Citizen science for freshwater monitoring: Motivations, purpose, and impact

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Executive summary

This report examines the role of citizen-led science in monitoring water and, to a lesser extent, soil. Drawing on interviews with citizens, scientists, and stakeholders, as well as two CaSTCo case studies and wider literature, it uses the lens of self-determination theory to examine why people get involved, how citizen science is perceived, the barriers it faces, and what it could look like in the future.

Why citizens take part:

- Motivations include enjoyment, curiosity, and learning new skills.
- Many see participation as a way to protect their local environment and leave a legacy of stewardship.
- Volunteers value the chance to generate evidence and take action, particularly where agencies are absent.
- Self-determination theory shows that autonomy, competence, and relatedness are key to sustaining engagement.
- In poor water quality areas, some citizens participate out of frustration and even anger.

What citizen science offers:

- Expands monitoring capacity far beyond what agencies or researchers can achieve alone.
- Fills critical data gaps, especially where professional monitoring has been reduced.
- Builds legitimacy for environmental action by combining scientific and lived knowledge.
- Creates public awareness and can act as an early warning system for environmental issues.

Barriers and challenges:

- Citizen science is often undervalued and citizen data treated as supplementary.
- Funding cycles are short-term, leading to “boom and bust” project lifespans.
- Participation is often skewed towards older, white, and financially secure groups, limiting inclusivity.
- Some projects risk being extractive, relying on volunteers without feedback or recognition.
- Unease among some professionals who see citizen science as a potential threat to their roles.
- Other barriers include inconsistent methods, lack of integration between projects, limited data use by agencies, and insufficient training.

Find out more about our time travel exercise (inspired by Rob Hopkins) on pages 36-37

READ MORE

Executive summary

Why scientists and wider stakeholders take part

- **Filling monitoring gaps:** Citizen science provides essential data that professional scientists cannot collect alone, offering breadth and frequency of coverage.
- **Extending coverage and targeting hotspots:** Large-scale volunteer networks can deliver monitoring intensity and spatial reach beyond the capacity of agencies.
- **Personal and professional fulfilment:** Scientists value the shared responsibility and enjoyment of working with communities that care about their rivers.
- **Cost-efficacy:** Volunteer-led monitoring generates extensive datasets more quickly and cheaply than professional-only surveys.
- **Driving scientific progress:** Citizen science - if it is to be referred to as 'science', must maintain integrity by producing data of publishable quality, ensuring it contributes meaningfully to science. Some suggested that citizen science efforts that are less 'science-focused' could be redefined as 'collaborative monitoring' or similar.

Key recommendations for future citizen science efforts

- Invest in long-term funding aligned with monitoring cycles.
- Provide ongoing training, seasonal refreshers, and clear quality assurance.
- Establish structured feedback loops so volunteers know how their data is used.
- Use inclusive recruitment, accessible language, and community partnerships to broaden participation.
- Blend volunteer- and coordinator-selected sites to reduce sampling bias.
- Ensure transparency about project purpose, whether awareness raising or monitoring.
- Position CS as complementary to professional monitoring, not as a replacement.
- Improve integration and standardisation across projects.
- Recognise contributions ethically through acknowledgement, data access, and shared ownership.
- Co-design projects with communities and stakeholders to ensure fairness and legitimacy (see Chivers et al, 2025).

Contents

01 | Introduction

Citizen science, perhaps better described as collaborative monitoring, has become a recognised approach in environmental research and monitoring. It enables members of the public to contribute to scientific processes, most often through gathering data, and has gained momentum as official monitoring resources have diminished and environmental pressures have intensified. Citizen science is often framed primarily as a data-gathering exercise, yet its value extends further into learning, trust-building, and experiential knowledge (Billaud et al., 2025). This perspective is particularly relevant in environmental monitoring, where uncertainty cannot always be eliminated and citizens contribute to navigating complexity rather than delivering prescriptive solutions. In the water sector in particular, citizen science has provided vital evidence on water quality, biodiversity, and pollution, often filling gaps left by statutory bodies.

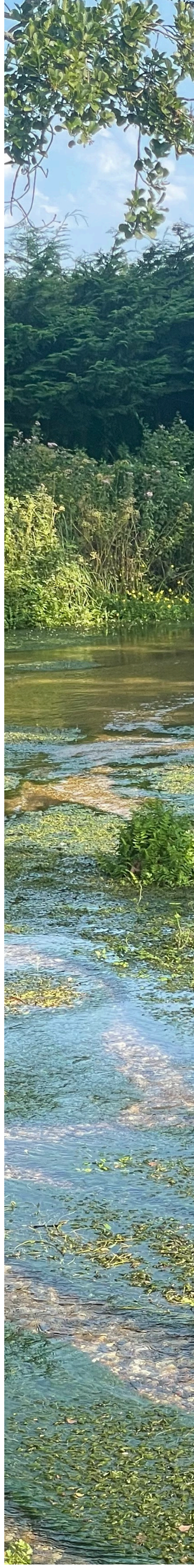
This report examines why citizens, scientists, and stakeholders engage in citizen science, with a particular focus on water-based initiatives. It explores motivations and attitudes towards participation, as well as perceptions of the accuracy, robustness, and purpose of citizen-collected data. The report applies self-determination theory, which highlights the importance of autonomy, competence, and relatedness in sustaining motivation and therefore engagement. This allows us to consider how long-term citizen science projects can be designed to maximise motivation, reduce obstacles, and enhance their overall impact.

The study also addresses the challenges faced by citizen science. Interviews with citizens, scientists, and stakeholders highlighted barriers that affect effectiveness, sustainability, and inclusivity. Some were practical, such as funding gaps, inconsistent methods, or limited training and support. Others reflected broader cultural and structural issues, including the perception of citizen science as undervalued, a lack of diversity in participation, and concerns from some scientists about its legitimacy or even its potential to threaten professional roles.

For scientists and stakeholders, citizen science is valued for its ability to extend monitoring reach, produce decision-relevant evidence, and enable more efficient use of limited resources. For citizens, motivations included personal fulfilment, opportunities for learning and knowledge exchange, and the chance to contribute to issues of topical and local concern. Recognising and building on these motivations is crucial to sustaining long-term engagement.

Throughout the report, we highlight recommendations for future efforts. These include providing ongoing training and quality assurance, creating structured feedback loops to show how data is used, developing more inclusive approaches to recruitment and engagement, addressing practical access barriers through transport and equipment support, reducing site-choice bias with a balance of volunteer- and coordinator-selected sites, and ensuring the ethical use of volunteers through transparency and acknowledgement. At a structural level, we emphasise the need for sustainable funding, greater integration between projects, framing citizen science as complementary rather than competitive with traditional science, and clearer communication of purpose. These measures offer a pathway towards citizen science that is more resilient, equitable, and impactful.

Evidence is drawn from two CaSTCo case studies, together with interviews with citizens, scientists, and wider stakeholders, and wider literature. The report also asks whether citizen science is solely about data collection, or whether it serves broader functions in awareness raising, advocacy, and democratic accountability. Finally, a forward-looking 'time travel' exercise considers how participants envisage the role and scope of citizen science in coming years.



01 | About CaSTCo

The Catchment Systems Thinking Cooperative (CaSTCo) has worked to deliver the first national framework for improved, integrated water environment data, integrated modelling capabilities, openly shared collaborative platforms and decision support tools driving environmental improvement. CaSTCo has reviewed monitoring methods through an audit process that identifies the methods' strengths and appropriate use. It has also provided guidance and investment to strengthen method protocols, training, and data management. This process improves data quality and interoperability so that data of known quality gets into the hands of decision-makers.

This involves collaboration between 24+ UK partners. The partners involved in this particular study include the Countryside & Community Research Institute of University of Gloucestershire, Southern Water, Rivers Trust, Agronomists, agricultural land managers, and wider citizens. Two CaSTCo initiatives we focus on in this report are Soil SmARt and River Guardians, both of which were carried out in the Arun and Rother catchment.

Soil SmARt has worked with farmers and land managers to establish practical, participatory approaches for soil monitoring and stewardship, showing how citizen science can link agricultural practice with environmental objectives.

River Guardians, meanwhile, has engaged community volunteers in monitoring and protecting rivers, with a focus on empowerment, feedback, and collective responsibility. Together, these projects demonstrate how CaSTCo's principles of collaboration, rigour, and openness are enacted in practice, translating frameworks into lived experiences that generate both data and democratic value.

Find out more about CaSTCo here: https://castco.org/

A Tiered Approach to Citizen Science in Catchments

The CaSTCo tiered framework sets out different levels of citizen science monitoring, ranging from simple awareness-raising to data suitable for regulatory decision-making (Figure 1). **Tier 0–1** approaches are about engagement: easy-to-use, low-cost methods that build participation and raise awareness of river health. **Tier 1–2** monitoring provides broader ecosystem screening, generating reliable baseline data and early warnings of pollution issues. **Tier 2–3** investigations are more targeted, using higher-quality methods and stronger quality assurance to identify sources of pollution or pressures in detail.

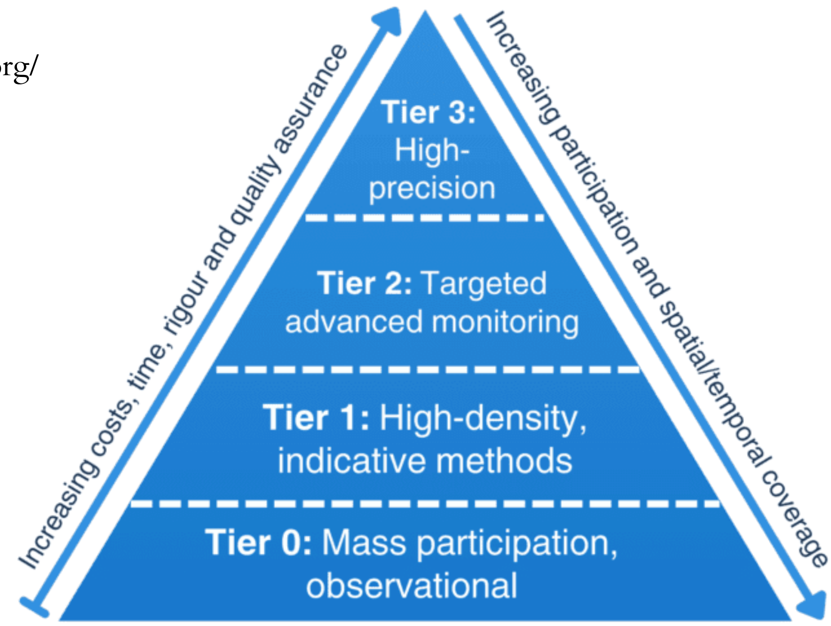
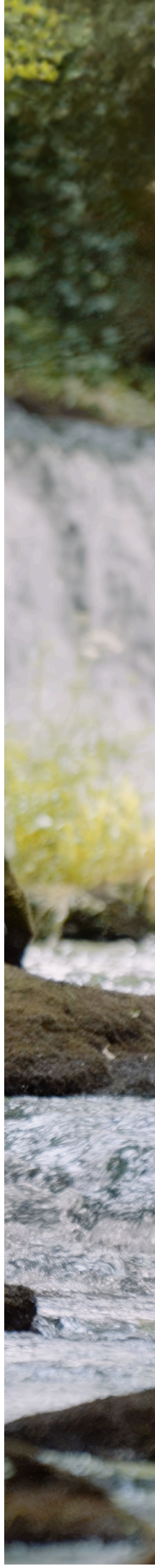


Figure 1: CaSTCo project (2022).

Crucially, programmes often move between tiers over time as their questions, capacity, and resources change. For funders and stakeholders, the implication is that each tier has value: lower tiers build capacity and engagement, while higher tiers can generate legally defensible evidence. Investment should therefore support a pathway across tiers, strengthening both community participation and the credibility of the evidence produced.

02 Methods: exploring perceptions towards citizen science



A suite of interviews were carried out with scientists, citizens involved in various citizen science projects including but not limited to CaSTCo, and wider stakeholders to examine their perceptions towards citizen-led science.

Exploring perceptions from outside of CaSTCo has allowed us to draw comparisons and gain a more national outlook of the citizen science landscape.

Methods

Interviews were carried out to gather qualitative, detailed insights to explore perceptions towards citizen science, ranging from motivations to experiences. Self-determination theory underpinned the protocol and analysis.

- 28 interviews with citizen scientists from outside of CaSTCo
- 15 interviews with citizen scientists engaged in CaSTCo projects (Soil SmARt and River Guardians) and 6 project team members
- 10 interviews with (primarily natural) scientists
- 10 interviews with wider stakeholders

CaSTCo citizen scientists

Ongoing evaluation interviews, which included questions about motivations and purpose, were carried out with CaSTCo citizen scientists involved in either Soil SmARt or River Guardians.

Citizen scientist interviews

We spoke to 28 volunteers involved in projects run by various organisations, including Bristol Avon River Trust, Essex and Suffolk Rivers Trust, River Aire Rivers Trust, Wildfish, Severn Rivers Trust, Riverfly, Westcountry Rivers Trust, Herts and Middlesex Wildlife Trust, and Riverwatch. Several participants were involved in multiple citizen science projects, suggesting a strong motivation to take part in such activities. A full list of projects that these 28 participants were engaged in are provided in the appendix.

Scientist interviews

We interviewed 10 scientists from a range of UK institutions, including Universities and research institutions. Participants came from a range of natural science backgrounds, including hydrology, ecology, and soil science. A variety of career stages were covered, from postdoctoral through to Professorial.

Stakeholder interviews

Stakeholder interviews included organisations who engage with, or may engage with, or lead citizen science. Organisations included government bodies, including senior representatives from Defra, environmental NGOs, and environmental businesses. A range of career stages and backgrounds were covered, including citizen science itself, soil science, and hydrology/river health.

Analysis

We used an inductive-deductive thematic analysis, informed by self-determination theory.

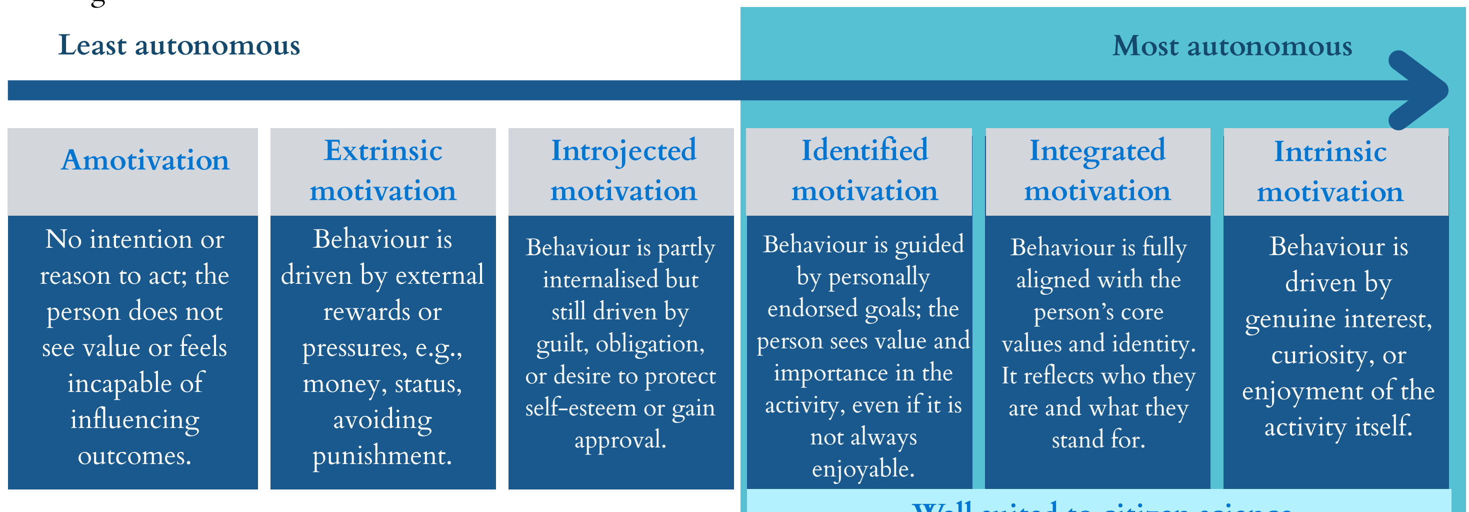
Quotations are included throughout the report to illustrate the lived experiences of participants and to demonstrate how our interpretations are firmly grounded in the data. These are attributed as follows: CS(number) for citizen scientists, RG(number) for River Guardians, SH(number) for stakeholders, and SCI(number) for scientists.

03 Self-determination theory and citizen scientists' motivations

Self-determination theory (SDT) is a relevant framework for understanding what motivates citizens, scientists, and others, to engage in citizen science activities and, crucially, what sustains their participation. Using this to underpin project planning and implementation can help inform future citizen-led science projects for maximising engagement, and ultimately, impact.

Relatively few studies have explored motivations to participate in water-related citizen science, at least not in the UK and Europe[1]. Self-determination theory distinguishes between different forms of motivation, which ranges from amotivation (no intention to act) through different forms of extrinsic motivation (driven by external pressures or rewards) to intrinsic motivation (driven by interest and enjoyment) (Ryan, Kuhl, & Deci, 1997). It suggests that intrinsic or highly autonomous motivation – identified, integrated, and intrinsic – are best suited to citizen science because they are more likely to result in sustained engagement, suggesting that longer term projects should draw on these to maximise retention. Meanwhile, extrinsic motivations (such as rewards or social pressure) may encourage initial involvement which may tend to reduce over time. In short, citizens need to feel genuinely invested if they are to remain engaged in water quality monitoring long term.

Figure 2. The self-determination continuum of motivation. More autonomous forms of motivation – identified, integrated, and intrinsic – are best suited to citizen science because they are associated with greater persistence, performance, social benefits, and wellbeing.



Alongside this continuum of motivation, SDT also identifies three psychological needs that underpin a person's motivation:

- **Autonomy:** feeling in control of one's own behaviours and goals.
- **Competence:** feeling capable, effective, and able to master challenges.
- **Relatedness:** feeling connected to others and experience a sense of belonging.

Citizen science is usually voluntary, so autonomy tends to be high from the outset. The challenge for project organisers is therefore to support competence and relatedness: ensuring participants feel confident in their skills, receive feedback that validates their contribution, and experience a sense of community. Doing so not only strengthens motivation but also helps move people along the continuum toward more intrinsic, sustained engagement, well suited to building impact in citizen science.

[1] One example is offered by Isaacs (2017), whose MSc thesis explored why citizens participate in Riverfly monitoring. Wider studies on motivations to engage in water related citizen science (often US-based) include: Church et al (2018), Lopez (2021). Motivations to engage in wider environmental citizen science include: Beza et al (2017); Phillips et al (2019); Viduka & Edney (2022); Bible & Clarke-De Reza (2023); Geoghegan et al (2016) and Hobbs & White (2012).

03 Self-determination theory for informing citizen science

The Soil SmARt experience

Soil SmARt was a co-designed CaSTCo project which invited farmers to monitor soils, the health of which are intrinsically linked to freshwater health itself. Both intrinsic and extrinsic motivations were identified during CaSTCo's Soil SmARt project. Intrinsic motivation was fostered by using co-design, which enabled citizen scientists - in this case, farmers, to choose soil tests that were of interest, by making the project relevant to farming practices, and carrying out outdoor training to inspire those who enjoy being outside (all farmers, we'd suggest!). Efforts to boost extrinsic motivations included providing free on-farm tests from a locally trusted agronomist, recommendations for improving their farm businesses, and social occasions including provision of refreshments. Participants who took part in wider interviews were also incentivised with gift vouchers, though many stated that they would have taken part regardless due to intrinsic motivation. By using co-design as far as possible (see related report by Chivers et al, 2025), the project could maximise autonomy, competence, and relatedness by giving participants as much choice and flexibility as possible.

River Guardians experience

The following River Guardians' accounts illustrate how the presence or absence of the SDT's key psychological needs (autonomy, competence, and relatedness) shapes motivation and sustained participation: Both River Guardians care deeply about their local rivers and choose to volunteer because they want to protect them for future generations (autonomy). Both feel capable in carrying out water testing (competence), even if one sometimes struggles with the IT side. For the first participant, the experience is energising. They receive feedback that shows how their results are being used, which reinforces their sense of making a difference (competence). Updates come through channels they already use, like WhatsApp and Facebook, and they attend meetings where they meet others who share their passion (relatedness). They feel part of a community, and this motivates them to stay involved. The second participant, however, has a different experience. They rarely hear whether their data makes an impact, leaving them unsure if their efforts have an effect (competence). They have no chance to meet other volunteers and the organisation only shares updates through platforms they don't use, like Instagram. Without social connection or clear validation, they feel isolated (relatedness) and start to disengage.

These two stories show that even when volunteers share the same values and skills, their experience depends on whether their needs for autonomy, competence, and relatedness are supported. When all three are met, motivation flourishes. When they are neglected, even the most committed volunteer may drift away.

Key Takeaways: Supporting Motivation in Citizen Science

- **Autonomy** matters - volunteers are most engaged when participation aligns with their personal values and is genuinely chosen.
- **Competence** needs reinforcement - regular feedback and clear evidence of impact sustain a sense of efficacy.
- **Relatedness** sustains commitment - social connection, inclusive communication channels, and community belonging are essential to long-term participation.

04 | Key challenges in citizen science

Interviews with citizens, scientists and stakeholders revealed a wide range of barriers that affect the effectiveness, sustainability and inclusivity of water- and soil-related citizen science (citizen science) projects in general. While some challenges were technical or logistical, many reflected structural or cultural issues within the wider science and policy landscape. The weighting of emphasis in this section reflects the frequency with which each theme was raised across the interviews.

According to citizens, scientists, and stakeholders, the following challenges continue to hamper citizen science, despite numerous concerted – and often successful efforts to address them:

Citizen science as undervalued

One of the most persistent challenges identified was the perception of citizen science as secondary to professional science – or, in occasional cases, not recognised as valuable at all. Several scientists described an entrenched culture in which data from citizen science was seen as supplementary at best and unreliable at worst. This undermined its uptake in decision-making and reduced the incentive for institutions to invest in sustained programmes:

"*There's a perception in some quarters that citizen science is just a nice-to-have, rather than a legitimate part of evidence gathering. That means it often gets sidelined when budgets are tight or when decisions are being made about what evidence to take forward.*" (SCI6)

Stakeholders echoed this, noting that some agencies "politely acknowledge" citizen science but rarely place it on a par with official monitoring. One stakeholder summarised the issue as a "branding problem" in which the term "citizen science" conjures associations with amateurism, even where the evidence base is robust.

Some citizens experienced this indirectly when their observations had to be carried by a professional before they were acted upon: "*Their word would be greater… I don't have that credential.*" (CS6)

- Perceived as undervalued
- Lack of funding
- Inclusivity/representation
- Extractive approaches
- Perceived threat
- Unrealistic expectations
- Restricted impact
- Accessibility
- Lack of consistency
- Unintegrated
- Limited use of data
- Training/support gaps
- Expertise not recognised
- Sampling bias

04 | Key challenges in citizen science: continued

Lack of funding

A lack of sustained funding was the second most prominent theme. Scientists and stakeholders described a "boom and bust" pattern in which grants covered start-up phases but not the long-term support needed to maintain equipment, retain volunteers and ensure data continuity:

"The problem is the money always runs out. You can get something set up, you can get people enthused, but then the funding stops and the whole thing falls apart. People lose interest if they don't see continuity." (SH7)

Funding cycles rarely match the long-term nature of environmental monitoring, with three-year grants seen as insufficient to capture meaningful trends. Equipment replacement, database maintenance and ongoing coordination were all cited as unfunded essentials. Citizens tended not to discuss funding directly but described its effects, such as kit shortages, lack of replacement parts and gaps in communication.

Inclusivity and representation

A lack of diversity among participants was widely recognised. Scientists and stakeholders noted that citizen science projects often attract individuals with the time, resources and inclination to engage with environmental issues, typically older, white and financially secure:
"We tend to attract the usual suspects: middle-aged, middle-class, often retired people who already have an interest in the environment. That's great, but it's not representative, and it means we're missing out on whole swathes of society." (SCI9)

Citizens added that the "science" label could deter people who did not identify as scientific, and that access to green space was a barrier in some communities:
"*There's a perception… that citizen science is not for them… people would think, I'm not a scientist, that's not for me… there's also the lack of access to nature.*" (CS7);
"*You're already selecting people… most people in my circle are white middle class, we all live in our silos.*" (CS2)

Extractive approaches

Some scientists and stakeholders raised concerns that citizen science could be extractive in practice, with volunteers providing data and labour without seeing tangible benefits or influence over outcomes: "*I have strong feelings about not taking advantage of volunteers… if we can't employ them, we'd rather offer free training so they get a tangible benefit.*" (SH1)

Citizens rarely used the term "extractive" but gave examples where their role felt tokenistic:
"*Sometimes I wonder if they only want us for the publicity photos, not for what we actually find.*" (CS6)

04 | Key challenges in citizen science: continued

Perceived threat to scientists
A smaller but significant number of scientists described unease among some professionals who saw citizen science as potentially replacing or undermining their work: "*Some scientists feel threatened that citizen science will replace their role or be used as a cheaper alternative. It's not about that, but the perception is there and it can cause tension.*" (SCI2). One stakeholder reported agency staff refusing to work with CS data on the grounds that it represented "competition" for their programmes.

Scientists' unrealistic expectations
In some cases, scientists overestimated volunteer capacity. Unrealistic targets, rigid schedules and insufficient training were causes of frustration and disengagement: "*There's a tendency to think you can just parachute in, give them a kit, and they'll deliver perfect data forever. That's just not realistic, people need support, and life gets in the way.*" (SH6). Environmental variability, permissions and regulatory requirements could also delay or disrupt projects: "*In some catchments, the complexity of permissions and regulations can be enough to stall a project for months before you even get to training volunteers.*" (SH7)

Citizen science used only for awareness raising: missed potential?
While public engagement was recognised as valuable, some scientists cautioned that projects presented as monitoring exercises were in practice only designed to raise awareness: "*I've seen projects framed as monitoring exercises when really they're just about awareness raising. That's fine if you're honest about it, but it's misleading to say you're generating decision-quality data if that's not the aim.*" (SH2).

Other barriers
Several less frequently mentioned but still important barriers included:

- **Accessibility:** Physical safety, transport and usability of equipment: *"The site I was assigned to is two bus rides away… I can't always make the times they want us there."* (CS14).
- **Lack of consistent science:** Variation in methods between projects, affecting comparability.
- **Lack of integration: citizen science** initiatives often working in silos without shared methodologies.
- **Limited use of data:** Datasets not being acted on by agencies.
- **Perceptions of 'not the experts':** Professional gatekeeping over volunteer observations: "*We live here, we know the river… sometimes it feels like they just nod and carry on without taking it seriously.*" (CS3).
- **Potential for sampling bias**: Volunteers choosing sites for safety or convenience.
- **Training and support gaps**: Initial training without refreshers, reducing skill retention.

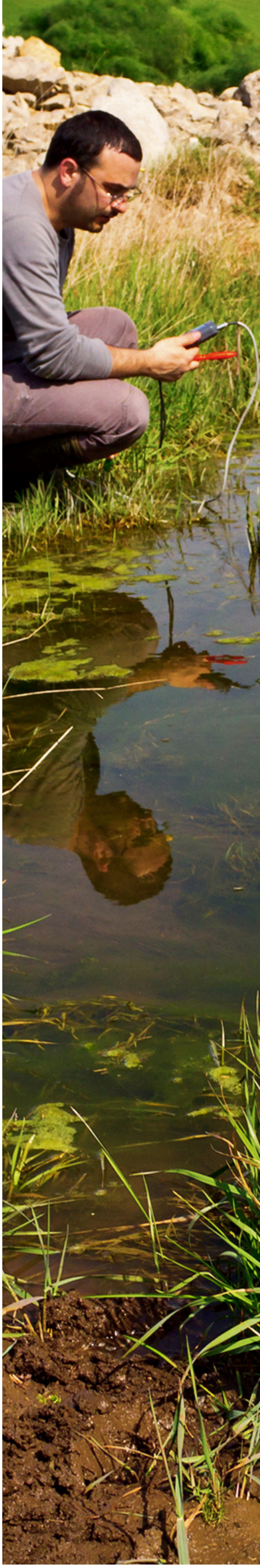
04 | Key challenges: solutions

Across the interviews, citizens, scientists and stakeholders suggested or implied several remedies that could address these barriers:

- **Ongoing training and quality assurance:** Seasonal refreshers, joint field visits, and accessible online modules to maintain skills and improve data reliability. Find out more about improving data reliability on page 30.
- **Structured feedback loops:** Regular updates on how data is used and what action results from it.
- **Inclusive recruitment and tailored engagement**: Outreach to underrepresented groups, avoiding alienating terminology, and working with community organisations.
- **Reducing access and safety barriers:** Strategic site allocation, transport or equipment support, and safe alternatives where needed.
- **Mitigating site-choice bias**: Blending volunteer-selected and coordinator-assigned sites, with support for harder-to-reach locations.
- **Ethical use of volunteers:** Transparency about data use, acknowledgement in outputs, and involving volunteers in interpretation.
- **Sustainable funding and programme continuity:** Aligning funding cycles with monitoring needs and pooling resources across projects.
- **Integration across projects:** Coordinating methods and data formats to increase interoperability.
- **Managing professional concerns:** Positioning citizen science as complementary rather than competitive, and communicating its added value to professional monitoring.
- **Clarifying project purpose:** Being explicit when the aim is awareness raising rather than decision-quality monitoring, to maintain trust.

05 The Perceived Purpose of Citizen Science

Citizen scientists described multiple, overlapping purposes for citizen science, often blending practical, political, and personal dimensions. Their accounts reveal how participation serves scientific, civic, and individual goals, while also meeting core psychological needs described by self-determination theory (SDT).



Filling Gaps Left by Statutory Monitoring

Many volunteers saw their role as compensating for the limited capacity of statutory bodies. As one explained, "*We're doing things that statutory authority should do… if a volunteer didn't do it, it wouldn't happen at all … We'd have no numbers*" (CS2). Another echoed this pragmatism: "*It's a way of obtaining information that an organisation didn't have the time or the resources to get*" (CS5). Others made explicit links to structural underfunding: "*Seeing how drastically underfunded the EA is, we, all of us, I think, have come to realise that we are performing a basic but useful function in alerting them to the state of the river*" (CS18). From an SDT perspective, this reflects **competence**: volunteers are motivated by knowing they are providing a service that is both necessary and valued.

Generating Credible Data at Scale

A second recurring purpose was the production of reliable and large-scale evidence. One participant noted, *"It enables large amounts of data to be collected that couldn't otherwise be collected*" (CS1). Here, participants expressed pride in contributing to "real science." This sense of mastering techniques and producing valid results aligns with SDT's principle of **competence**.

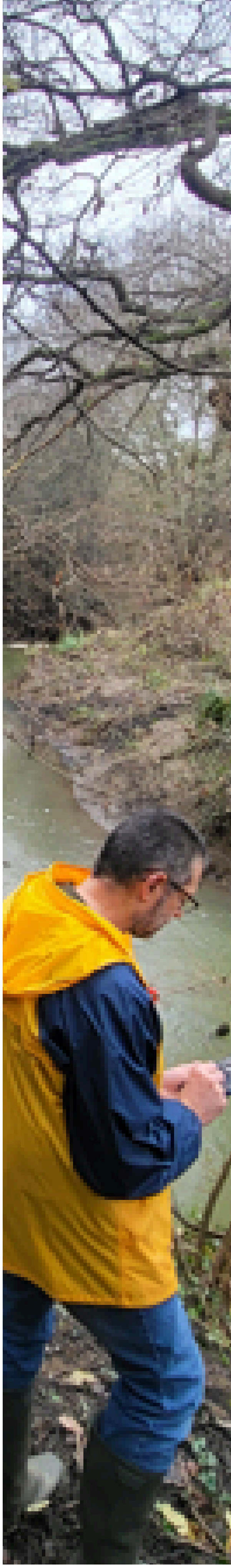
Acting as First Responders

Volunteers also saw themselves as an early warning system. As one described, "*five people walked down that stretch of the [river] and said the water doesn't look right. So let's get [CS's name] in who can then go and test it … Oh, he's not happy with the results. Let's send it up the road to Environment Agency and they can come down and do formal testing"* (CS3). Another summed this up succinctly: "*If there's something, an anomaly that comes up and that it's really bad water quality. Then they can send out kind of an expert to test there, but we're kind of the first sense check … the primary data collector"* (CS09). These accounts point to volunteers' sense of **autonomy** (deciding when to act) and **competence** (their ability to provide data that triggers an institutional response).

Influencing Policy and Systemic Change

For many, the ultimate purpose of data collection was to influence wider change. One participant anticipated cumulative impact: *"I would like to think that there will be a groundswell… a critical mass will be reached, then people will do something"* (CS3). A further citizen scientist made the link to industry: "*Because of that additional data… you've got more data, bigger sample size which can be more impactful to like a big company to help potentially change their policies*" (CS6). This reflects SDT's principle of **autonomy**: participants are motivated by the belief that their local efforts contribute to larger-scale political and environmental impact.

05 The Perceived Purpose of Citizen Science



Engagement, Learning, and Awareness

Participants also emphasised the personal and relational purposes of citizen science: "*It gives you purpose and meaning … a connection with your environment … but a connection also with other people that are kind of interested as well*" (CS1). The value to science was recognised: "*Knowing that you are doing something for science that is of value to somebody else… that is your reward*" (CS5). Similarly, one participant noted the "*empowerment of lay people that we feel that we're contributing and improving our knowledge and skills as well"* (CS8). These accounts align with **relatedness** in SDT: volunteers are sustained by connections to nature, science, and community.

Catalysts for Community and Behavioural Change

Several participants highlighted the wider cultural and behavioural shifts that citizen science could spark. One explained, "*By publicising what we do… more people know that somebody cares, and that can make a difference to farming practices"* (CS1). Another noted both local and national impacts: "*It puts back to the wider country for pushing for benefits for water quality and that kind of policy change, but also, for my village and my smaller community"* (CS9). This was extended further into democratic participation: "*If citizen science programmes were more widespread, then you'd have an electorate tuned into that… then you'll have politicians making decisions to promote nature. So it's, you know, citizen science is about gathering data, but it's just as important. It's about engaging people*" (CS23). From an SDT lens, these perspectives reflect **relatedness** (building collective responsibility) and **autonomy** (citizens stepping in to take action where others fall short).

Citizen Science as Personal Fulfilment and Wellbeing

Finally, many participants highlighted the personal fulfilment that underpinned their engagement. One admitted, "*Personally, I collect a lot of it from my own edification. If other people can make sense of that or use it, they're very welcome to"* (CS2). Another stressed enjoyment and learning: *"There is something delightful about standing in a river… it's about learning something new and seeing the changes over the seasons"* (CS1). Others emphasised wellbeing and connection: *"For me, it's fresh air, mental health and all of those benefits personally. But also a way of feeling more engaged with people in the community"* (CS9). Recognition and validation were also central. As one participant observed, *"You get the thanks… the feedback is the recognition that validates that there is a point"* (CS15). From an SDT perspective, these accounts demonstrate how citizen science can satisfy all three core needs: **autonomy** (personal choice and enjoyment), **competence** (learning), and **relatedness** (recognition, connection, and belonging).

Citizen scientists view the purpose of their work as more than just generating data. They see it as filling scientific gaps, strengthening community connections, and driving environmental change. By supporting autonomy, competence, and relatedness, citizen science meets core psychological needs that sustain motivation and long-term engagement.

06 What motivates citizens to engage in citizen science?

We analysed the citizen scientist interviews to examine what motivates them to take part in citizen science. The themes below are useful for informing future approaches – as demonstrated by the recommendations that follow.

Enjoyment and curiosity: For many, taking part was simply enjoyable. Standing in the river, collecting samples, or plotting results gave a sense of satisfaction that needed no further justification. These accounts reflect intrinsic motivation in SDT terms: "*There is something delightful about standing in a river, maybe not in the sleet, but it is something which is personal*." (CS12)

Learning and competence: A strong theme was the opportunity to learn, whether about invertebrates, new testing techniques, or the local environment. Citizens described steep but rewarding learning curves and the satisfaction of mastering new skills. This aligns with SDT's competence need: "*The learning curve was the new test … where the thresholds were, what the normal ranges were … I've enjoyed that and it has been genuine learning*." (CS5)

Belonging and being part of something bigger: Feeling part of a network or local group was highly valued. This sense of belonging connects with SDT's relatedness need and often extended beyond science to a wider sense of community: "*I wanted to do something where I was meeting people … doing something outdoorsy … being involved and contributing to a bigger thing always appealed to me*." (CS18)

Practical fit and autonomy: Citizens also reflected on the practicalities of participation. Monitoring was easier where sites were close to home, flexible systems were in place, or autonomy was supported. Where autonomy was constrained, frustration arose: *"I'm doing it independently … I've got the kit … I know the techniques but I can't report anything because I'm not a member of a group*." (CS6)

Generating evidence: Many saw their monitoring as valuable because it produced evidence to influence agencies and decision-makers. This reflects identified motivation in SDT, where activities are aligned with personally valued outcomes: "*We report stuff … a housing estate … chucking a load of sediment into my beck … I have to keep liaising with the Environment Agency and they come out and check it."* (CS7)

06 What motivates citizens to engage in citizen science?

Stewardship and identity: For some, volunteering was more than generating data. It was about stewardship and identity: giving back to nature, embodying values of care, and strengthening their role in local communities. This reflects integrated motivation, where participation is part of the self: "V*olunteering is the reverse of just accessing nature, it is giving something back, a stewardship role*." (CS20)

Filling monitoring gaps: A key driver was awareness of the decline in statutory monitoring. Citizens felt their work filled important gaps in knowledge and acted as a first line of response: "*It enables large amounts of data to be collected that couldn't otherwise be collected*." (CS1)

Taking action and advocacy: Many emphasised action beyond monitoring. Reporting incidents, escalating issues, or educating others was central to their motivation: "*We bring Riverfly data to the water company … we report incidents … we try to reach the wider public for awareness*." (CS21); "*Angling clubs are reporting pollution incidents … Fish Legal will take it all the way to the High Court*." (CS6)

Topicality and public salience: Media coverage of sewage spills and personal encounters with pollution spurred many to get involved: "*Publicity around Yorkshire Water … sewage leaks … that spurs people to want to do something*." (CS17)
"*I'm a wild swimmer … I wouldn't swim in the River Aire … I have a double-sided awareness of these things.*" (CS16)

Vested interests and lived ties: Personal use of rivers, especially for angling and recreation, provided an immediate stake in monitoring: *"It makes me feel more connected to living where I do … especially in a rundown town … there are still pockets of greenery and access to the water*." (CS16)

Ownership and recognition: Views varied on whether feedback or recognition were necessary, but both were discussed. Some wanted clearer ownership, while others were satisfied with the act of monitoring itself:
"*Not immensely … a thank you goes a long way … I've had the satisfaction of collecting it and writing it down.*" (CS3)

06 Case study: Citizens' motivations to engage in River Guardians

River Guardians is a successful CaSTCo project based in the Arun and Rother catchment area, led by the Western Sussex Rivers Trust. Over 160 volunteers have become involved in collaborative water quality monitoring.

River Guardians (RGs) described their role as both plugging gaps in official monitoring and raising awareness of water quality issues. Their data was seen as a potential lever to influence councils, water companies, the Environment Agency, and even Parliament. As one put it, "*It's raising awareness… producing data that can be used to lobby and inform decisions*" (RG12). For others, the project offered belonging: *"because you feel a tiny part of a bigger picture"* (RG4).

Leadership and Trust: The projects' Volunteer Coordinator was heavily praised as "*a real driver… he's transformed the organisation*" (RG12) and *"I'm very, very happy with the way they're engaging with people and helping us to understand the bigger picture"* (RG11). His responsiveness reinforced trust and motivation.

Data Validity and Scientific Confidence: Volunteers valued efforts to ensure credibility through comparisons with Environment Agency standards. While some acknowledged limits: "*You're not going to get as reliable data from people without a scientific background*" (RG7), most felt pride in producing defensible evidence: *"we're producing data that is in line with what the EA is producing"* (RG8).

Feedback and Scorecards: Feedback was central to sustaining enthusiasm. Scorecards and maps were especially valued: "*I know my data contributes… that's a really nice"* (RG12). Absence of feedback, by contrast, was remembered as demoralising (RG14).

Challenges of Participation: Challenges were described as modest and varied: self-discipline and routine (RG6), handling chemicals in poor weather or digital uploads (RG7), and maintaining enthusiasm in winter (RG9). Safety concerns were noted at some sites (RG1). Yet many reported "no real challenges" (RG5; RG10), suggesting experiences depended on individual circumstances.

Benefits of Participation: Benefits were described in expansive terms. RGs emphasised agency in the face of climate change: "*It takes away that feeling of helplessness… so you feel you're doing something*" (RG1). They valued learning and awareness (RG6), community and camaraderie, the chance to apply political pressure: "*The ability to put pressure on water authorities… you've got data they can stand up and show in the House of the Parliament*" (RG9), and to deliver stewardship for future generations: *"we are guardians of this world and we just we hold it for the future generations and we shouldn't mess it up while it's our turn."* (RG9).

River Guardians citizens' suggestions for maximising engagement in the future:

Strengthen Feedback Loops: Maintain and expand scorecards/maps; ensure timely, accessible feedback to keep motivation high.

Accommodate Varied Roles: Offer differentiated pathways (monitoring, analysis, advocacy) to reflect volunteers' different appetites for involvement.

Tackle Practical Barriers: Simplify digital uploads, provide ongoing kit support, and adapt schedules to seasonal conditions.

Bolster Data Credibility: Continue validating against professional benchmarks; offer training to help volunteers defend and communicate results.

Plan for Sustainability: Build institutional partnerships (e.g. councils, schools) to reduce reliance on short-term funding.

Amplify Advocacy: Equip RGs to communicate findings to media, councils, and MPs, reinforcing their influence and sense of purpose.

For volunteers, River Guardians offers more than data collection: it provides empowerment, belonging, and stewardship. Challenges are seen as minor compared with the rewards. Sustaining this impact will depend on transparent feedback, flexibility in roles, and long-term planning. In this way, River Guardians can continue as both citizen scientists and advocates for healthier rivers.

06 What motivates citizens to engage in citizen science?

Motivations that drive citizens to participate in monitoring are diverse and layered, ranging from enjoyment and curiosity to stewardship, advocacy, and the desire to generate credible evidence. Designing projects that respond to these motivations can strengthen retention, improve data quality, and increase long-term impact. Self-Determination Theory (SDT) offers a useful framework for understanding how projects can support intrinsic motivation, competence, autonomy, relatedness, and identity. The table below brings these insights together, showing how different motivations can inform project design while also highlighting which psychological needs to support. It can be used as a practical guide for strengthening volunteer retention, data quality, and long-term impact.

Table 1: Motivations for Citizen Science Participation and Implications for Project Design, Informed by SDT

Motivation / Design Focus	Implications for Project Design	Type of Motivation	Psychological Need Supported
Enjoyment and curiosity	Ensure a choice of activities that are pleasant and flexible, with accessible sites and schedules that allow people to enjoy the outdoors.	Intrinsic motivation	Autonomy
Learning and skill development	Provide initial training and seasonal refreshers, with opportunities to interpret data, deepen expertise, and sustain growth.	Identified / Integrated motivation	Competence
Belonging and connection	Build community groups, foster networks, and provide ways to connect across sites so volunteers feel part of something bigger.	Identified / Intrinsic motivation	Relatedness
Practical fit and autonomy	Offer choice over sites and tasks, minimise paperwork, and respect volunteers' preferences so participation fits daily life.	Identified motivation	Autonomy
Generating evidence	Clearly show how data feeds into decision-making, provide feedback loops, and communicate outcomes to validate	Identified motivation	Competence
Stewardship and identity	Frame participation as caring for and protecting local rivers and ecosystems, reinforcing identity and pride.	Integrated motivation	Relatedness/ Autonomy
Filling monitoring gaps	Highlight the unique contribution volunteers make by covering places and times agencies cannot reach.	Identified motivation (value-driven)	Competence/ Autonomy
Taking action and advocacy	Provide reporting routes for incidents, connect to advocacy groups, and support escalation so data can trigger change.	Identified / Integrated motivation	Competence/ Relatedness
Topicality and public salience	Link projects to current issues (e.g. sewage pollution, flooding, biodiversity) to maintain relevance and urgency.	Identified motivation	Relatedness
Vested interests and lived ties	Engage groups with direct stakes (anglers, swimmers, local residents), recognising their experiential knowledge.	Identified motivation	Relatedness
Ownership and recognition	Acknowledge contributions publicly, provide access to data, and give credit in outputs to ensure volunteers feel valued.	Identified motivation	Relatedness/ Competence

06 What motivates scientists and wider stakeholders to engage in citizen science?

Interviews with scientists and stakeholders revealed a diverse set of motivations for participating in citizen science projects focused on water and soil. While some were driven by organisational priorities or opportunities linked to public and political attention, most reflected a clear alignment between professional goals, personal values, and the practical benefits of volunteer-led data collection. The weighting of emphasis in this section reflects the frequency with which each theme was raised, with particular attention to the widely shared view that citizen science plays a critical role in filling data gaps left by resource constraints in formal monitoring systems.

Key motivations

- Filling data collection gaps and extending monitoring reach
- Personal and professional fulfilment
- Producing decision-relevant evidence and enabling action
- Cost-effectiveness and resource efficiency
- Learning and knowledge exchange
- Strategic and organisational drivers
- Topicality and public attention

Filling a data collection void and extending monitoring reach

The most consistently cited motivation was the ability of citizen science to fill critical gaps in environmental monitoring. Scientists and stakeholders alike emphasised that agencies and research institutions lack the capacity and resources to collect the volume, frequency, and geographical spread of data required for robust understanding. In this context, citizen science was seen not as a luxury, but as a necessary part of the monitoring landscape:

"I think in the research there's lots of interest… from the university perspective, because people see it as a way of expanding their ability to collect representative sets of samples." (SCI3)

"We could never have enough contracted professionals to do sufficient bird monitoring… it would be impossible to go back to having lots of funded ecologists going out. There would be pushback from volunteers too, because they get benefits and satisfaction from doing it themselves." (SCI8)

"One of the real values… is it's very useful to get large amounts of data that we otherwise wouldn't have the resources to get as scientists." (SCI5)

Stakeholders working in local catchments stressed that this capacity boost was not just about quantity but also about targeting hotspots and under-monitored areas:

"*It was the density of monitoring… not even the Environment Agency in their old days could have done the intensity in time and space across the Wye Valley that the 400 volunteers achieved. The data's not perfect, but it's helping to identify the hotspots, and that was the whole point.*" (SH10)

"*We really need help with the capacity… hundreds and hundreds of samples, each made up of 25 subsamples. There were literally thousands of samples to take.*" (SH6)

The gap-filling role was often framed as a response to the decline in official monitoring, described by one stakeholder as a "scandal" resulting from deliberate political decisions to reduce regulatory oversight.

06 What motivates scientists and wider stakeholders to engage in citizen science?

Personal and professional fulfilment

For many, participation was driven by intrinsic enjoyment of collaborative work and satisfaction in contributing to environmental stewardship. This often linked directly to personal values and professional identity.
"I just really enjoy working with people who care about their rivers. It's not just about the data, it's about fostering that shared sense of responsibility." (SCI10)
Some saw citizen science as inseparable from their vision of science as a public good.
"It's part of how I see my role now. Science shouldn't be locked away, it should be something people can take part in." (SH2)

Data for decision-making and action

The potential to produce decision-relevant evidence was a major motivator. Participants valued citizen science for generating data that could be used to trigger interventions, influence policy, and prioritise further investigation.
"For us to understand the world and its complexity, we need lots of different data… we can't always be everywhere collecting that data, so it makes sense to use some of that just to inform a basic understanding, which we can then use to prospect certain areas and delve deeper." (SCI2)
"If we see something wrong, we can act on it faster if there's a network of people collecting information regularly." (SH7)

Cost-effectiveness and resource efficiency

While several participants rejected the notion that citizen science was "free," many agreed it could be cost-effective when properly resourced. They pointed to its ability to produce large datasets across a range of conditions for far less than the cost of professional-only surveys.
"You can get a lot more data from citizen science, a lot more quickly, from a range of different climate, soil types and locations across the country, than if you've got to pay for PhD students or postdocs to be going out and running trials." (SCI5)
"It's not very cheap… you need that input without it, it doesn't get maintained… but it does overlook the real value of getting people to actually look at things." (SCI6)

06 What motivates scientists and wider stakeholders to engage in citizen science?

Learning and knowledge exchange

Learning was seen as a two-way process, with scientists and stakeholders gaining local insight from volunteers, while also sharing technical expertise: "*I've learned a lot from volunteers – they notice things I might miss, because they're out there more often than I am.*" (SCI1). For some stakeholders, supporting farmers and landowners to understand their own soil was seen as empowering and as a route to better land management: "*It would be useful to have ways to support farmers and land owners to know more about their soil… so that they then know how to manage it better.*" (SH2).

Strategic and organisational drivers

For some organisations, citizen science provided opportunities to meet engagement targets, strengthen community relationships, and build institutional reputation, while still producing valuable outputs: "*Some of it is practical – we have engagement targets to meet – but it's also genuinely valuable.*" (SH5).

Topicality and public attention

A smaller number noted that current political and media focus on issues like water quality created an opportune moment for engagement: "*Right now water quality is in the news all the time, so there's an opportunity to ride that wave and get people engaged.*" (SCI6)

Conclusions

The most powerful shared driver was the ability of citizen science to fill gaps in environmental monitoring that would otherwise remain unaddressed, extending both the reach and resolution of data collection. Closely linked were motivations around intrinsic fulfilment, producing actionable evidence, cost-effectiveness, and learning. Organisational goals and topical relevance played a secondary role, while a minority highlighted conditions that needed to be met for citizen science to achieve its potential. **The table below provides suggestions for maximising the likelihood of enhancing the motivations of scientists and stakeholders to engage with, or carry out, citizen science projects.**

Table 2: Scientists' and Stakeholders' Motivations for Citizen Science and Implications for Project Design.

Motivation	Planning Approach to maximise scientist/stakeholder enthusiasm
Filling data collection gaps and extending monitoring reach	Clearly communicate the importance of volunteers' contributions to covering under-monitored areas, involve them in prioritising sites, and give feedback showing how their data fills real evidence gaps.
Personal and professional fulfilment	Ensure that roles match participants' skills and interests, celebrate contributions publicly, and provide opportunities for self-directed involvement.
Producing decision-relevant evidence and enabling action	Share examples of how past data has influenced policy or management, involve volunteers in discussing results with decision-makers, and ensure visible follow-up on identified issues.
Cost-effectiveness and resource efficiency	Be transparent about project resources, show how volunteer effort enables broader coverage, and reinvest efficiency gains into training and support to build competence.
Learning and knowledge exchange	Create two-way learning structures such as joint fieldwork, peer-to-peer mentoring, and workshops where both scientists and volunteers share findings and methods.
Strategic and organisational drivers	Align project goals with institutional priorities while protecting volunteer autonomy, and communicate how the partnership benefits all parties.
Topicality and public attention	Link activities to current events or local issues, use media coverage to highlight volunteer contributions, and time initiatives to coincide with heightened public interest.

06 What defines a 'good day' for citizen science monitoring?

Across the interviews, participants gave rich accounts of what makes monitoring feel rewarding for citizens. These accounts often combined the immediate experience of being outdoors with broader feelings of contribution, discovery, and shared purpose – aligning with existing research around the wider benefits of citizen science (e.g. Pocock et al, 2023). While citizens, scientists, and stakeholders highlighted overlapping elements, each group emphasised different aspects of what they believe counts as a 'good day' for citizen science monitoring looks like.

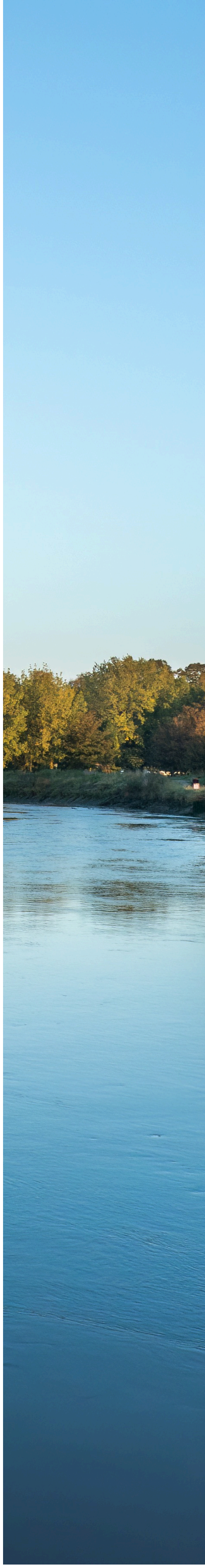
Escalation and drama: the power of discovery
A few citizens described a "good day" as one where something unusual or concerning was found, which lent drama and urgency to their efforts. One explained, "*It feels more worthwhile when you find something that shouldn't be there, like if the phosphate levels are way off. You know straight away that you've got evidence of a problem and it matters*" (CS4). For some, this linked directly to a sense of accountability, with one volunteer noting that it is "*satisfying to be able to say, look, here's the data, it's clear who's responsible*" (CS9).

Scientists tended to see this escalation differently, often stressing that drama must be grounded in robust data. As one scientist commented, *"A bad result can be useful, but only if it's repeatable. Otherwise it just causes noise and frustration*" (SSI6). Stakeholders echoed the citizens' excitement but cautioned that escalation needed to feed into decision-making: "*The good days are when data shows a clear issue and you can escalate it to the agency or council. That's when it feels like more than just numbers on a page*" (SH2).

Positive environmental findings
Not all citizens looked for drama. Most described satisfaction in seeing reassuring results: *"A good day is when the levels come back normal, because it means the river's in good shape"* (CS2). This linked closely to stewardship, with another volunteer adding, *"It's comforting to know the work we do isn't just highlighting problems but also confirming when things are okay"* (CS10).

Scientists tended to frame such outcomes in terms of monitoring stability: *"Sometimes a boring dataset is the best outcome, because it tells you the system is resilient"* (SCI10). Stakeholders highlighted how positive results could motivate communities: *"If the news is good, people want to hear it. A good day is when we can go back to the community and say, actually, things are improving"* (SH9).

Feeling part of something worthwhile
Across all groups, a dominant theme was the sense of contributing to something larger. A citizen explained, "*It's not just about my one site. It's knowing we're part of a bigger effort and that all our little bits of data add up to something meaningful*" (CS3). Scientists often spoke of this in terms of scaling knowledge. One put it bluntly: "*The good days are when you see the network working, when hundreds of samples mean you can say something at national scale"* (SCI5). For stakeholders, good days were those where volunteers felt valued: "*It matters when people don't just give their time but see how it makes a difference. A good day is when you can feed back and show them the impact*" (SH7).



06 | What defines a 'good day' for citizen science monitoring?

Learning and knowledge exchange
Learning was central to many citizens' accounts. One said, "*Every time I go out, I notice something new about the river, or I get better at using the kit. That feels like progress, like a good day's work*" (CS14). Others valued the chance to share knowledge with peers: "*The best days are when you bump into someone else on the riverbank and swap notes*" (CS7).

Scientists placed emphasis on structured learning, with one describing a good day as "*when you see volunteers really understanding why they're doing what they're doing, not just following instructions*" (SCI2). Stakeholders stressed that knowledge exchange had to flow both ways: "*A good day is when we learn from the volunteers as much as they learn from us. They see things we might miss*" (SH1).

Enjoyable conditions and being outdoors
For many citizens, a good day was simply one spent in pleasant surroundings: *"If the weather's nice and the river's looking beautiful, that's a good day regardless of the results"* (CS11). Others linked this directly to wellbeing, with one saying, *"It gets me outside, I slow down, and I notice things I would have missed. That's always a good day"* (CS6).

Scientists rarely described conditions in the same way, instead highlighting how enjoyable fieldwork depended on smooth logistics. Stakeholders often straddled the two perspectives, recognising both the restorative aspects of fieldwork and the practical benefits of efficiency: *"If the volunteers enjoy being out, they'll come back. If they can also cover a lot of ground, that's a good day for us too"* (SH6); "A good day is when you get through the sampling without equipment failing or permissions holding you up" (SH7).

General satisfaction
For all groups, there was also a simple baseline: a good day is one where things run smoothly and people enjoy themselves. One citizen summed it up as, "*The best days are when the kit works, the weather's kind, and you get your samples done without fuss*" (CS5). Scientists echoed this in practical terms: "*If you come back with all your samples intact and no missing data, that's a good day*" (SCI4). Stakeholders linked this general satisfaction to sustainability: "*If volunteers have more good days than bad ones, the project will last*" (SH10).

Comparing perspectives: citizens, scientists, and stakeholders

Citizens emphasised emotional and experiential aspects: discovery, enjoyment, learning, reassurance, and being part of a collective effort.

Scientists focused more on methodological robustness, efficiency, and scaling up data. For them, a good day was about reliable results and smooth project delivery.

Stakeholders often balanced both perspectives, highlighting citizen enjoyment as key to retention but also stressing the importance of turning data into action and maintaining credibility.

It is crucial that we recognise these differing mindsets, as a better understanding of what motivates each group can help to inform future citizen science efforts.

07 Achieving data accuracy: Scientists' and stakeholders' perceptions

This section draws on interviews with scientists, focusing on their views about whether data gathered by citizen volunteers is accurate and robust. The findings are interpreted through the competence construct of self-determination theory, which relates to perceptions of capability, skill mastery, and effectiveness.

Overall perceptions of data accuracy in citizen science

Views ranged from cautious acceptance to scepticism. Many scientists recognised the potential value of citizen science data, but raised concerns about quality, representativeness, and compatibility with professional datasets. Several noted that competence was influenced not only by volunteers' skills but also by project design, feedback mechanisms, and clarity of purpose.

The following quotes illustrate the wide range of views held by scientists surrounding citizen science and data accuracy:

"…We have these really well-trained citizen scientists, people working on CaSTCo projects who are collecting data which is, say, 80% as robust as if it had been gathered by scientists. But then you've also got others where you're just thinking, I wouldn't be confident in those results unless there's a proper QA process behind it. With something like SmartRivers, you have to do the training and they QA a sample each season, so I trust that more. With something like Riverfly monitoring, there's no way of checking what people have said, so I'd always take it with a pinch of salt." (SH9)

"…sometimes those local level stuff where people might just be dipping a bit of paper in a water sample, people are really going to question, do they have the right skill to do that, even if it is a really simple thing? Is it the right approach, are they reading it right, do they know what this species of plant looks like compared to that? Do they definitely know? That's what's being questioned a lot, because nobody tests them, nobody really goes out and tests a lot of people, particularly on a large-scale survey." (SH7)

I think the idea that you have to be careful with citizen science data quality is a slightly lazy criticism. Of course you have to be careful, like with any scientific research. Even professional-led surveys can have errors. With citizen science you just have less contractual control over how the data is collected, so you have to design the process to ensure quality. It should be able to produce something that is of publishable quality" (SCI8)

"If you haven't got confidence in the data, then the data's basically worthless… if you have got quite good confidence in the data then you can treat it the same as scientific data" (SCI5)

You can get really high-quality data, so it depends what you want to use it for" (SCI6)

"Personally I do [feel comfortable publishing peer-reviewed articles about citizen science data] because even though you're typically using low tech, low frequency, you're still using established methods. You know to combine the concentration data with discharge data and then use peer reviewed established conventional load estimation methodologies etcetera. So to my mind, it makes absolutely no difference." (SCI1)

07 Achieving data accuracy: Scientists' and stakeholders' perceptions

Barriers to achieving data accuracy and robustness
Scientists acknowledged the significant contributions of citizen science but pointed to several barriers that can undermine data accuracy and robustness. These challenges often reflected project design and institutional culture rather than volunteers' abilities. Concerns centred on sampling biases, sustaining volunteer engagement over time, and scepticism within professional communities. At the same time, many highlighted the importance of recognising volunteers' local expertise as a valuable complement to scientific knowledge.

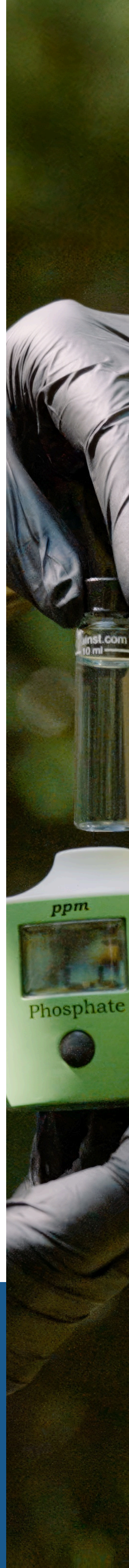
Sampling biases: Volunteers sometimes sampled where it was convenient or attractive, which could reduce representativeness. This was often an issue of project design rather than individual skill:
"*You get really high-quality data, but people tend to go where they want to go. Often your sample is not ideal, clustered around urban areas or nice places. A colleague of mine goes to Jura every year because he wants to go somewhere nice. So you don't get representative data, but you can still get high-quality data*" (SCI6)

Volunteer drop-off: There was concern about sustaining engagement and skill over time. Some suggested starting with a more resource-intensive first year, then scaling down while maintaining quality.

Competence in co-production: Many participants did not view citizen scientists as less capable, but rather as bringing different types of expertise. Local knowledge was frequently highlighted as a valuable complement to scientific skills, with competence building seen as a two-way process:
"I *don't see the citizen scientists as lesser trained… they know all of the local sites… the project would be a lot less without them"* (SCI10); "*…farmers were willing to be very rigorous… going over and above what we asked*" (SCI5)

Availability of tests: Several water quality and soil health-related tests were either seen as lacking accuracy themselves, costing too much (both time and money), or as needing further exploration into their applicability.

Institutional scepticism: Some scientists reported resistance from colleagues who doubted that citizen-collected data could match professional standards, which could limit the use of such data even when it was robust:
"*Internally… not everybody is convinced. There are people who think, 'Great, this is something we can use,' but there's others who are perhaps a bit more old school and just go, 'It's never as good as what we do. Why are we getting involved in something that's going to take resource and never deliver?'*" (SCI3)



What does the literature say?

In line with the findings of this report, literature about data accuracy and citizen science is mixed. This aligns with a likelihood that individual projects will vary in terms of data accuracy, based on the nature of the monitoring citizens are asked to do, the extent of training, validation, and quality assurance, and the skillset of the citizens engaged. There is a scarcity of UK- and European-based literature in recent years exploring the accuracy of water quality-related citizen science. A study in Ireland found that citizens provided with a simple water quality testing kit were able to gather data comparable with laboratory results (Quinlivan et al, 2020). Literature in a US context found that large scale citizen science monitoring datasets can be highly accurate (Albus et al, 2020). Further literature which examines data accuracy in wider, ecological citizen science includes: Clare et al (2019), Leocadio et al (2021), and Pocock et al (2024)

07 Achieving data accuracy: Scientists' and stakeholders' perceptions

Practical strategies for achieving robust and accurate citizen science data

Alongside the barriers to accuracy and robustness, scientists also identified a range of practical strategies for strengthening the reliability of citizen science data. Many of these directly respond to the challenges noted earlier; for example, addressing training gaps, ensuring simple and consistent methods, and integrating local knowledge. Others focused on building trust through quality assurance, combining datasets, and clear communication of purpose. Taken together, these approaches highlight how thoughtful project design and ongoing support can transform potential weaknesses into strengths.

Training, equipment, and ongoing support

Initial, practical training was seen as important, but one-off sessions were widely viewed as insufficient. Scientists stressed the value of refreshers, follow-up sessions, and access to advice:
"*Quite often one training session's never sufficient. So you've got to keep going with a few training sessions and reiterate the key points.*" (SCI1)

Method design and simplicity

Simple, standardised methods were considered crucial for enabling reliable data collection. Matching task complexity to volunteers' skills was suggested as a way to build competence while reducing error: "*Choose very simple methods that are really clear to understand… and metrics that still tell you a story even if there's a bit of error.*" (SH2)

Quality assurance and verification

Quality checks at multiple stages, including verification of entries, photo checks, outlier flagging, and comparison with gold-standard datasets, were viewed as essential both for accuracy and for reinforcing volunteer confidence: "*You're training people… and there's that continual investment in checking in with people.*" (SCI8)

Role allocation and consistency

Assigning the same person to repeat a given task, such as probe use or sample collection, was seen as a way to reduce variability and build task-specific expertise: "*…the same person does the same thing every time… which is the same as what you do in any science situation.*" (SCI10)

Weight of evidence approaches

Some argued for interpreting citizen science datasets in aggregate, emphasising that overall patterns and trends are more robust than any single observation.

Combining datasets

Integrating citizen-generated data with professional or laboratory datasets was suggested as a way to validate findings and enhance credibility.

Clear communication of purpose

Explaining how data will be used, and by whom, was seen as a motivator for volunteers to pay attention to quality.

Recognition of local knowledge

Scientists highlighted the importance of acknowledging and integrating volunteers' ecological knowledge, which can complement formal datasets and strengthen trust.

07 Achieving data accuracy: Citizens’ perceptions

This section draws on interviews with citizen scientists, focusing on their views about the accuracy and robustness of the data they collect. The findings are also interpreted through the competence construct of SDT, reflecting how volunteers perceive their own capability, skill mastery, and effectiveness, and how these perceptions shape motivation to participate. Where competence was reinforced, motivation to continue was strengthened; where it was undermined, some volunteers became disillusioned or disengaged.

Personal perceptions of data accuracy

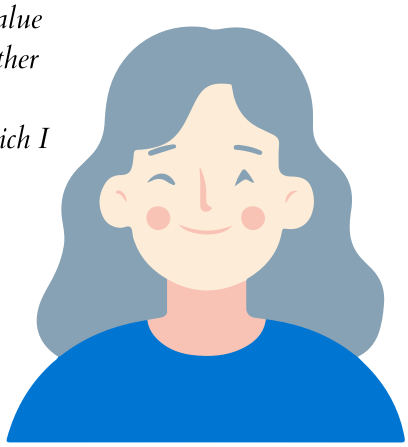
Citizen scientists generally expressed confidence in the quality of their data, particularly where projects provided clear training, simple methods, and quality assurance processes. Many felt their contributions were credible and valuable, even if not equivalent to laboratory-standard results. For some, accuracy was understood pragmatically: consistency and trends were considered more important than perfect precision. This reinforced their sense of competence, sustaining motivation to continue.

Trends and weight of evidence

… this is not going to be the same level of accuracy as you know, laboratory tests carried out by actual proper scientists, we get that. But there is still value here I think in as long as we are consistent - either consistently right or consistently wrong. A consistent approach will still show the trend, which I think is still valuable.” (CS14)

‘Better than nothing’

“So there are criteria on consistency, there is always going to be a risk given the number of people that are doing it … one person is going to categorise a species as one species, whereas the next person might see a subtle difference … It's still some data. It's still some knowledge that we wouldn't have had otherwise. It's not perfect, but it can help us achieve wider goals in the long run”. (CS07)



Motivation to be accurate

If you’re motivated to give your own time, your own fuel, and your own resources, are you not more likely to be conscientious?” (CS21)

Collaborative monitoring rather than an accurate ‘science’?

“ I suppose the criticism might be if it is not scientific. Citizen science has got to be statistically validated, and that means it's gotta have enough data points … I think citizen science on its own without adequate backing is hearsay rather than science.” (CS10)

Institutional frustration

“It frustrates me, and I know it frustrates other volunteers that the authorities like the Environment Agency will not accept citizen science data. So you're treated like you're an idiot. Really. And therefore again, it goes back to what's the point of doing it?” (CS21)

Summary of findings

Citizen scientists’ perceptions of data accuracy were nuanced. Personally, many expressed confidence grounded in clear methods, consistency, peer support, and local knowledge. Yet they also recognised barriers such as subjectivity, equipment issues, lack of feedback, and institutional scepticism, all of which could undermine competence. Validation processes and the perception of credibility were central for sustaining motivation. When volunteers saw their data confirmed, used, and valued, their sense of competence flourished. When accuracy was questioned or dismissed, engagement faltered. Accuracy, therefore, was not simply a technical question but a motivational one, shaping volunteers’ willingness to continue contributing.

07 Comparing Scientists' and Citizens' Perceptions of Data Accuracy

Taken together, the perspectives of scientists and citizen scientists reveal both points of convergence and areas of tension. Both groups emphasised the importance of training, clear methods, and ongoing support as essential foundations for reliable data. Both also highlighted the value of quality assurance processes, not only for safeguarding scientific standards but also for reinforcing volunteers' confidence and competence.

Scientists tended to foreground questions of representativeness, standardisation, and compatibility with professional datasets, sometimes expressing scepticism about whether citizen-generated data could match their own. **Citizen scientists, by contrast, often framed accuracy more pragmatically: consistency, trends, and early warnings were valued as legitimate forms of evidence**, even if individual data points lacked laboratory-level precision.

Another striking contrast lies in perceptions of institutional legitimacy. For scientists, institutional scepticism was a barrier to uptake; for volunteers, it was experienced more personally, as discouraging and demotivating. Recognition of citizen-collected data therefore emerges as a crucial issue, not just for ensuring credibility but also for sustaining volunteer motivation through the competence and relatedness needs identified in SDT.

Ultimately, both perspectives suggest that achieving and demonstrating data accuracy in citizen science is less about a simple technical threshold and more about the design of projects, the support provided to volunteers, and the willingness of institutions to value and integrate diverse forms of knowledge.

Table 3: Comparison of scientists' and citizen scientists' perceptions of data accuracy and robustness

Theme	Scientists' Perceptions	Citizen Scientists' Perceptions
Overall confidence	Cautious acceptance: some scepticism about robustness compared with professional datasets.	Generally confident when trained and supported; value data even if not lab-standard.
Competence and skills	Concern about variable volunteer skills; emphasise need for training and QA.	Self-critical about limits (e.g. invertebrate ID) but confident when trained; highlight peer support.
Representativeness	Worry about biased site selection (convenient/attractive areas).	Less focus on representativeness; prioritise consistency and local familiarity.
Accuracy vs. trends	Prioritise methodological rigour and comparability.	Value trends, early warnings, and "something is better than nothing."
Institutional legitimacy	Note scepticism among colleagues as barrier to uptake.	Experience scepticism as discouraging; desire recognition and validation of their contributions.
Training and support	Stress importance of refreshers, follow-up, and matching task complexity to skills.	Emphasise value of clear, practical training; appreciate ongoing advice and accessible instructions.
Quality assurance	Advocate multiple QA stages (verification, photo checks, gold standards).	Reassured by QA processes; lack of visible QA undermines confidence.
Local knowledge	Recognised as complementary, but secondary to technical expertise.	Viewed as central strength, adding credibility and insight to data collection.

08 Importance of feedback and validation

Citizens, scientists, and stakeholders alike recognised the importance of feedback and validation. Participants described how the absence of feedback could quickly lead to disengagement, while effective feedback systems fostered motivation, confidence, and a sense of shared purpose. Crucially, citizens should be provided with regular findings based on the data they have collected, alongside feedback about any impact their efforts have had. This is important for maintaining engagement and building trust in the data and overall approach. Regular communication is critical for ongoing engagement, particularly if projects have long-term goals or require ongoing monitoring.

Closing the gap between data collection and impact

The most common theme was the need to "close the loop" by ensuring that participants see how their data is used and what it achieves. Without this, data collection could feel extractive, leading to frustration or withdrawal from the project: "*You can't just take the data and disappear… people need to see that it has gone somewhere, that it's making a difference, otherwise you'll lose them.*" (SCI2)

"*If I've spent hours collecting samples, I want to know if they're any good, and I want to know what they've been used for.*" (CS4)

Several participants described feedback as essential for turning raw monitoring results into meaningful insights, especially when linked to visible action or policy outcomes.

Building trust and credibility through validation

Many participants highlighted validation as important for achieving data credibility. They stressed that providing validation could boost confidence in both the project and the individuals' own skills. This can also support in identifying further training and capacity building needs: "*We do a lot of cross-checking… and I always try to tell them when their samples matched ours, because it reassures them they're doing it right.*" (SH6)

"If you never hear whether you got it right or wrong, you just don't know… and then next time you might not bother being so careful." (CS9)

Validation was not only about quality control, but also about respect for volunteer effort. Participants suggested that making validation visible could address some of the scepticism around CS data within the scientific community.

Motivational benefits of timely and specific feedback

Feedback was frequently linked to motivation, particularly when it was timely, specific, and personalised. Delays in reporting results could undermine enthusiasm, while prompt feedback kept people engaged and encouraged repeated participation: "*The projects where we got the results back quickly, even just a quick summary, I was more likely to do it again.*" (CS2).

"*If you wait a year before telling people the results, the moment has passed… you've lost that energy.*" (SCI5)

Several participants felt that even small, informal acknowledgements could help maintain momentum between major reporting periods.

08 Importance of feedback and validation

Feedback as a tool for learning and skill development
Participants also viewed feedback as an important educational tool, particularly when it was constructive and detailed enough to help them improve their techniques:

"*It's great when someone tells you exactly what you did well and what to tweak, because then you feel like you're getting better at it.*" (CS6)

"*We had a session where we went through common errors and how to avoid them, and you could see people's confidence grow.*" (SH3)

Scientists noted that structured feedback could directly support competence, one of the core psychological needs in self-determination theory, thereby reinforcing long-term commitment.

Challenges and gaps in providing feedback and validation
Despite widespread recognition of its importance, many acknowledged that feedback and validation were inconsistently delivered. Time, funding, and logistical constraints were the main barriers. In some cases, validation was carried out internally but never shared with volunteers due to perceived complexity or the absence of systems to report it back.

"*We do the QA in-house, but we haven't really got a process for letting the volunteers know… it's a gap we need to fix.*" (SCI8)

Some citizen participants expressed frustration when feedback was promised but never arrived, interpreting this as a lack of respect for their contribution.

Recommendations for Effective Feedback and Validation in Citizen Science

1. **Share results regularly** with volunteers, showing clearly how their data is used and what it has influenced.
2. **Communicate quality-assurance outcomes** back to volunteers, highlighting when their data meets reference standards.
3. **Provide interim updates soon after data submission** to maintain momentum.
4. **Offer personalised feedback** that explains both strengths and areas for improvement.
5. **Create opportunities for participants to share results** and experiences with each other.
6. **Use feedback sessions** as training opportunities to build skills and confidence.
7. **Plan and budget for feedback and validation processes** from the start of the project.

08 Scorecards for sharing findings and fostering action: Coordinators' perspective

Volunteer coordinators' perspective

One of the River Guardians project's most valued innovations has been the introduction of scorecards which were designed to present complex data clearly and accessibly (see Figure 3 for an example). Volunteers embraced them not only as validation of their efforts but also as practical tools for community discussions and local decision-making. Their enthusiastic reception shows the importance of sharing results in formats that are both meaningful and actionable. The story of their development, launch, and national uptake is explored on the next page.

From the perspective of the Volunteer Co-ordinator, dissemination was about sharing data "*in a way that children, adults, people who have no scientific background can understand, and they can then make conscious decisions, be it what they pour down their sink … or just to be aware.*" From the very early project meetings with potential River Guardians, he raised the question of how best to communicate results. Drawing on examples from other catchments and international initiatives, he recalled that participants "*really liked that we were thinking about different ways to bring it back to them in spreadsheets and in tables and charts or in like a video webinar series or something like that. And there was a general appreciation for most of that, but they really like the scorecards as I did.*"

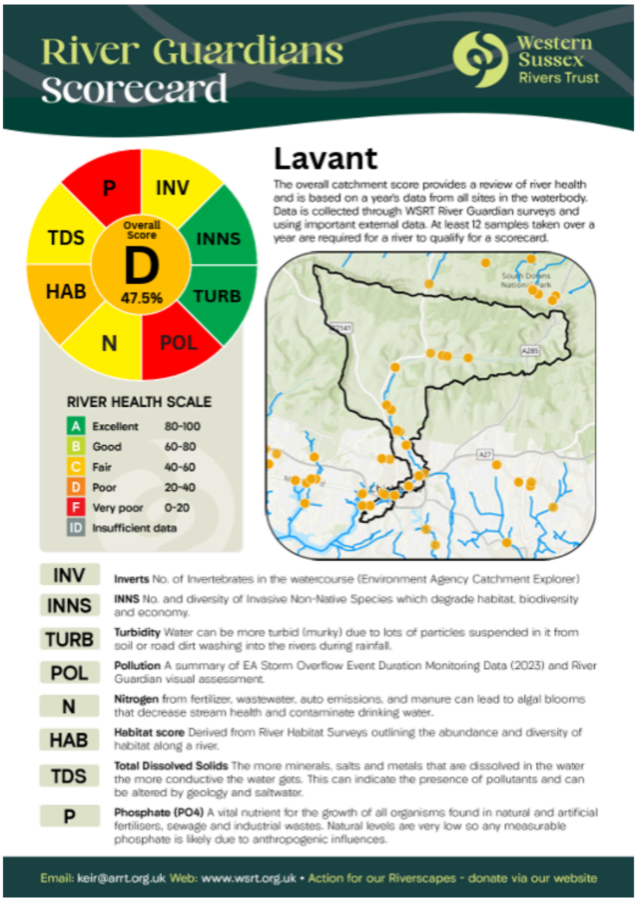


Figure 3: Example of a River Guardians scorecard presenting citizen science data

Designing the scorecards involved not only careful attention to visual style but also the technical challenge of determining the classifications used to represent phosphate, nitrate, and turbidity levels in a way that was both scientifically valid and publicly meaningful.

The scorecards allowed the River Guardians project to share results easily with local councils, community groups, and neighbours, transforming raw data into a resource for action.

"The scorecards really have taken off nationally, and there has been interest from wider rivers trusts towards copies, a lot of ambition to do either the exact same thing or something very, very similar to mine, which is fantastic."

Seen through the lens of SDT, the volunteer coordinators' reflections show how the scorecards supported three core psychological needs that underpin motivation. First, they enhanced competence, by providing feedback that validated volunteers' contributions and made their scientific efforts visible. Second, they strengthened relatedness, by enabling volunteers to connect with councils, communities, and other stakeholders through accessible tools that legitimised their role. Finally, they fostered autonomy, as the cards could be used flexibly by volunteers in advocacy, education, or awareness-raising, allowing them to act on the data in ways that mattered locally.

Taken together, this highlights a trajectory, from early discussions of dissemination, through iterative design, to widespread uptake, that illustrates how responsive data sharing can build legitimacy and resonance beyond the immediate project. The scorecards became more than a mode of reporting: they fulfilled volunteers' psychological needs, empowered local advocacy, and created a template of best practice now circulating at a national level.

08 Scorecards for sharing findings and fostering action: Citizens' perspectives

Citizen volunteers' perspectives

For River Guardians citizens, the introduction of scorecards was more than a technical innovation, it was a source of feedback, recognition, and motivation. As one participant explained, *"there's a scorecard for the [water body I test] and I know that my data is contributing to one part of that scorecard, and you can see it and you can send it to people and show them … and that's a really nice"* (RG9). Having a visible output made their work tangible, a validation that their efforts were not disappearing into what some described as a "black hole." This speaks directly to the SDT principle of competence: volunteers could see clear evidence that their data contributed to meaningful assessments of river health.

The visual and physical form of the scorecards also enabled action. As RG10 reflected, *"I carry the one with me … it makes it easy to explain to people. And yeah, you never know, other people will get involved and actually be more respectful of their river."* Similarly, RG01 used the scorecards *"to show people how well our area's doing and or how badly … they're really good."* In this way, scorecards became advocacy tools, something that could be shown to parish councils, MPs, or curious passers-by. This capacity to use the data locally reinforced volunteers' autonomy, allowing them to mobilise results in ways that mattered to their communities.

Volunteers repeatedly highlighted the motivational role of feedback loops. One noted, *"it's almost what keeps you going month on month – that somebody who's cleverer than I at these things is going to look at this data and make something of it and they can tell me what it all means"* (RG9)**. Here the emphasis is not only on competence – receiving expert interpretation of results – but also on relatedness, as volunteers felt connected to a collective endeavour where their contributions were recognised and contextualised.**

Scorecards were also associated with pride and ownership. RG9 recalled being shown a card for *"our stream and that was our data and there it was in beautiful technicolour."* Likewise, RG10 described how seeing his data represented was *"a good feeling … because if anything, it can be used to galvanise other people."* Such experiences reinforced volunteers' sense of belonging and identity as credible contributors to environmental monitoring. As RG11 put it, *"it was the data … that we had measured and it actually had some credibility as well. So I think that was perhaps a high point."* At the same time, not all accounts were uncritically positive. Some highlighted frustration when updates were delayed or static: *"they produce those cards every year, but they're static … nobody's communicating with me … compared to other citizen science projects I'm involved with, this is a very poor level of communication with volunteers"* (RG15). Here, unmet expectations around timely dissemination risked undermining motivation. From an SDT perspective, this points to the fragility of competence and relatedness when feedback loops break down.

Overall, the River Guardians' testimonies reveal that scorecards mattered because they validated contributions, sustained motivation, and created practical tools for community advocacy. They fulfilled key psychological needs for competence, autonomy, and relatedness, while also shaping a sense of collective identity. Yet they also underline the importance of responsiveness: when dissemination stalled, motivation faltered. These insights reinforce why co-designed, timely, and accessible dissemination practices are central not only to knowledge sharing but to sustaining the citizen science movement itself.

Volunteer coordinator vs citizens' outlooks on scorecards for sharing results

For the Co-ordinator, the scorecards were an exemplar of innovative, scientifically robust communication with broad resonance. For River Guardians, they were a source of motivation, validation, and local influence – proof that their data mattered. The comparison underscores that effective dissemination must be understood not only in terms of design and impact metrics but also in relation to the psychological needs and lived experiences of the volunteers who generate the data.

09 | A snapshot into the future: citizen science time travel

We asked scientists, stakeholders, and citizens what they think is in store for citizen science in coming years. They shared a wide range of ideas, from the highly ambitious and optimistic to potential downfalls or challenges. We interpreted the findings to create a vision for the future, entirely based on what they said. When you read the following page, imagine that it's 2035[1] and all of the below have been realised. How does it make you feel? What role will technology play? How can we achieve some, or all, of these future visions?

It is 2035. Looking back a decade, citizen science has grown from a fragmented, often undervalued activity into a mainstream, respected, and powerful form of environmental monitoring and democratic engagement. It has widened participation, delivered scientifically robust data, and influenced both practice and policy.

Widened participation: Ten years ago, concerns were raised about who was involved in citizen science and whether it reached beyond a narrow demographic. Today, participation is broad and diverse, with younger people contributing alongside a healthy and engaged retiree population. As one volunteer predicted, "*We've got an ageing population, you're going to have more, more people retire to tap into. There's probably a lot of opportunity going forward to engage people*" (CS12). Employers have also embraced citizen science, with workplaces now granting volunteering days: "*Citizen science projects could contact employers and say, would you be willing to give people, I don't know, a day a year, so that they can collect samples*" (CS16). Education has also become a core strand of citizen science, with schools embedding projects into their teaching and young people learning about environmental monitoring from an early age. As one River Guardian imagined, *"It's about getting this data with education, and a good next step would be going into schools and doing more about the importance of it"* (RG14).

[1] This approach was informed by Rob Hopkins' work on time travel (see 'How to fall in love with the future', 2025).

09 | A snapshot into the future: citizen science time travel

Filling the data void: One of the strongest drivers for citizen science has been the ability to fill gaps left by under-resourced government monitoring. Data is standardised and harmonised, with workable platforms for integrating multiple projects. A stakeholder recalled, **"***We really need help with the capacity of that because we're trying to do a very comprehensive soil sampling programme. So hundreds and hundreds of samples … literally thousands*" (SH6). Similarly, scientists emphasised that, **"***There isn't enough money to visit every farm … people see it as a way of expanding their ability to collect representative sets of samples***"** (SCI3). A citizen voice also foresaw this trend: "*I suspect the scope of it's going to expand and that there is going to be a transfer … from the professional realm to more voluntary work because we keep being told the government's got no money*" (CS27).

Citizen science recognised as a 'true science': A decade of methodological refinement, harmonisation, and investment in training has meant citizen science is no longer dismissed as "second-rate". As one participant argued at the time, "*I hope the term citizen science doesn't sort of apply mean that it's second rate science. I really don't think it is. I think it's top rate science, but just using lots of people***"** (CS10). Scientists also reinforced this aspiration, noting that if citizen science is to be taken seriously, "*it should be able to produce something that is of publishable quality*" (SCI2). This standardisation has been achieved, with consistent protocols now embedded nationally and internationally.

Strengthened democracy and advocacy: Citizen science is now recognised as a tool for democratic accountability, ensuring vested interests cannot silence environmental concerns. As one citizen explained presciently, "*Citizen science is an important tool in maintaining democracy … it is about a check and a balance on those in charge*" (CS23). With evidence collected by thousands, communities have been able to advocate for change, influencing policy decisions that were once left unchallenged.

Digital and AI integration: The adoption of digital technologies and AI has also transformed citizen science, supporting rather than replacing human effort. As one stakeholder reflected, "*There always needs to be a human component … a citizen can do that as well as a scientist in many instances when they're looking at an image*" (SH6). Digital sensors now complement citizen monitoring, improving coverage while ensuring citizens remain central to environmental stewardship.

Highly effective engagement and collective action: Perhaps the most significant achievement has been cultural. Citizen science is no longer a niche pursuit but part of everyday environmental action. As one volunteer said of its potential, "*It's a way to effectively tap into [the twin crises] and for local people to feel that they're there, you know, be able to take some meaningful action*" (CS8). **Citizens and scientists now communicate openly and co-design projects, ensuring relevance and impact.**

The ultimate paradox: success makes citizen science redundant?
Finally, some participants anticipated the ultimate paradox: if citizen science achieved its goals of clean, healthy rivers and resilient soils, it might one day no longer be needed. "*Ultimately we don't need it and it disappears because all the rivers are beautiful and the woods are growing and there's no pollution*" (CS15). While such a future is not yet here, the trajectory suggests that citizen science has fundamentally shifted how societies monitor, care for, and govern their environments.

10 | Is it really ‘citizen science’?

A future discussion: is ‘citizen science’ too broader term?

The findings presented throughout this report highlight that citizen science serves a range of purposes, which raises the question of whether the term citizen science is always the most appropriate descriptor.

Citizen science is not a single model but takes many forms, particularly as the approach (or aspects of it) become increasingly popular. Some initiatives are scientifically led, where professional researchers set the agenda and volunteers act largely as data collectors. These projects are usually top-down in structure and focus on generating robust datasets for scientific analysis. Others are more explicitly about public engagement and awareness raising, where the value lies less in the data itself and more in education, outreach, or fostering interest in environmental issues.

Projects also vary in scale and intensity. Mass participation projects often seek broad coverage with simple methods, enabling thousands of people to contribute a small number of observations. By contrast, targeted or intensive monitoring projects involve smaller groups of more committed participants, often requiring greater skill, training and long-term involvement.

Given this diversity, alternative terms can sometimes better reflect the nature of the activity. Table 4 summarises potential terminology for describing different types of participatory projects often referred to as ‘citizen science,’ highlighting variations in scale, leadership, orientation, and purpose. Collaborative monitoring refers to projects where professional scientists and communities work together across all stages, from design through to data use. Community science is increasingly used in place of “citizen science” to avoid excluding non-citizens and to emphasise local ownership and inclusivity. Citizen-led monitoring describes initiatives that originate within communities or interest groups themselves, often with a bottom-up focus on local priorities, and only later connect to scientific or policy frameworks.

Recognising this spectrum of approaches is important for setting expectations, supporting appropriate forms of facilitation, and ensuring that projects are judged on their intended purpose, whether that is to generate publishable data, to raise awareness, or to empower communities to act on environmental issues.

Table 4: Potential terminology for describing different types of participatory projects often referred to as ‘citizen science’

Term	Typical Scale	Who Initiates?	Orientation (Top-down vs Bottom-up)	Primary Purpose / Focus
Scientist-led citizen science	Often large scale, sometimes national or international	Professional researchers, universities, agencies	Predominantly top-down	Generating robust datasets for scientific research and policy evidence
Collaborative monitoring	Small to medium scale, often regional or catchment-based	Jointly by scientists and community organisations	Shared / co-produced	Co-designing methods, mutual learning, producing data both credible to science and meaningful locally
Community science	Variable scale, often local to regional	Community groups, NGOs, schools, local networks	Bottom-up, with external support	Building local capacity, improving environmental literacy, producing accessible outputs for communities and policymakers
Citizen-led monitoring	Usually local or catchment scale, focused on specific issues	Grassroots groups, interest associations (e.g. anglers, residents)	Strongly bottom-up	Addressing locally perceived problems, advocacy, influencing local decision-making, creating ownership and stewardship
Participatory learning projects	Typically mass participation, often short-term	Organisations, charities, campaigns, schools	Top-down with voluntary uptake	Public engagement, experiential learning, building awareness and interest rather than producing decision-quality data

11 Discussion and conclusions

This report has examined the motivations, purposes, and challenges of citizen science in the context of water and, to a lesser extent, soil. Drawing on interviews with citizens, scientists, and stakeholders, as well as two CaSTCo case studies and wider literature, it has shown both the transformative potential and the persistent structural barriers that shape the practice of citizen-led science.

A central finding is that citizen science is not only about data collection. While volunteers contribute to filling substantial monitoring gaps, their participation is also motivated by intrinsic enjoyment, curiosity, stewardship, and the desire to act on pressing environmental concerns. These motivations often intersect with more identified drivers such as contributing to community well-being or generating data that can influence policy. Self-determination theory provides a useful lens for understanding this spectrum of motivations, highlighting the importance of projects that nurture autonomy, competence, and relatedness.

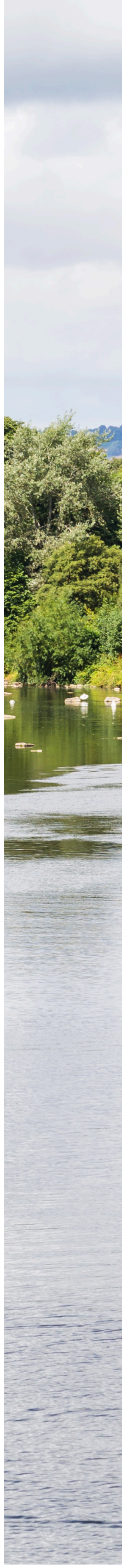
The evidence suggests that citizen science contributes unique forms of value that cannot easily be replaced by professional monitoring. For scientists and stakeholders, citizen science extends monitoring reach, enables rapid and dense sampling, and provides legitimacy through public engagement. For volunteers, it offers learning opportunities, a sense of contribution, and in some cases advocacy platforms. Yet despite this potential, citizen science remains undervalued in many institutional settings, often regarded as supplementary or unreliable. This perception undermines investment, integration, and long-term sustainability.

Challenges also include inclusivity, continuity, and ethics. Participants described citizen science as dominated by a narrow demographic profile, raising concerns about representativeness. A lack of sustained funding was widely recognised, creating a cycle in which enthusiasm and infrastructure dissipate once initial grants expire. Others noted the risk of extractive approaches, where volunteers provide data without seeing results or gaining influence over outcomes. In some cases, tensions were observed between citizen and professional science, including concerns that citizen-led data might threaten professional roles or standards.

At the same time, this research highlights shared remedies. Training and quality assurance, clear feedback loops, inclusive recruitment, transparent communication about project aims, and ethical use of volunteer contributions were all identified as ways to strengthen practice. Importantly, participants argued for greater integration and standardisation across projects, as well as more sustained funding that matches the long-term nature of environmental monitoring.

Looking ahead, our time-travel exercise with participants provided a vision of what citizen science could become if these remedies were taken seriously. In this imagined future, citizen science fills critical data gaps with consistently robust evidence, is recognised as a legitimate part of science, is supported by standardisation and digital technologies, and contributes directly to advocacy and democratic decision-making. Such a future depends not only on technical fixes but also on cultural and institutional shifts that value citizen-led knowledge alongside professional expertise.

In conclusion, citizen science has demonstrated its ability to mobilise communities, generate valuable data, and strengthen links between science, policy, and the public. Its impact, however, depends on addressing persistent challenges of funding, legitimacy, inclusivity, and integration. Recommendations offered throughout this report highlight practical steps to enhance future projects, ranging from ongoing training and feedback loops to structural reforms that embed citizen science within monitoring frameworks. If these are implemented, citizen science could not only provide robust evidence on environmental change but also help sustain democratic and collective responses to urgent challenges such as water quality and biodiversity loss.



11 Overall recommendations

Based on the findings and context-specific recommendations provided in this report, we make the following overarching suggestions for maximising motivation and engagement in future citizen science (or collaborative monitoring) efforts:

Co-design as standard: As far as possible, projects should be co-designed with citizens, scientists, and stakeholders from the outset to align priorities, build trust, and improve inclusivity (see Chivers et al., 2025 for detailed guidance).

Secure long-term and sustainable funding: Funding cycles should match the long-term nature of environmental monitoring. Multi-year or pooled funding mechanisms should cover equipment replacement, coordination, and data continuity.

Provide training and refresher programmes: Ongoing support is essential. Seasonal refreshers, joint fieldwork, and accessible online modules should maintain skills and data reliability.

Create clear feedback loops: Volunteers need to see the outcomes of their contributions. Regular updates should show how data has been used, what actions it has influenced, and where it has made a difference.

Integrate and standardise across projects: Methods, data formats, and quality standards should be aligned to enable interoperability and increase confidence in citizen-generated data.

Communicate project purpose transparently: Be clear if the aim is awareness-raising, education, or decision-quality monitoring. This clarity strengthens trust and expectations.

Address professional concerns: Position citizen science as complementary, not competitive. Emphasise added value such as extended coverage, early warning, and public legitimacy.

Recruit inclusively and diversify participation: Engage underrepresented groups through tailored outreach, avoid alienating terminology, and collaborate with community organisations.

Reduce access and safety barriers: Provide support with transport, site allocation, and safe alternatives. Offer roles beyond fieldwork, such as data interpretation, where needed.

Ensure ethical use of volunteers: Be transparent about data use, acknowledge contributions publicly, and involve volunteers in interpreting results to avoid extractive approaches.

Link projects to topical issues and advocacy: Connect activities to current debates such as water pollution, flooding or biodiversity loss. Show how findings feed into advocacy and management.

Harness intrinsic and identified motivations: Design projects that emphasise enjoyment, curiosity, learning, and stewardship, while enabling participants to feel their contributions make a real difference.

Build strategic partnerships: Align projects with institutional priorities, regulatory frameworks, and wider monitoring networks to increase legitimacy and policy impact.

Adopt digital and AI tools thoughtfully: Use new technologies where appropriate to expand capacity and standardisation, while ensuring they complement rather than replace hands-on volunteer engagement.

Promote advocacy and long-term impact: Support volunteers in moving beyond data collection into advocacy and action. Projects should contribute to wider environmental goals and democratic processes.

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Appendix 1
Full list of citizen science projects

We interviewed citizen scientists involved in a wide range of projects- including within CaSTCo and beyond. The following projects were represented in interviews:

- Riverfly monitoring
- Wildlife data collection (birds, bats, flora, fauna)
- River-course mapping and morphological observations
- Chemical testing (e.g. phosphates, nitrates)
- Archaeological mapping
- Seagrass counting (via scuba diving)
- Invasive-species removal (Himalayan balsam, Japanese knotweed)
- General river conservation (rubble/development monitoring)
- Treezilla surveys
- BioBlitz events
- Outfall Safari inspections
- Water-quality testing
- SmartRiver chemical monitoring
- Riverwatch community groups
- Water Guardian programmes
- River Detective initiatives
- CSI (Citizen Science Investigations)
- Waterwatch and Earthwatch campaigns
- Tree-scrub clearing and bashing
- Greenhouse open-day volunteering
- Friends-of-River restoration projects
- MORPH (morphological river monitoring)
- Seaweed surveys
- Big Butterfly Count, Birdwatch and related "water blitz" events
- Combined-sewage-overflow data collection
- Catchment-plan development (e.g. River Sid Catchment Plan)
- Earthworm counts
- National Plant Monitoring Scheme
- Botany Recording Scheme
- Butterfly counts
- Big Garden Birdwatch
- SeaWatch observations
- Treeconomics assessments
- POMS (Physical and Outdoor Measurement Studies) fit counts
- National Pollinator Scheme surveys
- Zooniverse contributions
- General biodiversity and plant-survey activities
- Lichen surveys

What motivates citizens to engage in citizen science? Appendix 2

Enjoyment and curiosity:
"I do it because I love doing it … I love writing a report … I love dots on maps." – Citizen 9
"I really enjoy getting out there and doing stuff … it's easier in the summer, it's a bit warmer, it's a bit lighter later." – Citizen 14

Learning and competence
"I certainly have learnt an awful lot … I didn't know what was in the river around me … as far as invertebrate life is concerned." – Citizen 11
"It would be good to find … get to the bottom of it … I just have this bee in a bonnet about my local little bit of the beck." – Citizen 7

Belonging and being part of something bigger
"It means being better connected … having a better sense of place and community … doing something in my own small way." – Citizen 16
"You can see anywhere in the country what their Riverfly counts are like … a bigger picture across the country … lots of communities all over the country … who care enough to go out once a month and kick about and count some bugs." – Citizen 19

Practical fit and autonomy
"You can pick and choose what you do … you don't have to do too much paperwork." – Citizen 15
"It's under half a mile away … so challenges in terms of motivation aren't really there." – Citizen 8

Generating evidence
"Reports and outputs are the key things that can influence things … send that record to the biological records centre … otherwise a consultant says there's no ecology on that site." – Citizen 3

Stewardship
"If people felt a better sense of place … and had a more active role, that would reduce littering and vandalisation." – Citizen 20
"I'm chairing ecologist for the Friends group … constantly engaged in the community." – Citizen 2

Filling monitoring gaps
"You can collate a lot of information if it's well organised." – Citizen 4
"It's a small thing that contributes to a bigger whole … upload our findings online … a bigger picture across the country." – Citizen 19

From Reflection to Action

You have now read this report. Take a moment to pause and reflect on what stood out to you and how you might act on it.

This page is for your personal use – a way of turning insights into meaningful action.

One thing that surprised me was:

One thing I will share with others is:

One action I will take is:

CCRI COUNTRYSIDE AND COMMUNITY RESEARCH INSTITUTE

Western Sussex Rivers Trust

WATER for LIFE from Southern Water

S.Woodley Crop Services

CaSTCo Rivers. Communities. Resilience.