



Citizen Science in Ireland

Joseph Roche^{1*}, Aoibhinn Ni Shuilleabhain², Peter Mooney³, Gillian L. Barber¹, Laura Bell¹ and Clíodhna Ryan¹

¹School of Education, Trinity College Dublin, Dublin, Ireland, ²School of Mathematics and Statistics, University College Dublin, Dublin, Ireland, ³Department of Computer Science, National University of Ireland, Maynooth, Ireland

Ireland has a rich history of public engagement with science and the growing number of national citizen science initiatives is in keeping with developments seen in other European countries. This paper explores several aspects of citizen science in Ireland, in order to assess its development and to better understand potential opportunities for the field. An introduction to the roots of citizen science in Ireland's past, from the first methodical observations of natural phenomena carried out at monastic settlements up to present day projects monitoring environmental change and biodiversity, is presented along with an overview of the current national citizen science projects running in the country. This cataloging of contemporary citizen science will be compared to the awareness of citizen science in the Irish education system at primary, post-primary, and university level. These measures of progress will be considered in the changing context of international citizen science funding and available support, such as the European Citizen Science Association and the EU-Citizen.Science platform. Citizen science in Ireland is at a critical point. If citizen science is embraced as a truly social and participatory innovation, Ireland has the chance to not only dramatically improve its citizen science output, but to also become a model of best practice for countries at similar stages of citizen science development.

Keywords: citizen science, Ireland, education, citizen scientist, public engagement, science communication, science and society, informal learning

OPEN ACCESS

Edited by:

Minela Kerla,
Consultant, The Association of Online
Educators, Sarajevo, Bosnia and
Herzegovina

Reviewed by:

Peter Michael James Brown,
Anglia Ruskin University,
United Kingdom
Ulisses Miranda Azeiteiro,
University of Aveiro, Portugal

*Correspondence:

Joseph Roche
Joseph.Roche@tcd.ie

Specialty section:

This article was submitted to
Science and Environmental
Communication,
a section of the journal
Frontiers in Communication

Received: 13 November 2020

Accepted: 18 January 2021

Published: 23 February 2021

Citation:

Roche J, Ni Shuilleabhain A,
Mooney P, Barber GL, Bell L and
Ryan C (2021) Citizen Science
in Ireland.
Front. Commun. 6:629065.
doi: 10.3389/fcomm.2021.629065

PUBLIC ENGAGEMENT WITH SCIENCE IN IRELAND

Citizen science refers to scientific research that involves people who do not identify as professional scientists. It can also refer to a theoretical or practical approach to research as well as being a field of research in its own right (Roche et al., 2020a). While the theoretical context of the individual terms “citizen” and “science” can vary greatly depending on a range of factors and circumstances (Eitzel et al., 2017), citizen science can provide a general indicator of a country's relationship between science and society. Public perceptions of science in Ireland are worth exploring at several key historical junctures. Taking stock of this history of engaging with science provides context for the current state of citizen science in the country and indicates potential future directions for the field.

Monastic Observers and Early Natural Philosophers

Ireland is home to one of the earliest and most significant historical sites for scientific observations. The Newgrange megalithic passage tomb near the River Boyne in Meath predates both Stonehenge and the Egyptian Pyramids and is considered to be “the oldest megalithic structure known for certain to have an astronomical function” (Ray, 1989, p. 344). Long before the term “science” existed, natural philosophers in Ireland were making systematic observations of the natural world around them. One of the first records of scientific writing in Ireland is from an unknown philosopher nicknamed “Augustinus Hibernicus”, who carried out astute observations of the Irish

environment in the seventh century while trying to reconcile those observations with biblical teachings (Moriarty, 1997).

The Irish annals—annual listings of events in Ireland recorded firstly by monastic communities and later by professional historians—are one of the most important sources for dating the role of science in early medieval Ireland (MacNiocaill, 1975; McCarthy, 2008). Although McCarthy and Breen (1997) highlight how the vast majority of the records provide a scattered and inconsistent overview of political and ecclesiastical events in Ireland, they also note that the annals contain observations of a range of phenomena such as “eclipses, comets, strange clouds, earthquakes, storms, famines, [and] plagues” (p. 118). The propensity for information to be written in the vernacular, and not just the more rarefied Latin that was the staple of monastic records across Europe at the time, made the work more accessible to local people (Bisagni and Warntjes, 2008). This meticulous cataloging of events in the natural world means that these monastic observers were some of the first citizen scientists—people systematically collecting data in order to better understand their environment (Silvertown, 2009).

From Medieval Ireland to the Golden Age of Irish Science

The history of natural philosophers in Ireland is not widely studied, in part due to the fact that there has traditionally been a dearth of professional practitioners focusing on the history of science (Outram, 1986). Although the first natural philosophers in Ireland were mostly confined to monasteries, by the 16th and 17th centuries Irish citizens could engage with science in places of public education, although these were still largely inaccessible to the vast majority of Irish people. The political and religious divisions in the country meant that the working class, largely Catholic, population of Ireland were less likely to have access to education and it was predominantly the upper classes, or “Protestant Ascendancy” (Hill, 1984), for whom engagement with science became more accessible.

The founding of the University of Dublin, Trinity College, in 1592 by Queen Elizabeth (McDowell and Webb, 2004) was significant, as medieval universities across Europe were the only places where meaningful sciences learning could take place at the time (Pedersen, 1997). The subsequently established Dublin Philosophical Society at Trinity College in 1683 became the first gathering of natural philosophers in Ireland to publicly share their learnings (Wilde and Lloyd, 1844). The society was modeled on the most famous at the time, the Royal Society in London (Hoppen, 1982), and this increased public engagement with science, at least in the upper classes, overlaps with the “golden age for Irish science”—a period spanning the 18th and 19th century when Ireland was home to renowned scientists in fields such as mathematics, geology, astronomy, “enjoying the highest of international scientific reputations” (Davies, 1985, p. 297).

Scientific Research and Education in Modern Ireland

Since the 19th century, political, religious, and economic factors have all played their part in shaping how Irish citizens engage

with science. The Catholic Church in Ireland initially deemed engagement with science and science education as being a threat to the Catholic faith (O’Riordan, 1897; Finnegan and Wright, 2015) and it was not until the early 20th century that scientists in Ireland could more freely engage the public, as the clergy abandoned efforts to provide meaningful competition with scientists in their interpretation of the natural world (Turner, 1978). By that stage, the professionalization of science across Europe (Ellis, 2014) was amplified in Ireland by the Irish state’s commitment to widespread access to education (Loxley et al., 2014) and later to scientific research funding (HEA, 2017). This signaled a move from an economy traditionally grounded in the manufacturing and agriculture industries, toward a more knowledge-based economy. Although Ireland’s expenditure on scientific research remains below the average for European Union countries (OECD, 2004; Butler, 2015), modern Ireland has a strong education and research environment with clear capacity for supporting citizens engaging with science.

CITIZEN SCIENCE IN CONTEMPORARY IRELAND

Citizen science projects, by their nature, can be participant-led, informal, and community-based. All of these aspects are strengths of the field, but this also means that some projects are difficult to capture in a systematic cataloging of initiatives. The most comprehensive examination of citizen science in Ireland to date is the work of Donnelly et al. (2014), which investigated the monitoring of biodiversity in Ireland and found that in grassroots initiatives the quality and the reliability of the data collected were not always at a high enough standard to be of scientific value. Specifically, there was a scarcity of formal data validation checks embedded in citizen science projects in Ireland. As the use of technology in citizen science has evolved and with platforms for collaborating and sharing best practices (See ‘International Opportunities’ section below), the recommendation by Donnelly et al. (2014) to consider data validation, verification, and harmonization methods for international comparability as a way of ensuring the success of citizen science projects is more pertinent than ever.

National Citizen Science Projects

A number of organisations in Ireland have initiated national citizen science projects or have actively supported them. The main organisations supporting citizen science in Ireland are listed in **Table 1**.

In general, citizen science initiatives in Ireland are localized and only have the capacity to “become national endeavors” when they have the support of an established public or private organisation (Eitzel et al., 2017, p. 9).

The projects shown in **Table 2**—which provides an overview of citizen science projects in Ireland in 2020—were gathered by collating publicly available information from national organisations, public websites, and social media. The projects were cataloged according to Haklay’s (2013) typology of participation. This typology has four levels of participation and engagement in citizen science, ranging from:

TABLE 1 | Organisations involved in citizen science in Ireland.

Organisation name	Organisation type	Involvement in citizen science
An Taisce	The National Trust for Ireland and the oldest environmental and non-governmental organisation in the country, founded in 1948	Leads the Irish arm of the “global learning and observations to benefit the environment” (GLOBE) citizen science programme
Environmental Protection Agency	Independent public body	Includes citizen science in its remit of environmental protection and policing, with a particular research focus on climate, water, and sustainability
Geological Survey Ireland	Part of the Government’s Department of the Environment, Climate and Communications	Maintains the National Public Earth Science Knowledge Centre and provides open access data and maps of Ireland’s subsurface
Heritage Council	Statutory public body	Maintains and protects Irish heritage and supports citizen science through increased community engagement and heritage awareness
Irish Wildlife Trust	Charity funded by the Government’s Department of the Environment, Climate and Communications	Runs the conservation groups Bat Conservation Ireland, Groundwork, and Badgerwatch Ireland
Marine Institute	State agency tasked with marine research	Promotes citizen engagement to support the sustainable development of ocean, sea, coastal and inland water resources
National Biodiversity Data Centre	Established and funded by the Heritage Council as well as the Government’s Department of Culture, Heritage and the Gaeltacht	Responsible for cataloguing Ireland’s biological diversity and maintains more citizen science projects than any other Irish organisation
National Parks and Wildlife service	State body and part of the Heritage Division of the Government’s Department of Housing, Local Government and Heritage	Encourages citizen science as means to help foster public awareness for nature conservation in Ireland
Teagasc	State-funded Agriculture and Food Development Authority for Ireland	Promotes citizen science for supporting research and innovation in the agri-food and bioeconomy sectors
Universities and research centres	Public and private higher education institutions	A number of Irish universities and research centres have developed and supported citizen science projects in Ireland

crowdsourcing, where the participants are tasked with simple data collection; distributed intelligence, where some analysis is carried out by participants and may necessitate basic training; participatory science, where participants have more input into the process, including defining the problem itself; and the top level, extreme citizen science, where the participants and scientists are on equal footing throughout an integrated collaborative process.

It is possible that some grassroots projects that do not have an online presence or are not connected to a formal research or education organisation may not have been captured in **Table 2**. The recommendations in the final section of this paper offer some suggestions as to how this limitation could be addressed in future research. The table shows only current projects based in Ireland, so international citizen science initiatives that are available in Ireland, such as the Zooniverse suite of projects, are not included. Similarly, completed projects or those that are currently on hiatus are not included.

The National Biodiversity Data Centre, established by the Heritage Council in 2007, is involved in a significant portion of the citizen science projects in Ireland and maintains a national portal to record sightings of specific species (<https://records.biodiversityireland.ie/start-recording>) as well as regularly publishing biodiversity reports on topics such as endangered species (Fitzpatrick, 2013) and invasive species (O’Flynn et al., 2014). Recent citizen science projects in Ireland have tackled topics such as water quality (Quinlivan et al., 2020), biosecurity awareness (Melly and Hanrahan, 2020), and light pollution (Coogan et al., 2020).

The information collated in **Table 2** demonstrates the overall state of national citizen science projects across the country and illustrates three key points:

- National citizen science projects in Ireland are predominantly focused on environmental conservation.

- A small number of organisations are responsible for the vast majority of the citizen science projects in Ireland.
- While there are some exceptions, the vast majority of citizen science projects in Ireland can be classified as being ‘Level 1: Crowdsourcing’ according to Haklay’s typology of participation.

Awareness of Citizen Science in Irish Education

Integrating citizen science and education is key to unlocking the potential for citizen science to be a truly social innovation (Kloetzer et al., 2021). To provide further insight into the state of citizen science in Ireland as presented in **Tables 1** and **2**, a basic impression of the awareness levels of citizen science among educators in Ireland is provided in **Table 3**. In 2018 and early 2019 three separate groups of educators in Ireland were surveyed about their familiarity with the term “citizen science”. These three groups were: primary school teachers (n = 50), post-primary science teachers (n = 114), and university-level scientists (professors and research fellows, n = 157). While stratified random sampling was used to contact both teacher groups, with surveys being sent to a cross-section of schools around the country, convenience sampling was used to reach the university educators. As such, the data presented in **Table 3** are neither exhaustive nor definitive, but merely provide an illustrative example of awareness levels in a critical area of citizen science research that deserves more attention in Ireland.

The survey participants in **Table 3** who answered that they had encountered the term “citizen science” were subsequently invited to define the term in their own words. Further insight into the awareness of citizen science among educators was provided by comparing these definitions from the participants with a benchmark definition, the Oxford English Dictionary’s 2014 definition of citizen science: “Scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional

TABLE 2 | Citizen science projects in Ireland in 2020.

Project name	Host organisation	Study subject	Website link
All Ireland CoastWatch Survey	CoastWatch Europe	Coastal wildlife and fauna	http://coastwatch.org/europe/survey/#all-ireland-survey
All Ireland Ladybird Survey	Fota Wildlife Park and University College Cork	Ladybirds	http://www.biology.ie/home.php?m=ladybirds2
Backyard Biodiversity Species	National Biodiversity Data Centre	Garden wildlife species	https://www.biodiversityireland.ie/projects/additional-survey-schemes/backyard-biodiversity/species
Bat Monitoring and Distribution Projects	Bat Conservation Ireland	Bats	https://www.batconservationireland.org/what-we-do/monitoring-distribution-projects
Big Beach Biodiversity Survey	National Biodiversity Data Centre and Environmental Protection Agency	Tidal marine species	https://exploreyourshore.ie/shore-surveys/the-big-beach-biodiversity-survey
Big Jellyfish Hunt	National Biodiversity Data Centre and University College Cork	Jellyfish	https://exploreyourshore.ie/marine-biodiversity-surveys/the-big-jellyfish-hunt
Bumblebee Monitoring Scheme	National Biodiversity Data Centre	Bumblebees	https://www.biodiversityireland.ie/projects/monitoring-scheme-initiatives/bumblebee-monitoring-scheme
Hop to it: National Frog Survey	Irish Peatland Conservation Council	Frogs, tadpoles, and frogspawn	http://www.ipcc.ie/help-ipcc/hop-to-it-national-frog-survey-irelandcard
Clean Coasts Programme	An Taisce	Coastal environments	https://cleancoasts.org/our-initiatives/clean-coasts-volunteering
Dragonfly Ireland 2019–2024	National Biodiversity Data Centre	Dragonflies	https://www.biodiversityireland.ie/projects/monitoring-scheme-initiatives/dragonfly-ireland-2019-2024
Farmer's Wildlife Calendar: Climate Tracker	National Biodiversity Data Centre	Weather, climate, and wildlife	https://www.biodiversityireland.ie/projects/additional-survey-schemes/farmers-wildlife-calendar-climate-tracker
Flower-Insect Timed Count (FIT Count)	National Biodiversity Data Centre	Flower-visiting insects	https://pollinators.ie/record-pollinators/fit-count
GLOBE Air Quality Campaign	An Taisce	Air quality	https://www.globe.gov/web/ireland/home/overview-of-air-quality-campaign
Invasive Species	National Biodiversity Data Centre	Invasive species	https://www.biodiversityireland.ie/projects/invasive-species
Irish Basking Shark Project	Irish Whale and Dolphin Group	Basking sharks	https://exploreyourshore.ie/marine-biodiversity-surveys/irish-basking-shark-project
Irish Butterfly Atlas 2021	National Biodiversity Data Centre	Butterflies	https://www.biodiversityireland.ie/projects/monitoring-scheme-initiatives/butterflyatlas
Irish Butterfly Monitoring Scheme	National Biodiversity Data Centre	Butterflies	https://www.biodiversityireland.ie/projects/monitoring-scheme-initiatives/butterfly-monitoring-scheme
Irish Garden Bird Survey	BirdWatch Ireland	Garden birds	https://birdwatchireland.ie/our-work/surveys-research/research-surveys/irish-garden-bird-survey
Irish Hedgehog Survey	National University of Ireland Galway and National Biodiversity Data Centre	Hedgehogs	https://www.irishhedgehogsurvey.com
I-WeBS	BirdWatch Ireland	Wetland birds	https://birdwatchireland.ie/our-work/surveys-research/research-surveys/irish-wetland-bird-survey
KelpRes	National University of Ireland Galway	Kelps	https://exploreyourshore.ie/marine-biodiversity-surveys/kelpres
Ladybird Atlas 2025	National Biodiversity Data Centre	Ladybirds	https://www.biodiversityireland.ie/projects/additional-survey-schemes/ladybird-atlas-2025/ladybird-atlas-2025-2
Leaf Miners	National Biodiversity Data Centre	Leaf mining fauna	https://www.biodiversityireland.ie/projects/additional-survey-schemes/leafminers-survey
LiDAR Public Feature Identification	Geological Survey Ireland	Karst	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=b7c4b0e763964070ad69bf8c1572c9f5
Local Authority Waters Programme	Local Authority Waters Programme	Waterways	http://watersandcommunities.ie/get-involved
National Vegetation Database	National Biodiversity Data Centre	Vegetation	https://www.biodiversityireland.ie/projects/national-vegetation-database
National Reptile Survey	Irish Wildlife Trust	Terrestrial reptiles	https://iwt.ie/what-we-do/citizen-science/national-reptile-survey
ORCA Ireland	University College Cork and Ocean Research Ireland	Marine megafauna	https://www.orcaireland.org/#Citizenscience
Pasturebase Ireland	Teagasc and Dairy Research Ireland	Grass	https://pasturebase.teagasc.ie
People for Bees	Irish Wildlife Trust	Bees	https://iwt.ie/people-for-bees
Project Lapwing	BirdWatch Ireland and National Biodiversity Data Centre	Lapwings	https://birdwatchireland.ie/our-work/surveys-research/research-surveys/project-lapwing
Purse Search Ireland	Marine Dimensions	Mermaids' purses	https://marinedimensions.ie/purse-search-ireland
RECONNECT	University College Dublin	Irish rivers	https://www.ucd.ie/reconnect
Rocky Shore Safari	National Biodiversity Data Centre and Environmental Protection Agency	Seaweeds and intertidal invertebrates	https://exploreyourshore.ie/shore-surveys/rocky-shore-safari
Seasearch Ireland	National Biodiversity Data Centre	Inshore marine biodiversity	https://seasearchireland.ie
Seashore Snapshots Survey	National Biodiversity Data Centre and Environmental Protection Agency	Barnacles and limpets	https://exploreyourshore.ie/shore-surveys/seashore-snapshots

(Continued on following page)

TABLE 2 | (Continued) Citizen science projects in Ireland in 2020.

Project name	Host organisation	Study subject	Website link
Seashore Spotter	National Biodiversity Data Centre and Environmental Protection Agency	Seashore marine species	https://exploreyourshore.ie/shore-surveys/seashore-spotter
Solitary Bee Monitoring Scheme	National Biodiversity Data Centre	Solitary bees	https://pollinators.ie/record-pollinators/solitary-bee-monitoring-scheme
Spring Flowering Plants Project	National Biodiversity Data Centre	Spring flowering plants	https://www.biodiversityireland.ie/projects/additional-survey-schemes/spring-flowering-plants-project
Waterways for Wildlife	Irish Wildlife Trust	Waterway wildlife	https://iwt.ie/waterways-for-wildlife
Whale and Dolphin Sighting	Irish Whale and Dolphin Group	Whales, dolphins, turtles, and crustaceans	https://iwdg.ie/get-involved
Wild Honey Bee Study	National University of Ireland Galway and National Biodiversity Data Centre	Honey bees	https://www.biodiversityireland.ie/projects/additional-survey-schemes/wild-honey-bee-study

TABLE 3 | Awareness of citizen science across the Irish education system.

Irish education level	Participating educators	Awareness of citizen science (%)
Primary school teachers	50	6
Post-primary school science teachers	114	13
Scientists at an Irish university	157	53

scientists and scientific institutions”. While the number of teachers who had previously come across the term citizen science was quite modest, their definitions were broadly accurate (for example, “*Science conducted by ordinary people who are interested in science but aren’t professional scientists themselves*” was the answer from Primary Teacher no. 27 and “*Individuals other than scientists taking part in scientific investigations or contributing to scientific projects by gathering data*” was the answer from Post-primary Teacher no. 78). Those at third level, while having a higher awareness level of the term, also offered a number of definitions that would fit interpretations of the terms “science communication” or “public engagement”, but were incorrect as definitions of citizen science (for example, “*informing the public about how science issues impact their everyday lives*” — Scientist no. 59, and “*Science for the layman?*” — Scientist no. 28). These insights suggests that improving the awareness and understanding of citizen science in the Irish education system may be an important first step toward successfully realizing its potential.

FUTURE OPPORTUNITIES FOR CITIZEN SCIENCE IN IRELAND

While the number of national citizen science projects in Ireland is not quite at the same level as some European countries, such as Austria, Spain, or the United Kingdom for example (Eitzel et al., 2017), there is enough capacity and infrastructure within the research and education systems in Ireland that, with appropriate funding and support, Ireland could quickly become a country synonymous with best practice in citizen science. The citizens taking part in citizen science initiatives in Ireland mirror the social demographics seen in other public events in Ireland that focus on science education and science communication. Citizen

scientists in Ireland are more likely to be highly educated, close to middle-age, wealthier, more concerned about environmental issues, and have higher levels of employment than the general population in Ireland (MacDomhnaill et al., 2020). This is largely true of any events in Ireland where public audiences engage in science, from large-scale science festivals (Roche et al., 2017) to intimate science comedy nights (Roche et al., 2020b). The most important recommendation for the future of citizen science in Ireland aligns with a key recommendation from the US National Academies of Sciences, Engineering, and Medicine; issues of power and equity should be taken into consideration at all phases of citizen science project development and implementation to ensure citizen science is as accessible and inclusive as possible for all members of society (Pandya & Dibner, 2018).

Funding Developments

A crucial step toward improving the national capacity for citizen science in Ireland is to capitalize on the increasing availability of funding. Over the past 10 years, funding support for citizen science across Europe has risen, particularly through Horizon 2020—the research funding program of the European Commission. The European Commissioner for Research, Science and Innovation, Carols Moedas, highlighted the openness and accessibility of science as “an increasingly crucial ingredient” to the vision of scientific research being “open to the world” (Ramjoué, 2015, p. 167; Moedas, 2016). This signaled a change in how citizen science was discussed in policy documents and funding programmes and the European Commission subsequently highlighted citizen science as an approach that, in giving “citizens a greater role in science”, could “deliver the vision of science for the people, by the people for Europe” (European Commission, 2015, para. 4). In successive “Science with and for Society” (SwafS) work programmes of Horizon 2020, the term “citizen science” went from being entirely absent from the 2014–2015 program, to being mentioned five times in the 2016–2017 program, to being present throughout (60 times) the 2018–2020 program. This increased focus on citizen science resulted in €58.3 million being invested in 22 large scale citizen science projects across Europe so far, with more likely to be added (Warin and Delaney, 2020).

While the specific portfolio of “Research, Science, and Innovation” was functionally discontinued in 2019 when Mariya Gabriel became the European Commissioner for a new portfolio of “Innovation, Research, Culture, Education and Youth”, she recognised the

significant contributions that large numbers of empowered citizens have made to scientific progress and committed to continuing European level support for citizen science (Warin and Delaney, 2020). An additional important mechanism for developing citizen science collaborations in Europe are “COST” (European Cooperation in Science and Technology) actions, which provide invaluable funding opportunities for establishing research networks. In particular, the COST Action CA15212 (“Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe”) provided the opportunity for researchers to work together on pan-European citizen science efforts such as establishing a research agenda to investigate the role of citizen science in education and learning (Roche et al., 2020a) and to make policy recommendations regarding sustainability (Sauermaun et al., 2020).

International Opportunities

The US has played a leading role in modern citizen science. The National Academies, for example, highlighted the great potential of citizen science to enrich education systems (Pandya and Dibner, 2018). While there have long been calls to research how culture and language can affect learning in citizen science (Bonney et al., 2009), the benefits of citizen science to education systems and wider society are being actively investigated by a number of relatively recently established international citizen science associations. Most prominent among these are the Citizen Science Association (a US-based organisation with a global membership), the Australian Citizen Science Association, and the European Citizen Science Association (Storcksdieck et al., 2016; Roche and Davis, 2017). The European Citizen Science Association’s “Ten Principles of Citizen Science” (ECSA, 2015) and “Characteristics of Citizen Science” (ECSA, 2020) offer guidance to the field on how to recognise and classify citizen science. The European Citizen Science Association is also coordinating one of the most wide-reaching citizen science projects funded by the European Commission: EU-Citizen.Science. This online platform and mutual learning space will serve as a hub for citizen science and represents an ideal platform to connect the various networks and citizen science projects in countries across Europe.

Future Directions for Citizen Science in Ireland

A traditional shortcoming of citizen science in Ireland—that the various networks are not linked with each other and need to be connected to better share expertise and resources (Donnelly et al., 2014)—could be addressed through the fledgling EU-Citizen.Science platform. It presents an ideal space for grassroots initiatives across Ireland to find a home where practitioners can remotely connect with like-minded citizens and initiatives, particularly in the post Covid-19 pandemic era. As previously noted, most of the ongoing national citizen science projects in Ireland are either run or supported by state bodies. To increase awareness of citizen science and to align with the commitment to support citizen science at European levels, the Irish government should adopt an official policy on citizen science that sets out how the field will be supported and developed to improve the lives of Irish citizens. Such a policy

could utilize citizen science to help Ireland with the dual goals of becoming more aligned with the UN’s Sustainable Development Goals (Fritz et al., 2019) as well as strengthening trust between science and society, which will be more vital than ever in a post-pandemic world (Provenzi and Barello, 2020). This may be possible with the newly established Department of Further & Higher Education, Research and Science, where there is, for the first time, a specific and particular focus on research funding and capacity to publish new policies related to such endeavors. Ireland is facing a critical point in its engagement with citizen science. With the involvement of key organisations, government support, and international partnerships, Ireland has the potential to mirror the global trend toward embracing the transformative opportunities of citizen science and usher in a new golden age of science that focuses on participatory approaches and the empowerment of Irish citizens.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Trinity College, Dublin. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JR and ANS led the conceptual design of the manuscript, while PM designed the original approach to cataloging citizen science in Ireland. GLB, LB, and CR carried out subsequent analyses and developed individual subsections of the paper. All authors reviewed the manuscript and agreed to its final version.

FUNDING

This work would not have been possible without the support of the EU-Citizen.Science project which received funding from the European Union’s Horizon 2020 Research and Innovation Program under Grant Agreement no. 824580. This work was also supported by Science Foundation Ireland through its ‘Discover’ programme, Trinity College Dublin through its ‘Arts and Social Sciences Benefactions Fund’, and the Irish Research Council through its ‘New Foundations’ and ‘COALESCE’ funding schemes.

ACKNOWLEDGMENTS

The authors are grateful for the support of the COST Action CA15212 (“Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe”).

REFERENCES

- Bisagni, J., and Warntjes, I. (2008). The early Old Irish material in the newly discovered Computus Einsidlensis (c. AD 700). *Eriu*. 58 (1), 77–105. doi:10.3318/ERIU.2008.58.77
- Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., and Rosenberg, K. V. (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. *BioScience* 59 (11), 977–984. doi:10.1525/bio.2009.59.11.9
- Butler, D. (2015). Irish government under fire for turning its back on basic research. *Nature*. 519 (7543), 273. doi:10.1038/519273a
- Coogan, A. N., Cleary-Gaffney, M., Finnegan, M., McMillan, G., González, A., and Espey, B. (2020). Perceptions of light pollution and its impacts: results of an Irish citizen science survey. *Int. J. Environ. Res. Publ. Health*. 17 (15), 5628. doi:10.3390/ijerph17155628
- Davies, G. L. H. (1985). “Irish thought in science,” in *The Irish mind*. Editor R. Kearney (Cork, Ireland: Mercier), 294–310.
- Donnelly, A., Crowe, O., Regan, E., Begley, S., and Caffarra, A. (2014). The role of citizen science in monitoring biodiversity in Ireland. *Int. J. Biometeorol.* 58 (6), 1237–1249. doi:10.1007/s00484-013-0717-0
- ECSA (2020). ECSA’s characteristics of citizen science: explanation notes. Retrieved from: https://ecsa.citizen-science.net/wp-content/uploads/2020/05/ecsa_characteristics_of_citizen_science_explanation_notes_-_v1_final.pdf (Accessed November 10, 2020).
- ECSA (2015). Ten principles of citizen science. Retrieved from: https://ecsa.citizen-science.net/wp-content/uploads/2020/02/ecsa_ten_principles_of_citizen_science.pdf (Accessed November 10, 2020).
- Eitzel, M. V., Cappadonna, J. L., Santos-Lang, C., Duerr, R. E., Virapongse, A., West, S. E., and Metcalfe, A. N. (2017). Citizen science terminology matters: exploring key terms. *Citiz. Sci. Theory Pract.* 2 (1), 1–20. doi:10.5334/cstp.96
- Ellis, H. (2014). Knowledge, character and professionalisation in nineteenth-century British science. *Hist. Educ.* 43 (6), 777–792. doi:10.1080/0046760x.2014.964006
- European Commission (2015). *Digital agenda for Europe: citizen science*. Brussels, Belgium: European Commission. Retrieved from: <http://ec.europa.eu/digital-agenda/en/citizen-science> (Accessed November 10, 2020).
- Finnegan, D. A., and Wright, J. J. (2015). Catholics, science and civic culture in Victorian Belfast. *Br. J. Hist. Sci.* 48 (2), 261–287. doi:10.1017/S0007087414000594
- Fitzpatrick, U. (2013). *National biodiversity data Centre series No 1*. Waterford, Ireland: NBDC. Ireland’s red lists – a national standard.
- Fritz, S., See, L., Carlson, T., Haklay, M. M., Oliver, J. L., Fraisl, D., and Wehn, U. (2019). Citizen science and the United Nations sustainable development goals. *Nature Sustainability*. 2 (10), 922–930. doi:10.1038/s41893-019-0390-3
- Haklay, M. (2013). Citizen science and volunteered geographic information: overview and typology of participation. in *Crowdsourcing geographic knowledge*. Dordrecht, Netherlands: Springer, 105–122.
- HEA (2017). Review of the allocation model for funding higher education institutions. Available at: <https://hea.ie/assets/uploads/2018/01/HEA-RFAM-Final-Report-for-Publication.pdf> (Accessed February 5, 2021).
- Hill, J. R. (1984). National festivals, the state and “protestant ascendancy” in Ireland, 1790–1829. *Ir. Hist. Stud.* 24 (93), 30–51.
- Hoppen, K. T. (1982). *The papers of the Dublin philosophical society 1683–1708: introductory material and index*. Dublin, Ireland: Irish Manuscripts Commission. 151–248.
- Kloetzer, L., Lorke, J., Roche, J., Golumbic, Y. N., Winter, S., and Jõgeva, A. (2021). “Learning in citizen science,” in *The science of citizen science*. Editors, et al. (Berlin, Germany: Springer Nature). 283–308.
- Loxley, A., Seery, A., and Walsh, J. (2014). Investment in Education and the tests of time. *Ir. Educ. Stud.* 33 (2), 173–191. doi:10.1080/03323315.2014.920616
- Mac Dohnnail, C., Lyons, S., and Nolan, A. (2020). The citizens in citizen science: demographic, socioeconomic, and health characteristics of biodiversity recorders in Ireland. *Citiz. Sci. Theory Pract.* 5 (1), 1–17. doi:10.5334/cstp.283
- MacNiocaill, G. (1975). *The medieval Irish annals: No. 3 in the medieval Irish history series*. Dublin, Ireland: Dublin Historical Association.
- McCarthy, D., and Breen, A. (1997). An evaluation of astronomical observations in the Irish annals. *Vistas Astron.* 41 (1), 117–138. doi:10.1016/s0083-6656(96)00052-9
- McCarthy, D. P. (2008). *The Irish annals: their genesis, evolution and history*. Dublin, Ireland: Four Courts Press Ltd.
- McDowell, R. B., and Webb, D. A. (2004). *Trinity College Dublin, 1592–1952: An academic history*. Dublin, Ireland: Trinity College Dublin Press, in association with Environmental Publications.
- Melly, D., and Hanrahan, J. (2020). Tourist biosecurity awareness and risk mitigation for outdoor recreation: management implications for Ireland. *J. Outdoor Recreation Tour.* 31, 100313. doi:10.1016/j.jort.2020.100313
- Moedas, C. (2016). *Open innovation, open science and open to the world—A vision for Europe*. Luxembourg: Publications Office of the European Union.
- Moriarty, C. (1997). “The early naturalists,” in *Nature in Ireland: a scientific and cultural history*. Editors J. W. Foster and H. C. Chesney (Ithaca, NY: McGill-Queen’s Press), 71–115.
- O’Riordan, M. R. (1897). The university question. *The New Ireland Review*. 6 (1), 350–357.
- OECD (2004). Organisation for economic Co-operation and development. *Review of national policies for education: review of higher education in Ireland. Examiners’ Report*. Dublin, Ireland: OECD.
- Outram, D. (1986). Negating the Natural: or why historians deny Irish science. *Ir. Rev.* 1 (1), 45–49.
- O’Flynn, C., Kelly, J., and Lysaght, L. (2014). *Ireland’s invasive and non-native species – trends in introductions National Biodiversity Data Centre Series No. 2*. Waterford, Ireland: NBDC.
- Pandya, R., and Dibner, K. A. (2018). *Learning through citizen science: enhancing opportunities by DesignA consensus study report of the national Academies committee on designing citizen science to support science learning*. Washington, DC: National Academies Press.
- Pedersen, O. (1997). *The first universities: Studium generale and the origins of university education in Europe*. Cambridge, United Kingdom: Cambridge University Press.
- Provenzi, L., and Barelo, S. (2020). The science of the future: establishing a citizen-scientist collaborative agenda after covid-19. *Frontiers in Public Health*. 8 (282), 1–3. doi:10.3389/fpubh.2020.00282
- Quinlivan, L., Chapman, D. V., and Sullivan, T. (2020). Validating citizen science monitoring of ambient water quality for the United Nations sustainable development goals. *Sci. Total Environ.* 699, 134255. doi:10.1016/j.scitotenv.2019.134255
- Ramjoué, C. (2015). Towards open science: the vision of the European Commission. *Inf. Serv. Use*. 35 (3), 167–170. doi:10.3233/ISU-150777
- Ray, T. P. (1989). The winter solstice phenomenon at Newgrange, Ireland: accident or design?. *Nature*. 337 (6205), 343–345.
- Roche, J., Bell, L., Galvão, C., Golumbic, Y. N., Kloetzer, L., Knoblen, N., et al. (2020a). Citizen science, education, and learning: challenges and opportunities. *Frontiers in Sociology*. 5 (613814), 1–10. doi:10.3389/fsoc.2020.613814
- Roche, J., and Davis, N. (2017). Citizen science: an emerging professional field united in truth-seeking. *J. Sci. Commun.* 16 (4), R01–R06. doi:10.22323/2.16040601
- Roche, J., Davis, N., O’Boyle, S., Courtney, C., and O’Farrelly, C. (2017). Public perceptions of European research: an evaluation of European Researchers’ Night in Ireland. *Int. J. Sci. Educ. Part B*. 7 (4), 374–391.
- Roche, J., Fairfield, J. A., Gallagher, Á., and Bell, L. (2020b). Bright club: establishing a science comedy variety night in Ireland. *Sci. Commun.* 42 (1), 130–140. doi:10.1177/1075547019890347
- Sauermann, H., Vohland, K., Antoniou, V., Balázs, B., Göbel, C., Karatzas, K., et al. (2020). Citizen science and sustainability transitions. *Res. Pol.* 49 (5), 103978. doi:10.2139/ssrn.3511088
- Silvertown, J. (2009). A new dawn for citizen science. *Trends Ecol. Evol.* 24 (9), 467–471. doi:10.1016/j.tree.2009.03.017

- Storksdieck, M., Shirk, J., Cappadonna, J., Domroese, M., Göbel, C., Haklay, M., et al. (2016). Associations for citizen science: regional knowledge, global collaboration. *Citiz. Sci. Theory Pract.* 1 (2), 1–10. doi:10.5334/cstp.55
- Turner, F. M. (1978). The Victorian conflict between science and religion: a professional dimension. *Isis.* 69 (3), 356–376. doi:10.1086/352065
- Warin, C., and Delaney, N. (2020). Citizen science and citizen engagement: achievements in Horizon 2020 and recommendations on the way forward. in *Directorate-General for Research and Innovation Science with and for society*. Brussels, Belgium: European Commission.
- Wilde, W. R., and Lloyd, O. (1844). Memoir of the Dublin philosophical society of 1683. *Proceedings of the Royal Irish Academy*, 160–176.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2021 Roche, Ni Shuilleabhain, Mooney, Barber, Bell and Ryan. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.