CITIZEN SCIENCE:
THEORY AND PRACTICE

The Role of Volunteers and Citizen Scientists in Addressing Declining Water Quality in Irish River Catchments

REVIEW AND SYNTHESIS PAPER

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ABSTRACT

Integrated Catchment Management (ICM) frames water management in Ireland to account for the complex hydrological, biophysical, and environmental interactions along with the political, socio-economic and cultural influences inherent in the management of river catchments. Despite a range of European Union (EU) Directives, national laws, policies, and incentives, the quality of water and biological diversity in Irish rivers is declining. In response, there has been an increased effort to involve local communities in ICM through a bottom-up, nature-based citizen science approach to activate local cooperation and environmental stewardship. This paper assembles 157 examples of citizen science water-based projects (48 in Ireland as of 2021) to appraise the position of community-led water monitoring in ICM. Notable differences found between the Irish and international programmes found a greater emphasis on habitat internationally, while a taxonomy focus was evident in Ireland despite a lower number of skilled volunteer activity-based citizen science projects. The continuing decline in water quality in Ireland, even with appropriate regulations, commendable governance changes, and expansion of citizen science, suggests more work is necessary before there will be successful ICM and improvements to river water quality.

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INTRODUCTION

Nothing links humans more to the natural world than our connection to and dependence on fresh water. Good-quality water that is not polluted is essential for life and human health, yet globally, nationally, and locally in Ireland, river water quality is in decline (Malmqvist and Rundle 2002; Dodds, Perkin, and Gerken 2013; EPA 2019). To support a rapidly growing global human population, there is a corresponding growth in urbanisation, industrial activity, energy consumption, and intensification of agricultural activity, and these are major contributors to the current state of environmental degradation in this Anthropocene era (Crutzen 2006). Increased concentrations and cumulative loads of environmental pollutants, unsustainable use of natural resources, and loss of natural habitats and biodiversity impact water quality and impair freshwater ecosystem services, and this is against the public good (Dodds, Perkin, and Gerken 2013). Ecosystem services include direct provisions, such as food, medicine, raw materials, freshwater supply and energy; and indirect supports, such as photosynthesis, flood control, pollination and nutrient cycling (Sandifer, Sutton-Grier, and Ward 2015).

European Union Habitat, Nitrates and Water Framework (WFD) Directives provide strong statutory frameworks for managing river basins to ensure that water quality is maintained or improved to achieve at least good ecological status. Progress was made in the first cycle of River Basin Management Plans 2009–2014 under the WFD on the scientific aspects of catchment management in the Republic of Ireland, such as in catchment delineation, catchment characterisation, and increased monitoring, as well as baseline and applied research (EPA 2019, 2020). However, these regulatory or top-down successes in freshwater management in Ireland failed to achieve legislative objectives, and surface water quality, particularly in rivers, has continued to decline (EPA 2019). Regulations, incentives, implementation frameworks, and European, national, and community schemes to protect natural habitats and water quality may have even contributed to challenges of their acceptance, and thus their ineffectiveness, because they did not allow for meaningful participation and social learning with local stakeholders (Boyden 2015; Daly, Archbold, and Deakin 2016). Pressures from human activity are causing the deterioration in Ireland's river water quality, so an acknowledged causative factor in the continued decline is a lack of local community engagement in state-led water protection systems (Rolston, Jennings, and Linnane 2014; EPA 2019).

Integrated Catchment Management (ICM) is endorsed nationally and internationally as essential to successful water management. ICM is the approach prescribed by the River Basin Management Plan (RBMP) from 2018 to 2021, as part of the second RBMP cycle to best implement the WFD objectives by stressing the importance of increasing public participation and stakeholder engagement in decision-making. It is being implemented by the newly created Local Authority Waters Programme (LAWPRO) in conjunction with Ireland's Environmental Protection Agency (EPA), working with local authorities and multiple other stakeholders. ICM is about bringing water issues, organisations, and people together, at the right scale, to deliver effective solutions that offer multiple benefits. ICM fosters the integration of both the top-down and bottom-up approaches that may foster a meeting in the middle that achieves water protection through collaborative action (Rollason et al. 2018).

Community engagement in water protection issues include volunteer participation in decision-making, active on-the-ground engagement, and more recently, citizen science initiatives. These models can foster environmental stewardship, caring for nature and water, increased scientific literacy, and good community citizenship (Bonney et al. 2009; Conrad and Hilchey 2011). Citizen science is a valuable form of public participation that involves non-professional scientist volunteers in collaborative scientific investigations, providing professional researchers with access to localised data at extensive spatial and temporal scales that would otherwise be impossible or prohibitively expensive to obtain (Dickinson et al. 2012).

Some citizen science project models are broadscale and internet-based, and they utilise multiple participants to collect data on large geographical scales, while others are more focused and activity-based, and organise targeted groups of volunteers to tackle local-scale issues (Conrad and Hilchey 2011). Owing to technological advancements, more citizen science projects are using Information and Communication Technology (ICT) mobile applications and websites to record data and promote projects, and this can increase uptake in projects related to biodiversity and the environment (Kobori et al. 2016; Bautista-Puig et al. 2019). Not only has data gathered by citizen scientists informed researchers of environmental conditions, but citizen science activities also help to build local community awareness of those environmental conditions. This can increase ecological identity and a sense of place that can motivate and empower individuals to take action or to become involved in volunteering and in policy and decision-making to remedy environmental issues within their local communities (Gooch 2003; McKinley et al. 2017). Citizen science, both broadscale and focused, is increasingly being promoted and actioned as a mainstream exercise to bridge the gap between top-down environmental regulation and bottom-up individual behaviour (Bautista-Puig et al. 2019).

The aim of this review paper is to examine community-led water quality monitoring in ICM, and to evaluate the role of citizen science. A range of international biodiversity and in-stream citizen science projects are collated and analysed. A summary of water governance, and comparisons with recent citizen science developments in Ireland helps identify gaps and acts as a first step for future plans to co-develop holistic community-based initiatives. The research is based on the concept that citizen science efforts in Ireland lag behind other countries owing to a predominantly top-down approach that lacked opportunities for public participation.

METHODOLOGY

This article uses review and synthesis methods, including a scoping review and meta-analysis. Firstly, the key components of water governance in Ireland and particular characteristics (governance, organisations, and projects) were assembled from primary published studies and authors' professional experiences to provide stakeholder context. Secondly, key characteristics of community-led citizen science projects, including programme focus and target audience, were evaluated to help identify potential gaps and inform future plans for community engagement.

Key review themes related to freshwater environments, catchment management, community engagement and volunteerism, and citizen science models were reviewed by summarising material from primary published studies between the years 2000 and 2021. Using Google Scholar and Web of Science (with Ex Libris's Summon), keyword searches were conducted with variations in terminology such as "natural resource management," "river basin management," and "catchment management," or "citizen science," as well as "participatory action research," "environmental stewardship," and "community-based monitoring," followed by systematic Boolean search combinations with terms such as "water quality," "river," "surface water," or "catchment" to narrow responses. Other combinations include the terms "citizen science" or "volunteer" with the words "barrier," "benefit," "health," "confidence," "education," "policy," "effective," "satisfaction," and "long-term."

Once the literature was collected, each study or review was further examined along with internet searches to elucidate examples of aquatic or riparian-based citizen science projects. These projects were collated in a metadatabase. The Excel file was populated with a non-exhaustive list of 157 global English-language, water-related citizen science projects to aggregate examples from the individual studies. Variables recorded include programme focus, region, type of survey, and target audience. The projects were classified according to their programme focus, whether habitat monitoring (water chemistry, nutrient levels, pollution, or other abiotic conditions), taxonomy (specific taxa), both habitat and taxonomy, biodiversity (non-specified flora and fauna), and invasive alien species. The type of survey was classed as either broadscale internet-based or focused activity-based. Projects were then subdivided by target audience for data provided by either skilled volunteers who are trained to sample and/or identify biodiversity to species level, or members of the public reporting on casual sightings of specific taxa, invasive species, or non-specified biodiversity. It must be noted that there was a deliberate bias in the metadata searches towards citizen science projects in Ireland. The comprehensive list of Irish water-related citizen science projects was then compared with the wider list for the comparative ratio of project types, activities and level of skill required.

RESULTS

WATER GOVERNANCE IN IRELAND

In response to criticisms of a top-down approach in the first cycle of the RBMP, the second RBMP cycle focused on increasing communication, stakeholder engagement, and public participation (Rollason et al. 2018). Key players in water governance in Ireland are included in Supplemental ***Table 1***. In 2015, a new three-tier governance framework was established: (1) A water policy advisory committee; (2) the EPA, who are responsible for coordination and technical implementation; and (3) the Local Authority Water and Communities Office (LAWPRO), who are tasked with coordinating public participation at the regional and local levels (O Cinnéide, O'Riordan, and Boyle 2021). Additionally, An Fórum Uisce (The Water Forum) was established as a statutory body in 2018 to strengthen democratic inputs and facilitate stakeholder engagement in water governance and decision-making.

Catchment management associations, Rivers Trusts, nongovernmental organisations (NGOs), community groups, and European Innovation Partnership (EIP) projects now also populate the landscape of community engagement with water in Ireland. However, community-led initiatives can struggle to access sufficient funding and technical expertise to implement their catchment plans. Some NGOs have secured European Union (EU) funding for example, through the LIFE programme (CINEA 2022) and INTERREG (2022), but they still require technical support, particularly when undertaking management actions in Special Areas of Conservation (SACs) or Special Protection Areas (SPAs). Recent efforts to address this have resulted in the pilot Resilience Project which provided partial funding to employ project officers for two rivers trusts (Inishowen and Maigue) to drive forward the goals of the rivers trusts and LAWPRO.

CITIZEN SCIENCE NATURE-WATER PROJECTS

A literature and internet review of citizen science nature-water projects was conducted to examine key characteristics (programme focus, region, type of survey, and target audience) and to help inform future plans for community engagement. This resulted in the collation of 157 water-focused citizen science projects in a metadatabase. A recent review by Capdevila et al. (2020) assembled 34% of these (published) projects in an examination of characteristics for success. Citizen science water-related projects (both published and ongoing) focus on habitat monitoring (45%) for data on water chemistry, nutrient levels, pollution or other abiotic conditions, taxonomy (22%), both habitat and taxonomy (16%), biodiversity (10%), and invasive alien species (6%) (**Figure 1**). There were more programmes focused on activity-based local scale projects than there were broad geographical scale ICT-based projects in which volunteers submit data on chance sightings (**Table 1**).

A wide range of data was sought, varying from reports provided by skilled volunteers who are trained to sample and/or identify biodiversity to species level through to members of the public reporting on casual sightings of specific taxa, invasive species, or non-specified biodiversity. ICT or gamified (task, game, activity) projects attract

TYPE OF PROGRAMME	ACTIVITY-BASED	ICT BASED	ICT AND ACTIVITY- BASED	TOTAL
Alien invasive species	3	6	0	9
Alien invasive species & Habitat	0	1	1	2
Biodiversity	3	12	1	16
Habitat	41	26	3	70
Habitat & Taxonomy	25	0	1	26
Taxonomy	14	20	0	34
Total	86	65	6	157

Table 1 Summary of activity-based (focused) and Information Communication Technology (ICT) (broadscale) aquatic citizen science programmes (n = 157).

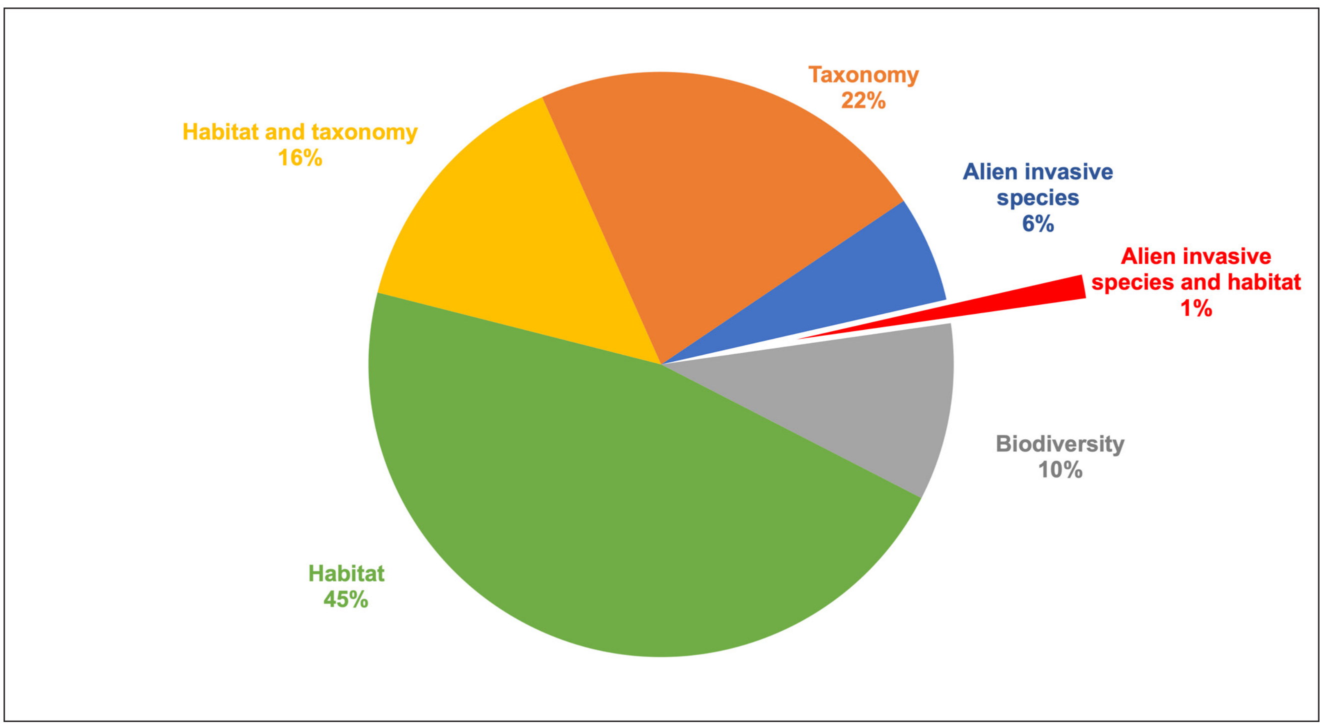

Figure 1 Summary of aquatic citizen science projects and their programme focus (n = 157).

technophiles (Curtis 2015), and there are purely online formats, such as Zooniverse (2022), which offers a choice of 87 projects on a range of subjects for their 1.6 million registered volunteers, and *CitSci.org* (2022), which has a facility for researchers to build customised online research projects that can collect, analyse, and provide feedback on data and project participants.

Activity-based projects focus on more intense modes of participation and maximise the role of the individual participant through professional training opportunities, specialised equipment, and rewards (Crall et al. 2011; Catlin-Groves 2012). Citizen science initiatives to monitor local river issues are a source of community action and a way for people to come together with the aim of addressing collective and individual concerns (Haklay 2013). For example, researchers can learn of the presence of rare or invasive species, gaps, patterns, relationships, and trends in climate, in habitats, or in ecosystems (Bonney et al. 2009), and scientists are also combining and comparing historical and current datasets from different citizen science programmes to glean information (Dickinson, Zuckerberg, and Bonter 2010). Some international environmental protection agencies use volunteer water quality data to target streams and rivers for protection (McGoff et al. 2017), and community-based rainfall, river levels, and flood observations, alongside traditional sources of hydrological information, support characterisation of catchment response more accurately (Starkey et al. 2017). Monitoring physical habitat mosaics and human pressures (MoRPh) within short river reaches was the focus of a project by Shuker et al. (2017), while smaller waterbodies were examined in McGoff et al. (2017), filling a gap in statutory water quality monitoring programmes (Shuker et al. 2017).

The review revealed 157 global projects as of 2021 that could be categorised as citizen science for water stewardship. The projects were separated by region, resulting in 109 non-Ireland, international projects, which are included in Supplemental Table 2, and 48 Irish-based projects, which are included in Supplemental Table 3. The 48 Irish projects represent an increase compared with previous reviews of citizen science projects in Ireland (Donnelly et al. 2014; Roche et al. 2021). Just four of the water quality projects in Ireland have been published as of 2021: The CITCLOPS project/Forel-Ule Colour Index System (Garaba et al. 2015), the Citizen Science project for Sustainable Development Goal 6 (Garaba et al. 2015; Quinlivan, Chapman, and Sullivan 2020), the Backdrop project (Hegarty et al. 2020; Hegarty et al. 2021), and a biosecurity mobile application to report on alien invasive species (Melly and Hanrahan 2018). The projects in Ireland are equally split between coastal/marine and freshwater environments, whereas of the 109 international projects, 82% focus solely on freshwater and 10% on marine. In Ireland, more than 28% of projects are habitat focused, while 36% target taxonomy and 19% target biodiversity (*Figure 2*). In contrast, 51% of the non-Irish projects target

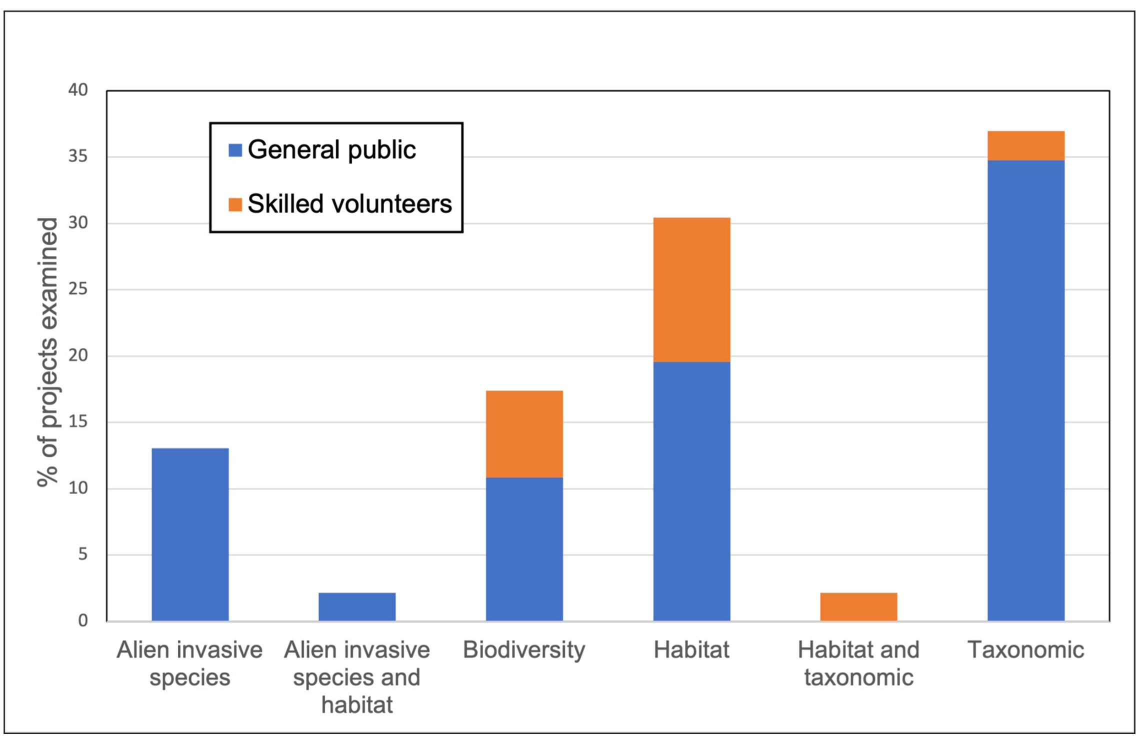

Figure 2 Summary of Irish marine and freshwater citizen science programmes and level of skill required (n = 48).

habitat, 16% target solely taxonomy, and 23% target both habitat and taxonomy. In Ireland, the majority (79%) of projects target members of the general public, while 21% focus on more skilled volunteers, whereas with the non-Irish projects, the majority (67%) target skilled volunteers and 27% the general public (*Figure 3*).

This notable difference between the Irish and international programmes suggest that activity-based citizen science projects targeting skilled volunteers to monitor freshwater habitats could be further developed in Ireland.

DISCUSSION

FRESHWATER ENVIRONMENTS

This review of water-focused citizen science projects has revealed a diversity of project types across regions, types of water, and geographical scale. The dynamic nature of water and its complex range of scale, interested parties, and interacting sites make waterscapes one of the most challenging natural resource environments to manage, particularly when being sensitive to local cultural symbolism, landscape, and connectedness to water (Acharya 2015). The water in rivers constitute common resources along with their plants, invertebrates, and wild fish, and thus are freely available for all to use. This also brings threats of overuse, damage, and degradation. Adding to the complexity, rivers are natural geographical markers, often chosen to delineate boundaries between political, administrative, and privately-owned lands, and while the variously-owned and managed river banks may grow, shift, and shrink, the water in the rivers remains common property (Blomley 2008).

In contrast, the catchment can be an ambiguous geographical entity for many people to contemplate and a challenge when developing citizen science initiatives. In terms of scale, it is more difficult for people to appreciate large-scale spatial and long-term temporal biogeographical and ecological processes (Saunders, Brook, and Myers Jr. 2006), which are often the subject of ICT-focused citizen science projects. Thus, environmentally damaging behaviour can stem from a lack of awareness that local actions can cause far-reaching negative consequences. While small-scale river restoration initiatives may be more successful in activating local engagement, it is management at the wider catchment scale that offers the greatest potential. Thus local activity-based projects need to be properly rooted in catchment management plans. Rivers constantly interact with the surrounding landscape as they collect water along with any pollutants, chemicals, and nutrients as they flow downstream from their sources and headwaters to their flood plains and outlets. Successful management initiatives require building awareness of these intricate interactions, in collaboration with local communities, whilst drawing attention to protection on a catchment scale (Kerr 2007; Surridge, Holt, and Harris 2009).

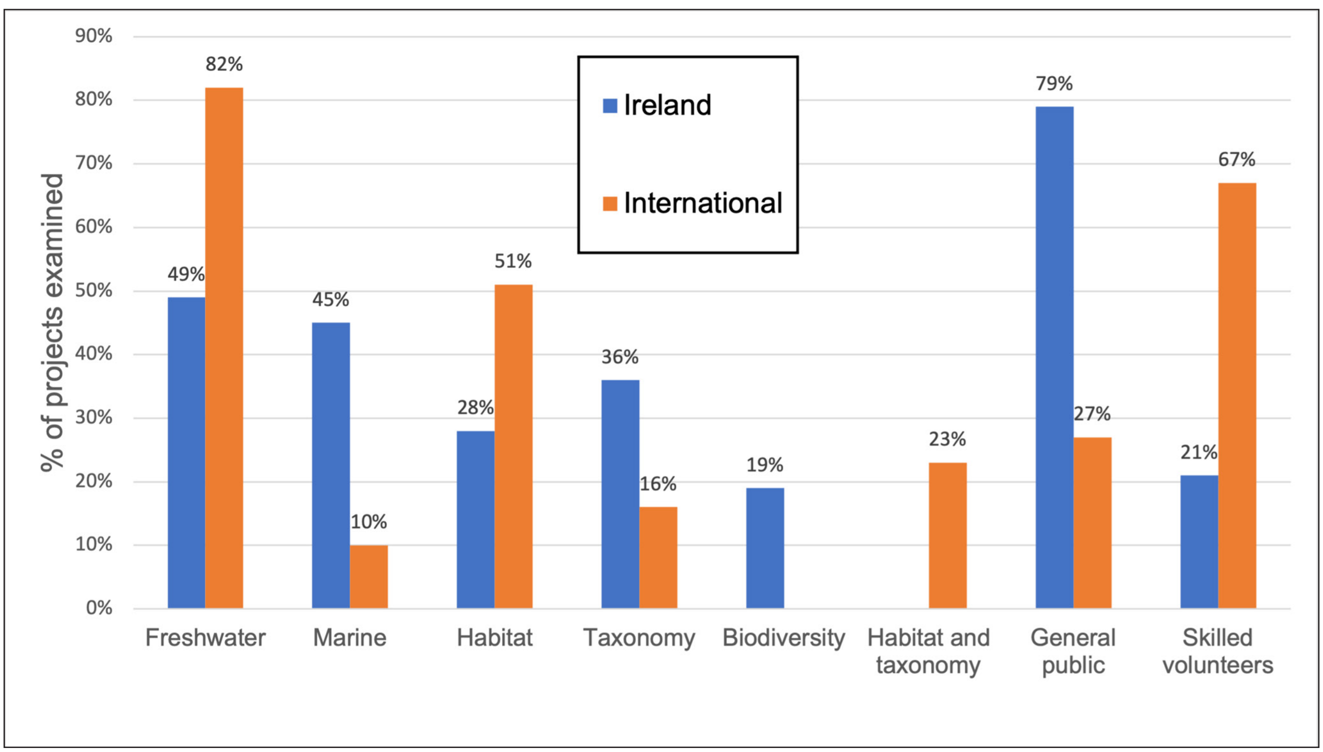

Figure 3 Comparison between Irish (n = 48) and international (n = 109) water-related citizen science projects and project focus.

CATCHMENT MANAGEMENT

ICM is based on the concept that catchments are distinct, unique biophysical units on the scale of an entire river drainage basin. Included in each unit are all the influencing political, socio-economic, and cultural factors inherent and omnipresent within a river catchment (Surridge, Holt, and Harris 2009). ICM focuses the scale to all the potential influences and impacts within a river basin for the protection of ecology, water quality, and socio-economic functions (Rollason et al. 2018), and it also ensures water quality can be monitored, that there are appropriate policy objectives and organisational structures, and that there is integration of scientific and local community involvement. The recent governance changes and emergence of a new landscape of community engagement with water in Ireland has the potential to fulfil ICM more effectively.

A collaborative, integrative approach is fundamental to successful ICM if the programme is adequately supported and implemented, all stakeholder aims are identified, and it is flexible and tailored to the characteristics of the people and landscape of the catchment (Ballinger et al. 2016). Community-based natural resource management is a bottom-up, participatory approach to ICM that fully involves all stakeholders in water planning and implementation to achieve water quality restoration objectives (Dublin Statement 1992). This collaborative, social learning process can give insight to the multi-faceted scope of catchment biophysical processes that can help multiple stakeholders understand that resilience and sustainable solutions come from a catchment-scale perspective (Micha et al. 2018). Challenges in terms of governance, supports, and funding have constrained community-led programmes in Ireland to-date. Moreover, integrated management approaches for water resources have also been criticised for their vagueness, for their overly-ambitious aims, and for the difficulty in implementing plans that adequately address all interests of stakeholders without creating new problems (Butterworth et al. 2010).

CITIZEN SCIENCE FOR RIVER STEWARDSHIP

Surface water or blue spaces, such as lakes, rivers, and coasts, are globally recognised as physical, ecological, economic, and cultural assets and attractions in the landscape (White et al. 2010). In contrast, water quality is a less tangible entity and has been described as invisible (Capdevila et al. 2020). Thus, the challenge in citizen science for river stewardship is how best to motivate and sustain stakeholder involvement to fulfil the fundamental participatory component of ICM.

The tendency of a person towards pro-environmental behaviour increases if that person feels a connection to nature (Mackay and Schmitt 2019). If their identity is intertwined with their emotional attachment to a particular place, for example a river, then they may be more predisposed to protecting it (Lokhorst et al. 2014), particularly if it is at risk of pollution or deterioration (Stedman 2002). Positive nature experiences can increase feelings of connectedness to nature (Mayer et al. 2009; Lokhorst et al. 2014) that can lead to further pro-environmental behaviour and, thus, improved or maintained environmental conditions (Toomey and Domroese 2013). A complex combination of personal (age, gender, education, personality), social (urban/rural, class, geographical proximity, childhood experience) and cultural (religion, values, politics) traits can influence the propensity towards pro-environmental behaviour (Gifford and Nilsson 2014). An examination of the profile of Irish citizen scientists will be an important component in the next research stage.

Citizen science provides numerous benefits to science, research, and volunteers, can complement top-down environmental regulation, and can facilitate a meeting in the middle for stronger, more effective water quality protection. Citizen science initiatives must further scientific knowledge to achieve genuine outcomes (ECSA 2019), and not simply be infotainment and a greenwashing exercise. Additionally, there are criticisms of citizen science data due to potential biases, errors, and variability (Dickinson, Zuckerberg, and Bonter 2010; Dickinson et al. 2012). Methods to improve data validity may include researcher-prepared reference data, increasing supervision and training, and recruitment of long-term volunteers or those with an economic, health, or personal stake in the outcome of the research (Aceves-Bueno et al. 2017). All of these are challenges for the development of citizen science in Ireland, particularly in terms of being an opportunity for meaningful engagement, use and management of the data, and longer-term project implementation. Thus, the design of the initiative is important for its effectiveness as well as its ability to attract volunteer participation and maintain long-term engagement.

FUTURES FOR COMMUNITY ENGAGEMENT WITH WATER IN IRELAND

Water governance reform at national, regional, and local levels represents a welcome advancement in the water sector in Ireland. The developments aimed at coordinating public participation at the regional and local level are very positive and are providing stronger leadership and opportunities for local communities (Hegarty et al. 2020). The proliferation of water quality–related citizen science projects across nations, and the expansion of community players and projects in the Irish landscape suggest a brighter future for community engagement with water in Ireland but also present challenges. Despite laudable citizen science provision and expansion as well as new governance structures, water quality in Ireland has continued to decline.

Further collaboration and partnership between agencies and all catchment communities is necessary to reach scientific outcomes and potential solutions. Additional vertical and horizontal learning opportunities are needed to build capacity to address environmental challenges at local scale. Successful, well-implemented nature-based volunteer and citizen science initiatives have the potential to offer numerous benefits to the environment, society, and the economy including improvements in biodiversity, active community engagement, and enhanced ecosystem services (***Figure 4***). However, without adequate supports, funding, and structured data repositories, bottom-up, community-led programmes will have limited scientific value (Ballinger et al. 2016).

The contrasts highlighted between the international projects and the Irish projects demonstrate that there is room in Ireland to develop projects that train volunteers to conduct skilled monitoring of freshwater habitats. This would be particularly useful to science if volunteers were trained to monitor the water quality in the rivers and streams adjacent to their private lands where state agencies or scientists have no access. To optimise the potential of success, this gap could also be filled with citizen science programmes that are co-designed by community members using the principles of social learning, which might help identify problems and encourage stakeholder agreement on remediation measures. A nationally coordinated water-focused programme developed in this manner with standardised protocols and adequate supervision and training may simplify the complex citizen science landscape of multiple short-term ad-hoc projects and data collection initiatives. For example, tiered levels of data collection starting from (1) submissions on chance species sightings, to (2) regularly scheduled site surveys for specific and invasive species, to (3) water-based chemical and nutrient testing, and (4) beginner macroinvertebrate sampling up to (5) advanced levels of macroinvertebrate identification. This would offer volunteers a wider range of opportunities to suit their differing interests, motivations,

Figure 4 Benefits of nature-based citizen science.

skills, and commitment, as well as offer progression and upskilling to help sustain longer-term volunteerism, which would also help improve problems of data validity (Aceves-Bueno et al. 2017). LAWPRO launched a catchment-based training programme in 2021 to be delivered to community groups that focuses on healthy waters, sustainable activities, citizen science, catchment management, and local biodiversity planning and restoration works (LAWPRO 2021). The recruitment, engagement, and confidence-building that citizen science provides may ultimately lead some volunteers to progress to the more informed volunteer and advanced scientific data collection (Donnelly et al. 2014), and others to become more active in policy consultation and decision-making.

Capdevila et al. (2020) identified three key contributory factors that ensure success in citizen science projects in water quality monitoring: (1) individual attributes of participants, (2) organisation characteristics, and (3) supporting structures. In Ireland, much of the decline in water quality is associated with agricultural activities (EPA 2019). Community-led citizen science may offer farmers the social norm that can initiate behavioural change (Goldstein, Cialdini, and Griskevicius 2008), and because citizen science is voluntary, it may increase potential for greater uptake in the farming community compared with compulsory regulations (Barnes, Willock, and Hall 2013). Farmers have an intimate knowledge of the land and the ability to observe changes in biodiversity over time, and with the proper design and support, citizen science may provide the tool for farmers to autonomously monitor impacts of their farming practices on water quality, and also the means to communicate that knowledge and data. More work needs to be done to reach rural communities and to increase awareness of the wide range of opportunities to get involved, either as individuals, as families, or with a community group. With the recent upsurge in the number of new water-related citizen science projects, it could be a matter of publicising the available citizen science opportunities, and also allowing for some time for public participation to build. A centralised system would help in assessing project success in terms of levels of engagement and sustained engagement and upskilling, and it would help support community groups with project implementation by providing a means from which they can easily report on data and provide participants with regular feedback, which would help them to maintain volunteer engagement for the long term (Haklay 2015). With increased uptake, Ireland's citizen science landscape may still foster the sharing of information and social learning that is necessary for bottom-up engagement, successful ICM, and, ultimately, improvements in water quality.

CONCLUSION

Shared common resources within a catchment, such as rivers, lakes, coastal waters, and fish, risk pollution, overexploitation, and unsustainable use unless there are locally-designed and community-led systems based on local knowledge to protect those resources. Despite its limitations, citizen science can be a multi-beneficial bottom-up approach to water quality monitoring that can complement top-down catchment management and governance in Ireland. With proper design, promotion, implementation, and training, nature-based citizen science can meet the goals of both scientists and volunteers.

SUPPLEMENTARY FILE

The Supplementary File for this article can be found as follows:

- **Supplemental Tables.** Tables 1 to 3. DOI: *https://doi.org/10.5334/cstp.447.s1*

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Each author approved the final manuscript, agreed to be named on the author list, approved the full author list, and significantly contributed to the conception and design, drafting, reviewing, and/or revising the article.

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