies. Effective communication of the results of the project will help to ensure the maximum use of the collected data, which could also inform future strategies. The written communication style for this audience will usually be very different to that used for a public or media audience. Scientists and policy makers will be interested in the broad results (e.g. what data show and how the results fit with the wider picture) but also in the details (e.g. the methods and analyses employed, data quality, types of graphical or statistical outputs etc...).

### **3. Media and press**

This kind of audience prefers short phrases that explain what has been done and for what purpose, so that the communication is relevant to viewers or readers. In this case the feedback can be a brief summary written in a way that will capture their interest and imagination.

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*Case study*

**India Biodiversity Portal,  
an example of data verification  
guided and supported  
by the citizens**

The India Biodiversity Portal (IBP) is an open access biodiversity information platform launched in India in December 2008, with two main objectives: aggregating curated biodiversity data for all species in India and creating/ stimulating social networks where biodiversity amateurs and experts can interact. The portal is participatory and all information is freely and openly accessible by any member of the public. IBP operates on the belief that biodiversity and conservation information are essential social goods that should be freely

available for all to access. The observation of the citizens, with supporting media (image, audio or video), location, date and a taxonomic name (if known) along with observation notes, can be upload via web and the “Observation module” facilitates crowd sourcing of biodiversity information and participation through citizen science, to aggregate spatial and temporal species distribution data. Interested participants can interact on an observation by helping identify the documented organism, agreeing with an existing identification and wcommenting upon the observation. Multiple participants may agree upon a suggested name and the maximum voted name is chosen

by the system as the reigning name for the observation. Species curators may also validate a name to lock the observation identity. On identification and allotment of a scientific name, observations are automatically associated with the corresponding species page and location coordinates are instantly added to the occurrence map of the species. Furthermore, the date of its observance is harnessed for plotting its temporal distribution; custom fields may contribute to specific species page fields and images from the observation becomes available for experts to validate and be extracted into the species page gallery.

<http://indiabiodiversity.org>

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*Case study*

**UK Ladybird Survey,  
an example critical  
communication and feedback**

The UK Ladybird Survey is a programme launched in 1971 that collates and analyses records of ladybird species found in Britain and Ireland. The observation of citizens (Species, presence/

absence (often abundance), life stage, colour, habitat, and behaviour notes) can be submitted by on line recording form or mobile phone app. A rapid feedback is provided through email for every record received with a photograph. The species are validated by expert and automatic checks for date and locality. Different types

of feedback at different level of detail are also provided by national and regional press, website, Twitter, publications, talks, workshops, exhibitions. The feedback to volunteers is critical for ensuring continued contribution to the UK Ladybird Survey.

<http://www.ladybirdsurvey.org>

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# The citizen

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## The engagement

Citizen science is an important way of connecting people with nature, of increasing awareness of the environment and of the resources that nature provides us and can be used to help organisations and policymakers to communicate the importance of their work in the area of nature conservation. However, without a specific target definition some initiatives could miss their mark and fail to provide the expected benefits to science, society and policy.

There are several societal and technological trends that boosted the growth of citizen science today (improved education, enough income to be able to spend leisure time, ownership of smartphones with access to internet) which have favoured the engagement of “white men aged 20-65 from well-to-do socioeconomic backgrounds<sup>3</sup>”. This trend could hinder the social inclusion value of citizen science, with special regard to the inclusion of new or disadvantaged social groups. Therefore, if a citizen science initiative means to have a value from the social inclusion point of view, the choice and the engagement must be intentional foreseeing specific tools.

Specifically, in defining the target it is necessary to assess: the profile of those to be engaged, the age, their motivations, the geographical level, and subsequently the correct approach and specific tools to be used towards the achievements of the results. It is crucial to consider that the recruitment strategies or tools will influence participant profile. There are simple routes to overcoming this challenge but, more generally, special attention should be paid to those that are, mostly unintentionally, excluded from citizen science activities<sup>3</sup>.

In any case, there are some advices that should be put in place: identify target participants early on; bear in mind what can be their motivation, tailor supporting material accordingly; run a small-scale trial; take into account the option of a face to face meeting; be open to change.

### In short:

- ▶ It is important to define the targets and motivations at an early stage.
- ▶ For citizen science to have social value, target and tools must be clearly identified.
- ▶ Recruitment strategies can influence participant profile.
- ▶ Citizen science can engage a broader audience in social agenda.

For a successful citizen science initiative it is critical to respect citizens' contribution, treating wisely and fairly the mutual relation and giving, when appropriate and possible, something back to the volunteers. This would also avoid the citizens feeling “exploited”.

The majority of citizen science initiatives focus on the engagement of groups with an existing interest in the subject of the campaign. This may be an effective strategy to engage an interested and skilled audience, which can favour the production of good quantity and quality data. The “altruistic motivations” are also very important (such as help nature or contribute to scientific knowledge). Many citizens participate for sharing or enjoyment reasons, to gain practical skills or for “personal” motivations (such as specific threats to the community the citizen belongs to).

Citizen science can represent a method to outreach, educate and engage a broader audience in a broader environmental and/or social agenda<sup>9</sup>, especially to social and environmental activism at local scale. Citizen science at local scale may be very effective to bring people together around a collective concern. Citizens may strengthen their expectation that local action will result from their data, but for many reasons this may not occur. Once again, it highlights the importance of make clear the citizens' motivation at an early stage.

At country level, citizen science can be very supportive for specific policy objectives and processes. Numerous citizen science initiatives have been developed at country level especially for environmental issues (i.e. air quality, noise level) and ecological monitoring. But citizen science has proved to be effective also in other fields as medical research or food production and agriculture (for example a project has been carried on in 2009-2013 engaging 400 farmers in France for provide observations on pollinators, earthworms, molluscs and beetles useful as biodiversity indicators but also to improve farming practices).

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*Case study*

**OPAL, an example of social value of citizen science**

The Open Air Laboratories (OPAL) network is a UK-wide citizen science initiative funded by the Big Lottery Fund since 2007. This initiative is very remarkable in its success to balance the scientific value and the ability to engage marginalized groups in society.

Citizen scientists submitted more than 54,000 surveys for 23,000 sites and 21 scientific papers were published. The project engaged over 930,000 people and many of the 3,500 schools that have taken part are settled in areas of high deprivation. Different purposeful activities have been carried out to diversify the participation of citizens, as OPAL is meant to allow citizens

“to get hands-on with nature, whatever age, background or level of ability”.

Notwithstanding an emphasis on education and awareness purposes, some activities provide the opportunity for participants to become experts in the classification of species.

<https://www.opalexplorenature.org/>

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*Case study*

**IspyNature, an example of biodiversity awareness for young people**

iSPYnature was created to encourage young people to develop their interest in nature or wildlife specifically in Ireland. The project takes a different approach to increasing biodiversity awareness, through not simply give out information

on species and habitats but encourage younger generation to directly make observations of local wildlife and record what they see. iSPYnature provides online tools so that the user can see a plant or animal, record it in a note book and then use iSPYnature.com to mark its approximate location on a map, and write in their nature notes. Only the user can see its online notes and the data belongs to the

user who submitted it. Since no data is gathered for scientific purposes, the project has a relevance for its education/ awareness value. In particular, the website is very simple and user friendly, and the colours and drawings used are effectively studied to attract young people.

<http://ispynature.com/index.php>

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## Communication

The amount, level, tools, targets of promotion of an initiative must be carefully planned at an early stage. Promotion is particularly critical to the successful recruitment of participants without which a citizen science initiative would be impossible.

The amount of promotion required depends basically on the size of audience that are aimed to reach. It is important not only to attract but also to retain people willing to contribute their time and effort for a citizen science initiative. The majority of volunteers performs activities just one day and do not return. Keeping volunteers engaged requires finding out what motivates them in the long time scale, and collecting first positive hands-on-experiences with science, continuous information flows and well adapted tasks<sup>8</sup>.

In general, communication via the mass media is appealing for many organisers of citizen science initiatives, especially for some large, funded projects that can benefit from the efforts of dedicated staff. Smaller but equally valuable projects may rely on scientists, teachers and community organisers with limited time and resources for recruitment and communications. Especially in such cases, it is crucial to explore alternatives, as organisations' newsletters or social media (e.g. Twitter and Facebook) which has

opened up new opportunities for promoting projects and communicating with participants.

Social media can allow communication to be targeted to potential audiences, and provides the opportunity for promotion to be amplified via "word of mouth". Workshops and training sessions can provide invaluable face to face contact with project participants<sup>5</sup>.

Different publication offer comparative analysis of the various tools (for an example see Figure2 below). Whilst not advocating that every citizen science initiative should involve meetings with all participants, many examples highlight the need to consider alternative ways. Technology is only part of the tools, and face-to-face communication is sometimes vital for developing long-term cooperation with participants.

In general, varied approaches to communication will ensure projects are promoted in a way that meets the requirements of the diverse range of potential participants.

To offer advice on recruiting volunteers, the Cornell Lab of Ornithology's developed a citizen science toolkit<sup>1</sup> highlighting the importance of considering how chosen recruitment strategies will influence the participant profile: using new technologies such as smartphones could be a useful way to engage young

Method		Reasons for use (and associated challenges)
Online/offline communication	Websites	Allows quick and easy updates, using maps and pictures to visualize results
		Enables all partners to contribute/share content
		Allows for dedicated research findings websites
		Host forums for discussion and chat (moderation of the forum is often by volunteers)
	Newsletters	Enables to save money avoiding printing and posting
	Social Media	Allows easy information sharing
	Emails	Two-way communication with individuals (must be careful not to bombard participants, can be time-consuming)
Face-to-face communication	Media (press, radio, TV)	Opportunity for mass communication
	Annual conference, workshops, meetings	Meeting in person
		Offers talks
		Involves some training

people, or it could present a barrier to participation for those who are less likely to have access to such technologies.

It is important also to notice that new ways of interaction through social media also may improve the interaction between science-society-policy agents.

There are also some initiatives highlighting the value of artistic approaches for participatory

science, bringing wider public into the process and encouraging creativity: “the emotional side of communication acquires a new dimension while new formats of visualization of scientific data are consolidated. The number of shared spaces of conceptualization, observation and interaction between science-technology-arts is growing as complement of more established spaces like science museums”<sup>8</sup>.

**In short:**

- ▶ Communication is critical for successful recruitment.
- ▶ Amount, level, tools, targets must be planned at an early stage.
- ▶ It is important not only to attract but also to retain participants.
- ▶ Face to face communication can be vital for developing long term cooperation.

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*Case study*  
**Best for Biodiversity,  
an example  
of the most appropriate  
engagement methods**

The main objectives of the LIFE Information and Communication project BEST FOR BIODIVERSITY, (LIFE10 INF/ PL/000673), also honoured as best of the best LIFE project in 2016, were to promote in Poland best practices for the protection of forest species and habitats, and to raise societal awareness of the importance of forest biodiversity and the activities being conducted to protect forest ecosystems, especially in Natura 2000 sites.

The project gathered together this information and promoted it to two target groups: the general public and experts (especially forest managers). For two such different targets, the project partners have developed and used two radically different approaches. In particular, workshops and manuals were directed to managers while a series of films were produced to increase the awareness of citizens. The documentary series “A World Preserved” was first broadcast on TVP1 in May 2014, with repeat showings on other national television channels. Each 30-minute episode was hosted by a well-known presenter in

Poland and featured different guest celebrities, including actors, musicians and other TV personalities, to help draw in larger audiences. These films attracted nearly 8 million TV viewers, while 44 films trailers were seen on TV by more than 12 million viewers. In 2016, the series is still on air on some channels. The project produced all expected quantified results and in some cases exceeded expectations thanks to financial savings. The trump card of this project it was to clearly define the target and locate the most appropriate engagement methods.

[www.bestpractice-life.pl](http://www.bestpractice-life.pl)

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*Case study*  
**The Riverfly Partnership,  
an example of bottom-up  
approach**

**The Riverfly Partnership** was a project in UK conservationists, entomologists, scientists, water course managers and relevant authorities, working together to protect the water quality of rivers, to understand and conserve river-

fly populations and habitats. This project had a bottom-up approach involving citizens because it concerned places that were important to them, empowered them to seek improvements in water quality. A further motivation comes from knowing that their data could have impacts on management of the river. This feeling was enhanced through jeopardy, because the rivers were potentially vulnerable

to pollution events which, without the data, would go undetected. In this case the citizen science and policy mutually reinforcing. The partnership successfully worked to create a larger sense of community among participants across the country, so supporting the efforts of individuals.

[www.riverflies.org](http://www.riverflies.org)

# The projects

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## Education values

The involvement of citizens in scientific projects tends to have an educational value, implicit or explicit; while education is not an explicit goal it is frequently a strongly valued purpose.

Citizen science generates a diverse set of outcomes for science, participants and socio-ecological systems, which moreover, determine the success of a project. The most important goal of all citizen science projects is scientific progress, but also improvements in participants and local communities, as well as educational benefits should be considered. The degree to which the different outcomes are realized depends on the type of project and on its main purposes.

As regards the scientific progress, a citizen science project might focus on a specific species, habitat, ecosystem or environmental process. In these cases, participants will benefit, at least, by acquiring a deeper understanding of that specific species or habitat.

Besides providing opportunities to gain knowledge about the environment, citizen science projects help develop scientific, problem-solving and creative skills and address environmental education goals through hands-on, outdoor activities that promote connections with and an appreciation of nature, biodiversity values and ecosystem services.

In any case, citizen science is valuable in enhancing understanding of how science works providing a first hand experience. While citizen science activities must be fun in order to be engaging, the research aspect must also be taken seriously if participants are to appreciate that they are contributing to “real science”. The goal of scientists is often to introduce citizens to their domain and to increase participants’ understandings of scientific processes in general and the role of science in society.

Educational value depends to some extent on the baseline level of knowledge of participants as well as the level at which they are engaged in the scientific content. If participants are only involved in simple activities, such as taking measurements or recording observations, they are likely to have few opportunities to learn.

In these cases, the full potential of citizen science in education may not be realised.

Various researchers have argued that most citizen science projects benefit scientists (through data collection) more than they do citizens.

It is widely agreed that citizen science should go further to resolve issues of participation in science or promote scientific literacy. Mueller<sup>4</sup>, for example, suggests that the reimagining of entire science education systems could provide the basis for societies that take a more participatory approach to decision-making, starting with teachers, who become “active agents of democracy”.

While in the majority of projects the informal learning aspect of adult citizens is addressed, schools are more and more considered an important target for the introduction and promotion of citizen science. Within a formal education context, it is important to recognise the role that teachers play as facilitators, as with the appropriate support and resources, they are able to encourage their students to participate. Teachers play a relevant role easing the deployment of experiments and transmitting the socio-scientific values of their contributions to their students.

Designing a citizen science project that connects with both teachers and students, or different categories of participants requires catering to different audiences.

Many citizen science guiding material, suggest to provide customized education and training material for specific target groups so as to give access to appropriate information and therefore ensure the appropriate quality level of the data gathered. Some misguided perceptions of citizen science assume that, because the people who contribute the data are not employees, they cannot be put into appropriate training programs, and be asked to follow quality assurance procedures, or be expected to use standardized equipment.

One of the major barriers to the use of information produced through citizen science is the perception that the quality of research carried out by citizens does not match that of research carried out by scientists. However, various researches ensure that citizens can certainly attain appropriate levels of scientific rigour if adequately trained and mentored throughout the projects duration.

Training provides an excellent way to build skills and retain involvement in a project, and provides rewards for participants.

The educational potential of citizen science projects has also received policy attention.

For example, UNESCO identified citizen science as an important area within the agenda of Information and Communication Technologies (ICT) use in science. In the final World Summit on the Information Society (WSIS+10) Declaration, there is an explicit call on UN members to “encourage the use of ICTs, (...) to facilitate greater participation in the entire scientific process including public participation in scientific research (citizen science) activities and the introduction of e-science activities in the context of all forms of education”.

#### **In short:**

- ▶ Citizen science can have educational value.
- ▶ Citizen science can help developing scientific, problem-solving and creative skills.
- ▶ Citizen science can help citizens to understand and appreciate the role of science in society.
- ▶ Citizen science should empower citizens to adopt more active roles in society.

Moreover, the European Commission stated in its official declaration for Horizon 2020: “with the aim of deepening the relationship between science and society and reinforcing public confidence in science, Horizon 2020 should favour an informed engagement of citizens and civil society on research and innovation matters by promoting science education, by making scientific knowledge more accessible, by developing responsible research and innovation agendas that meet citizens’ and civil society’s concerns and expectations and by facilitating their participation in Horizon 2020 activities”. In the best-case scenario, citizen science should empower citizens, through education and involvement in scientific and decision-making processes, to adopt more active roles in society.

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#### *Case Study*

#### **The Big Butterfly Count, an example of a nationwide survey**

The Big butterfly count is a nationwide survey carried out in the UK since 2010 and rapidly become the world’s biggest survey of butterflies. Over 36,000 people took part in 2016, counting almost 400,000 individual butterflies. The project is directed by the Butterfly Conservation Charity Organization, with the support of actress Joanna Lumley OBE also known in the UK for her social engagement. Butterflies have been chosen for their role of biodiversity indicators, as their declines are an early warning for other wildlife losses. Following this assumption, a very effective slogan has been adopted: “The Big Butterfly Count is about more than just counting butterflies – we’ll be

taking the pulse of nature”. Citizens are asked to simply count butterflies for 15 minutes during bright (preferably sunny) weather during a selected time of year. For example, big butterfly count 2017 will take place from Friday 14 July to Sunday 6 August. Records are welcome from anywhere: from parks, school grounds and gardens, to fields and forests. Through an handy identification chart provided by the project, participants will be helped identify which species of butterflies have been seen and submit records online or by using a free application. Very interesting is the method adopted to train the potential participants. On the project website, citizens can find a brief video tutorial (3 minutes) in which Mike Dilger, an ecologist and ornithologist very well known in the UK as a reporter on

the wildlife of a BBC program, explains and demonstrates what needs to be done to take part in the project by following the steps that each must follow. The project is easily accessible to citizens via the intuitive and explanatory site graphics. Through an interactive map, visitors can view the count’s results in a specific geographic area, or in a limited time period, or for a precise habitat or observations of a single species. There is also a table listing the species of butterflies more reported and the comments of the people who took part in the project. The downloadable version of the project poster is available on the website, not only in English, but also in Welsh and Gaelic, in order to attract as many people as possible.

<http://www.bigbutterflycount.org/>

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*Case study*

**Celebrate Urban Birds,  
an example of youth  
development opportunities**

Celebrate Urban Birds is a citizen science project founded in 2007 and focused on better understanding the value of green spaces for birds. The main goal is to collect high-quality data from participants that provide valuable knowledge of how different environments will influence the location of birds in urban areas. Launched by the Cornell Lab of Ornithology in the USA, the project connects people of all ages and backgrounds to birds and the natural world through the arts and neighbourhood activities.

The participants range in age from preschoolers and kindergartners to seniors, and more than 75% have little or no experience with birds. The sixteen target focal species can be found in a wide range of environments throughout North America and the project participants collect data from Canada and Mexico.

The project website is very attractive and clear, offering information (both in English and Spanish) on objectives, how to cooperate, results etc. It is active on all the main social media (Facebook, Twitter, Flickr) and an educational kit, newsletter and blog have been developed.

The project offers also mini-grants as youth development

opportunities. In the last 10 years, CUBs has partnered with over 12,000 community-based organizations, distributed more than 500,000 educational kits, and awarded dozens of mini-grants. The project has also developed side initiatives to engage people also through arts. For example, the Funky Nests in Funky Places contest. People are invited to participate in the contest sending picture, video, poem, or artwork about a bird nest in a funky place (“a hanging flower basket, a street light, a store sign, your barbecue grill, an old boot ...”).

<http://celebrateurbanbirds.org/>

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## Tools and technology

Even though not everyone is technology expert and some people do not have ready access, in financial and/or coverage term, it is beyond doubt that over the past decade, technological developments are revolutionising citizen science. Advances in technology have made it easy to set up and promote data collection, but also visualization and analysis of data.

### Data collection

Web-based data capture, analysis and presentation tools and smartphone apps are in common use, and a wide range of next generation environmental sensors are under development.

#### *Website*

Websites have become the mainstay of citizen science projects. Almost all citizen science projects have a website to promote and explain projects, and a majority collect data via the website. A good website can allow online data entry, data validation and real-time mapping of citizens' results. It can also provide background materials, training resources and forums and blogs through which participants and project developers can interact as part of a project community.

#### *Smartphone apps*

The progressively wide diffusion of smartphones is enabling a revolution in data collection, considering also the availability of GPS for accurate geographical locating. With a smartphone, the citizens can participate submitting the data directly from the field and where it is collected and submitting geolocated photographs helps validation and verification. Many apps provide also a similar function in allowing users to furnish automatically a location, submit a photograph and provide some additional pieces of information.

#### *Sensors*

The use of sensors for collecting data has been increasing with the advances of in-built sensors in

smartphones and the development of plug-in sensors. The development of plug-in sensors for smartphones allows specific information to be collected from the sensor and combined with other advantages of the smartphone (e.g. mobile connectivity and GPS)<sup>6</sup>. A development of built-in and plug-in sensors could provide high spatio-temporal resolution data, which may be particularly relevant for surveillance of air quality or weather, and other physical characteristics. Downloading data from remote automatic sensors in the field could become a competitive activity, similar to geocaching.

#### *Image and sound analysis – extracting information*

Citizen science often involves people also in interpretation of things they sense in the natural world and in a subsequent submission of a summary (e.g. a species identity, a measurement, or a count). Alternatively the citizens can be a collectors of samples (e.g. images or sound recordings) from which information can be extracted in an automated and systematic way.

### Infrastructure to visualize, and provide feedback

Technology is also important not only to collect data but also for infrastructure, the use of online databases, visualisation of data and feedback. There are many examples of mature technologies for databases and for visualisation that generally can be divided into:

- 1) bespoke technologies that are designed for a specific purpose and audience
  - 2) adaptable template type platforms where the project leader can modify the content within the bounds of the fixed parameters of the platform<sup>5</sup>.
- The development of new technologies and their application in citizen science will provide exciting opportunities not only for data collection, analysis, data sharing and hence greater use and re-use of citizen science data, but also in various applications and in regulatory decisions. To build robust societies, sharing data and creating open systems, policy-makers and the public must have access to the right data and information to inform good decisions.

### In short

- ▶ Technological developments are revolutionising citizen science.
- ▶ Technology have improved data collection and infrastructures development.
- ▶ Policy makers and the public must have access to data to inform good decisions.

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*Case study*

**California Roadkill Observation System, an example of web mapping application**

The California Roadkill Observation System (CROS) system is used in USA to record observations about road-killed wildlife. Citizens can contribute using mainly forms and drop-down lists on the CROS website. The observations recorded include information such as the type of animal and/or species found, where the road-kill was

located, when it was found, how long it might have been dead, pictures of the road-kill, and other additional details about road or traffic conditions. CROS develops a spatial database which is used to store all of the road-kill information. GIS analysis is performed on this database. Web mapping applications are built from the database. Information about where wildlife vehicle collisions occur, what animals are involved, on what kinds of roads are collisions frequent, and other data can help inform

policy, management, and financial investment in reducing road-kill. The mission is to provide a safer environment for wildlife in relationship with California motorways. This includes the application of GIS and statistical modelling to predict road-kill hotspots, to measure the contributing factors to road-kill, to quantify impacts, and to estimate benefits of different remedial actions.

<http://www.wildlifecrossing.net/california/>

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*Case study*

**Open Source Beehives, an example of use of sensor in citizen science**

The bees are important pollinators facing myriad problems ranging from car exhaust to a pesticides and fungicides, all threatening to push bees to extinction. Technology come to the rescue and help us monitor and perhaps save these important insects.

Open Source Beehives is one of the first projects that is using open source hardware, software, and community-collected data to understand the causes of and solutions to the decline in bee populations. The project expects to design hives that can support bee colonies in a sustainable way, to monitor and track the health and behaviour of a colony as it develops. Each hive contains an

open source sensory kit “The Smart Citizen Kit (SCK)”. SCK can transmit information to an open data platform: Smartcitizen.me. These sensor enhanced hive designs are open and freely available online, the data collected from each hive is published together with geo-locations allowing for a further comparison and analysis of the hives.

<https://opensourcebeehives.com/>

<https://www.treehugger.com/clean-technology/smart-sensors-citizen-science-save-bees.html>

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# The community

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## Data use

The breadth of environmental-based citizen science is potentially immense. Citizen science provides an important means of combining environmental research and education with wildlife recording. The most common form of involvement of citizen in environmental citizen science is in the contribution of data in the form of observations (species, habitats, water quality etc). Most of the project involve citizens as data collectors which surveying for and monitoring a broad range of taxa, and also contributing data on weather and habitats.

There are many examples of the utility of data collected by volunteers. One of these is for example the production and use of national atlases with maps of presence/absence. Atlas maps and the accompanying datasets have been put to numerous uses. The results of Atlas surveys can also identify important declines in species frequencies, which have then been taken up by policy makers<sup>6</sup>. Citizen science in these cases has also set the policy agenda rather than merely provided information required to further policy requirements defined elsewhere.

Environmental citizen science can give a support to identify the demands of Biodiversity 2020 targets

and need for evidence to underpin policy through various statutory indicators require such data.

However is evident that the value of citizen science for monitoring the environment and providing evidence to underpin policy has been underestimated. Over the last few years there have been a number of publications that demonstrate the utility of citizen science for policy and other purposes highlighting the role of volunteers in environmental monitoring, even though the citizen science is not always explicitly mentioned.

Many European projects make links to key policy objectives, and even provided data to support monitoring as outlined under European law, for example, the National Bat Monitoring programme delivers “information needs” to help fulfil the UK’s obligations under the Habitats Directive<sup>7</sup>.

Whilst these demonstrate the power of citizen science for generating evidence, both citizens and policymaking could also benefit from more participatory approaches.

At present, there appear to be relatively few examples of participatory and interactive citizen science initiatives. It is desirable that such types of projects increase and have a tangible impact on decision.

### In short

- ▶ There are many examples of utility of data collected by volunteers.
- ▶ Citizens and policy making can benefit from participatory approaches.
- ▶ Citizen science could have more tangible impact on decisions.

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### Case study

#### **National Bat Monitoring Programme, an example of monitoring to supports European Law**

The National Bat Monitoring Programme NBMP is an annual andw periodic programme to monitor population trends of bats in the UK in order to determine their status and deliver information needs for country biodiversity strategies. The NBMP was designed to encourage maximum involvement of volunteers

and to be as inclusive as possible, whilst also using the best available survey techniques and technologies available at the time. Volunteers sign up to the programme from a wide range of sources. The main recruitment routes are NBMP bat detector workshops, bat group members, the website, other internet sources and through existing volunteers and country-level Bat Officers. Information from the NBMP is used to help direct relevant conservation action to sustain bat populations and the

habitats on which they depend. The programme provides information that helps measure outcomes for UK country biodiversity strategies and information that allows the conservation status of bats in the UK to be assessed in accordance with the Habitats Directive, the UK Biodiversity Action Plan and the UK and England Biodiversity Indicators.

<http://www.bats.org.uk/pages/nbmp.html>

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*Case study*

**The YardMap project,  
an example of interactive  
citizen science project**

The YardMap project, created by the American non-profit organization Cornell Lab of Ornithology, seems to be the first interactive citizen scientist social network. It combines an interactive mapping application with an online community site. It designed to cultivate a richer understanding of wildlife habitat, for both professional scientists and people concerned with their local environments. The mapping

application allows users to map their gardens, with habitats for wildlife in mind, and the community elements encourage discussion among map creators. The scientist collect data by asking individuals across the country to literally draw maps of their backyards, parks, farms, favourite birding locations, schools, and gardens and they connect the citizens with the landscape details also providing tools to make better decisions about how to manage landscapes sustainably. In other words citizens involved in YardMap help scientists to know what practices improve

the wildlife value of residential landscapes, which of these practices have the greatest impact, what impact do urban and suburban wildlife corridors and stopover habitats have, for example, on birds which measures (bird counts? nesting success?) show the greatest impacts of practices etc.... YardMap represents a peculiar case in which the involvement of citizens drives the management of landscape, on sharing strategies, maps, and successes to build more wildlife habitat.

<http://content.yardmap.org/>

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## Interoperability and networking

In an increasingly complex and interconnected world, it is more and more important to define common rules and shared practices. This is especially true for cross-borders issues such as patterns of bird migration, pollution or biodiversity monitoring that requires collaboration among multiple countries.

There is a need to set coordination mechanism both at technological, procedural and legal level. From the start of the data gathering process, it is crucial to be aware of the source of the data and on information that accompany the citizen science information (metadata) to assess the relevance on information for a given analysis. This is particularly true in the cases where citizen science is part of an approach used for achieving policy goals. From a policy making perspective, in fact, the quality/origin of data used for decision making is crucial.

One of the most important metadata standard in place, the one introduced in 2007 through the EU INSPIRE directive (Infrastructure for Spatial Information in the European Community), do not include citizen science data since it assumes that the information are produced in an industrial standardized process.

The Aarhus Convention, introduced in 1998 to regulate the public access to environmental legislation, participation in decision making and access to justice, ensured the provision of environmental information to the public; but at the time it was set, the potential of public participation for the production of environmental information was not envisaged.

There is therefore the need of further legal amendments and/or guidance to integrate citizen science data into the overall framework thus allowing the data sharing with common rules.

In recent years, the scientific community generally supports the culture of openness for data and access to data. But open access, which implies that the outcomes of research are free to access and reuse, is critical for several aspects, first of all for citizens in terms of recognition and learning. As specified by Muki Haklay in his report<sup>3</sup>, “as citizen scientists gain recognition within the scientific community, it becomes more common to recognize their contribution in scientific publications or in published datasets. (...) Such feedback has been shown to be part of the motivation for citizen scientists to continue their engagement (...).

The other contribution of open access publications is to allow citizen scientists to learn more about the topics they are investigating”.

Open access is critical also for issues as privacy or sensitive environmental data. Individual citizens' privacy could be protected by not collecting any personal information, but this would limit the communication with participants and the potential of feedback which is instead very important. Similarly, access to information about rare or endangered species must be appropriately regulated.

Opening data sets raises also important question of ownership and IPR issues. Only few projects have a clear policy about this, and very often volunteers are not informed about the intellectual property rights of projects they have been involved in.

Moreover, economic issues should be considered. Access to data can represent a source of income necessary to maintain the infrastructure and projects' overheads. Open access could then undermine a fundamental source of funding.

Furthermore, there are also technical challenges. There have been some efforts towards the interoperability of data and data sets but defining data standards that all citizen science projects can use seems still far from being realized.

Some worldwide initiatives have been put in place. For example, data portals such as the Global Biodiversity Information Facility (GBIF) provide access to free and open-to-use biological records, of which about a third originate from citizen science records. In the US, DataOne is a repository that lists where different environmental datasets are stored and how they can be accessed by others.

Besides, in recent years the scientific communities involved in citizen science initiatives recognised the need to organize themselves in structured association and share best practices. The first organization to be created was the Citizen Science Association (CSA), based in the US, with the aim of supporting the global community of citizen scientists.

More recently, the European Commission and European Environment Agency (EEA) recognised the value of citizen science with the establishment in 2013 of the European Citizen Science Association (ECSA). The EEA supports ECSA carrying out dedicated workshops and providing information, while the European Commission indicated citizen science as an important issue in several Horizon 2020 calls.

In 2014, the Citizen Science Network Australia (CSNA) was established to focus on creating a community of citizen science practice in Australia.

The three organizations maintain a dialogue with each other to ensure coordination. This is particularly important since the coordination inside the citizen science community will help develop and agree on ethical and quality guidelines which should define methods and infrastructures for data collection and sharing: quality, reliability and interoperability standards, data handling tools, sensitive data

processing, policy restrictions, intellectual property rights and ethical issues.

It is widely recognised that results of any publicly-funded research should be accessible to everyone, and because citizen science information is produced on a voluntary basis, there are growing calls for the information to be shared with those who provided it as well as with the scientific community.

Exchange of data, as well as of expertise, is crucial for progress and needs to be enhanced.

**In short:**

- ▶ It is important to define common rules and shared practices.
- ▶ There is the need to set coordination mechanism at technological, procedural and legal level.
- ▶ Open access may be critical for recognition, privacy, ownership and sensitive data.
- ▶ Citizens associations worldwide are important to address critical issues in a coordinated manner.
- ▶ Exchange of data and expertises is crucial for progress and needs to be enhanced.

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*Case study*

**The European Citizen Science Association, an example of continental cooperation**

Launched during the EU Green Week in June 2013, the European Citizen Science Association (ECSA) is a non-profit association set up to encourage the growth of the Citizen Science movement in Europe in order to enhance the participation of the general public in scientific processes. ECSA's goals include advancing knowledge about sustainable development and engaging with disadvantaged communities to

encourage them to “take an active role in the development of a sustainable society helping to protect and improve health and the environment.”

ECSA draws on +200 individual and organizational members from over 28 countries across the European Union and beyond, offering the opportunity to interact among groups and disciplines that already have or want to build a relation to citizen science. As set in the ECSA strategy, it will conduct research and support refinement of methodologies, increase capacities and develop three interrelated

key competencies: Promoting Sustainability through Citizen Science, Building a Think Tank for Citizen Science, Developing Participatory Methods for Cooperation, Empowerment and Impact.

ECSA Vision is that, in 2020, citizens in Europe are valued and empowered as key actors in advancing knowledge and innovation and thus supporting sustainable development in our world.

[www.ecsa.citizen-science.net](http://www.ecsa.citizen-science.net)

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*Case study*

**Citizen Science Italia, an example of national cooperation**

In January 2016, has born the informal working group named Citizen Science Italia (CSI). Members of the CSI are mainly

Italian researchers involved or interested in citizen science initiatives and projects.

CSI has set an online forum through which members can exchange ideas and best practices, raise proposals and agree on progresses to be made.

# Conclusions

## Main achievements

- ◆ CSMON has contributed to promoting a national movement for the development of citizen science activities to monitor biodiversity, laying the foundations for an active community of citizens, researchers and decision makers.
- ◆ CSMON has established a solid data validation protocol, a key factor for research and for the development of new environmental policies.
- ◆ Thanks to the engagement of local institutions and organizations as an element of contact between citizens and science, activities carried out by the project can be transformed into concrete actions.
- ◆ Conveying Data to the National Biodiversity Network of the Ministry of the Environment boosts the results achieved and returns value to the citizens
- ◆ CSMON has proved to be a project of extensive replication in term of approaches, technologies and protocols.
- ◆ The choice of tools must be commensurate with the results that are to be achieved: with very specifically-targeted activities, few good quality data can be collected; while engaging a large number of citizens can launch more widespread activities requiring high commitment by experts for validation, but collecting many data, often of considerable interest.
- ◆ When activities involve the use of target species, these should be chosen taking due account of the skills of the group of citizens engaged. In addition, their identification must be possible from a photo, to allow for accurate validation.
- ◆ Citizen science helps citizens to develop new skills to be used to improve the environment and quality of life.
- ◆ Citizens are keen to contribute to decision-making and to be an active part in achieving concrete goals.

## Challenges faced and proposals

- ◆ New social media are important facilitators, but they are not sufficient and other communication tools must be put in place to stimulate citizens participation.
- ◆ It is not easy to effectively communicate to the general public the value of a citizen science approach in the field of biodiversity, and consequently communication should be entrusted to professionals.
- ◆ It is very difficult to retain users; botanical gardens, zoos and natural history museums, as well as professional and volunteer organizations, which are permanently present in the territory, can play an important role as catalysts of interest.

## Lessons learned

- ◆ Shared knowledge is crucial for effective management strategies
- ◆ Citizens' engagement in science has a value of cultural progress in itself
- ◆ It is important to go beyond the specific sectors and overcome sectoral divisions by integrating all the different components

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