Citizen Science in Ireland

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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 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

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 (MacNiacail, 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 science 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:
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/       |
| 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.iemarine-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-ireland/card     |
| Clean Coasts Programme        | An Taisce                                                                         | Coastal environments               | https://cleancoasts.org/our-initiatives/clean-coasts-volunteering            |
| Dragonfly Ireland             | 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) GLOBE Air Quality Campaign | National Biodiversity Data Centre                                               | Flower-visiting insects             | https://pollinators.ie/record-pollinators/fit-count                           |
| 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/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-wetland-bird-survey |
| Ladybird Atlas 2025           | National University of Ireland Galway and National Biodiversity Data Centre      | Ladybirds                           | https://exploreyourshore.ie/marine-biodiversity-surveys/ladybirds              |
| 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://dcmrn.maps.arcgis.com/apps/webappviewer/index.html?id=b7c4b0e765364070ad69bf8c1572c9f5 |
| 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 and National Biodiversity Data Centre                       | Terrestrial reptiles               | https://www.ormorcarlireland.org#Citizenscience                              |
| ORCA Ireland                  | University College Cork and Ocean Research Ireland                               | Marine megafauna                    | https://www.orcaireland.org/                                                  |
| Pasturebase Ireland           | Teagasc and Dairy Research Ireland                                                | Grass                               | https://pasturebase.teagasc.ie                                                |
| People for Bees               | Irish Wildlife Trust                                                             | Bees                                | https://lwt.ie/people-for-bees                                                |
| Purse Search Ireland          | BirdWatch Ireland and National Biodiversity Data Centre                         | Lapwings                            | https://birdwatchireland.ie/our-work/surveys-research/surveys/project-lapwing |
| RECONNECT                     | Marine Dimensions and National Biodiversity Data Centre                          | Mermaids’ purses                    | https://www.marinedimensions.ie/purse-search-ireland                         |
| Rocky Shore Safari            | University College Dublin                                                        | Irish rivers                        | https://www.ucd.ie/reconnect                                                   |
| Seasearch Ireland             | National Biodiversity Data Centre and Environmental Protection Agency            | Sea weeds and intertidal invertebrates | https://exploreyourshore.ie/shore-surveys/rocky-shore-safari                   |
| 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 Whales and Dolphin Sighting | Irish Wildlife Trust | Waterway wildlife Whales, dolphins, turtles, and crustaceans | https://iwt.ie/waterways-for-wildlife |
| 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 suggest 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” (SwaS) 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 (Sauermann 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 (Storksiek 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.

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**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.

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