



OPEN ACCESS

EDITED BY

Joseph Roche,
Trinity College Dublin, Ireland

REVIEWED BY

Nils Ekelund,
Malmö University, Sweden
Claire A. Murray,
Diamond Light Source, United Kingdom

*CORRESPONDENCE

Natalie Iwanycki Ahlstrand,
✉ natalie.iwanycki@snm.ku.dk

RECEIVED 06 July 2023

ACCEPTED 30 August 2023

PUBLISHED 27 September 2023

CITATION

Iwanycki Ahlstrand N and Tøttrup AP
(2023), Beyond the usual suspects: using
cross-sectoral partnerships to target and
engage new citizen scientists.
Front. Environ. Sci. 11:1254047.
doi: 10.3389/fenvs.2023.1254047

COPYRIGHT

© 2023 Iwanycki Ahlstrand and Tøttrup.
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.

Beyond the usual suspects: using cross-sectoral partnerships to target and engage new citizen scientists

Natalie Iwanycki Ahlstrand* and Anders P. Tøttrup

Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark

Citizen science offers enormous benefits to enhance public knowledge and understanding of science. Several opportunities to engage and share information with citizens are possible in citizen science projects. Recent evidence demonstrates however that individuals who participate in citizen science projects are demographically speaking not very diverse. For citizen science projects to successfully achieve their full potential in increasing public awareness and understanding of science, a wider social demographic needs to be engaged. We present a nationwide approach developed to achieve just that with respect to targeting and engaging residents in Denmark that did not previously have a prior connection to or interest in nature. Under the auspices of a campaign entitled *Our Nature*, our approach included the formation of a new, cross-sectoral partnership, and co-creating and implementing of a wide array of communication tactics and nature-based activities, including the development of a new citizen science project. Our cross-sectoral partnership allowed us to broaden the sectors of society that could be reached and develop cross-disciplinary activities to achieve goals for broad engagement. Extensive third-party evaluation revealed that 70% of the Danes interviewed across the country heard about *Our Nature*, and 70% of these gained more knowledge about Danish nature through the campaign. In addition to presenting our co-created projects and activities by working cross-sectorally and interdisciplinarily, we discuss the successes, challenges and limitations related to reaching our goal, based on evaluation results and our own experiences in citizen science and science communication. The citizen science project *Denmark Explores* that emerged from this campaign is used as a case study to demonstrate how our approach facilitated the broad engagement of citizens across the country—beyond the usual nature enthusiasts.

KEYWORDS

citizen science, science communication, co-creation, science engagement, phenology, cross-sectoral partnership

1 Introduction

Citizen science offers enormous benefits to enhance public knowledge and understanding of science (Bonney et al., 2016). Throughout the life of a citizen science project numerous and diverse opportunities to engage and disseminate scientific information with citizens are possible. Scientific communication can be carried out from the initial onset of a project such as for the recruitment of participants, throughout the project to motivate and retain participants, and to disseminate project results (de Vries et al., 2019). However, for

many citizen science projects, “who” the citizen scientists are, and how good the reach is in terms of improving public understanding in science is very much in debate. Recent studies from the United Kingdom and United States demonstrate that individuals who participate in citizen science projects are demographically speaking not very diverse. Citizen scientists were found to be well-educated, with up to a fifth of participants holding advanced degrees, and were middle-aged, white, and predominantly male (Dawson, 2018; Cooper et al., 2021; Pateman et al., 2021; Allf et al., 2022).

In citizen science projects that are focused on biodiversity monitoring, amateur naturalists and nature enthusiasts are the usual participants (e.g., see Richter et al., 2021). Members of nature enthusiast groups are easy to engage, and in many cases already have competencies that facilitate biodiversity and environmental data collection, meaning that they may not need specialized training to complete their tasks. The type and frequency of science communication may not have to be customized as the gap between scientist and citizen scientist in such scenarios is not so large. While this model is arguably the easiest for researchers to follow with respect to the ease and quality of data collected, the relative societal reach and gain in terms of science education is arguably limited. In order to successfully achieve the full potential of citizen science in terms of increasing public awareness and understanding of science, and to narrow the gap between researchers and the public, a wider social demographic needs to be engaged.

New strategies and approaches are being sought to reach a broader range of the public and improve the benefits of citizen science (Paleco et al., 2021; Senabre Hidalgo et al., 2021). The move toward inclusion and diversity in citizen science—i.e., the “engagement from all members of society, regardless of their social status, sociocultural origin, gender, religious affiliation, literacy level, or age” (Paleco et al., 2021)—is right at the core of today’s citizen science movement though still in its infancy (Cooper et al., 2021; Allf et al., 2022; Ellwood et al., 2023). Making science engagement activities accessible for all to participate in is also increasingly being recognized (Howlett et al., 2021; Worm et al., 2021). Many of the principles of inclusion and diversity, including measures to address accessibility, can be drawn on to achieve a greater level of citizen engagement. For example, tactics to increase the reach and achieve greater inclusiveness and diversity in citizen science can include involving citizens and/or civil society organizations in the co-creation of citizen science projects (Hickey et al., 2018; Chesser et al., 2020; Hildago et al., 2021), adopting new communication strategies and improving efforts to work collaboratively between academic, private and public agencies and/or cross-sectorally (Humm and Schrögel, 2020; Paleco et al., 2021), meeting people “where they are” (Humm and Schrögel, 2020), planning for a multitude of “entrance points” and various levels or types of participation (Kidney and McDonald, 2014; Lee et al., 2014; Humm and Schrögel, 2020), and fine-tuning or reframing research questions to make them relevant at local scales (Paleco et al., 2021).

We present and discuss an approach developed to target and engage a diversity of residents in Denmark that did not previously have a prior connection to or interest in nature. The approach

included the formation of a new cross-sectoral partnership, under the auspices of a campaign entitled “*Our Nature*” (Vores Natur), with the shared goal to co-create new science communication, outreach, and engagement activities across the entire country that would provide new knowledge and experiences in Danish nature and ultimately stimulate Danes to take an active part in nature. A nation-wide citizen science project was a focal activity co-created and implemented as part of the campaign. We present methods used to co-create science engagement activities and work cross-sectorally and transdisciplinarily. We discuss the successes, challenges and limitations related to reaching our goal for broad engagement, based on the results of an extensive evaluation of the *Our Nature* campaign and our own experiences in citizen science and science communication. The citizen science project that emerged from this campaign is used as a case study to demonstrate how communication approaches can successfully be applied to engage new sectors of society.

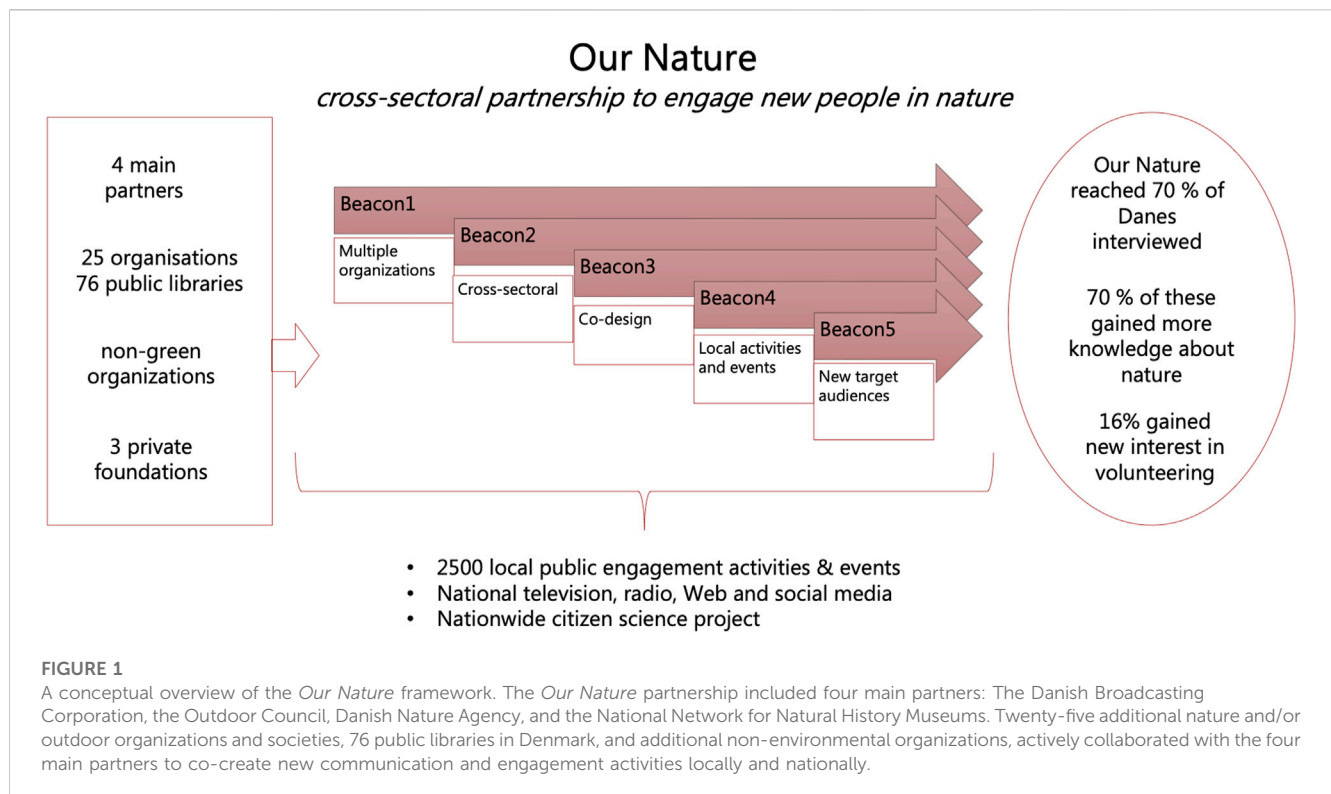
2 Materials and methods

The year 2020 was themed as the “year for Danish nature” by the Danish Broadcasting Corporation (DR) and several new media programmes were developed by DR to feature Danish nature in new and educational ways, including a high-quality television documentary about Danish nature to provide the public with a “wow” experience and motivate them to seek out their own experiences in Danish nature. Taking advantage of this unique opportunity, leading nature and environmental organizations in the country from both private and public sectors, including the Outdoor Council, Danish Nature Agency, and the newly established National Network for Natural History Museums, joined forces with DR, and a nationwide campaign entitled *Our Nature* was launched (Figure 1; see [Supplementary Material](#) for additional information). Our approach for broad engagement included working transdisciplinarily through the cross-sectoral partnership, establishing beacons for public engagement, and co-creating a multitude of outreach and engagement activities.

2.1 Engagement activities and events for all

The *Our Nature* partnership made use of the nature theme adopted by DR to plan synergistic activities for hands-on science communication and engagement, complementing the nature stories revealed in documentaries televised by DR. A series of workshops set up between the large number of collaborating organizations resulted in the co-creation of many new ideas for engagement activities and events. The activities were planned to stimulate interest and motivate citizens to learn about and experience Danish nature and included a new nationwide citizen science project, local activities falling under five thematic beacons, as well as other events, both in-person and online, intended to appeal to broad audiences.

Five thematic beacons of public engagement (Duncan and Manners, 2012) were designed to help to communicate the overall *Our Nature* campaign. These thematic beacons served as



critical infrastructure in the *Our Nature* framework to help organize the collaborating organizations into smaller working groups and facilitate collaboration and communication activities. The five *Our Nature* beacons included: nature in summer, nature by night, nature underwater, wild food, and wild nature where you live. Multiple organizations worked together cross-sectorally to co-create and deliver local science engagement activities under each.

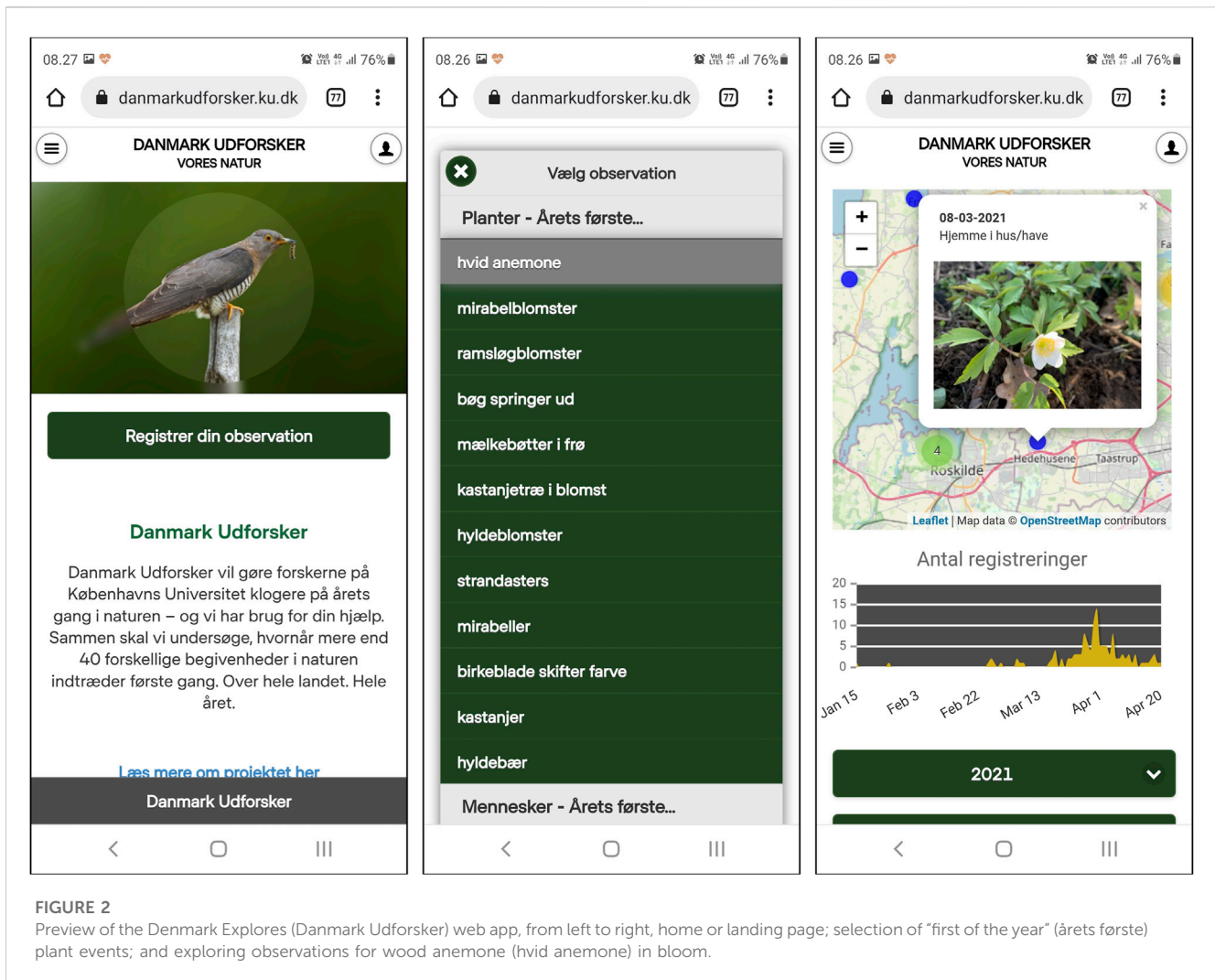
Funding was made available to carry-out these activities and events, with the main stipulation that activities had to be planned or offered in a way to be inclusive and attractive to new groups and reach parts of society that didn't already have an active connection to nature. These were local activities, to meet people where they are (Humm and Schrögel, 2020), across the country. The settings for activities were selected to ensure that people of all ages could participate, and many of the events were planned for those with mobility challenges in mind. In attempt to attract new user groups, many projects included cross-disciplinary activities, for example, combining bird watching with eating (wild) food, as well as activities that were planned at an introductory level or were appealing to new user groups, such a nature hike that was accessible to the inexperienced or accessibility-challenged hiker.

Examples of in person events included nature bingo, family nature walks, introductory bird watching, wildflower identification, fossil hunts, geology walks, and nights out in nature, etc. In addition, many new cross-disciplinary activities were generated such as combining hobby fishing with marine monitoring, foraging wild plants and cooking them, nature viewing in art sculpture parks, practicing yoga out in nature, and arts and crafts using material found in nature. Experienced guides and interpreters representing the participating organizations were the main modes of science communication planned for these engagement activities. In

addition, online engagement activities were also offered. One example included a Q & A session intended to connect the public with researchers following the prime time viewing of DR's new nature documentary series "Wild, wonderful Denmark." A digital chat platform was created, and links were provided via DR's media channels with an invitation to all to join online and ask researchers questions about the nature content they had just seen. Three researchers from natural history museums across the country were present to respond directly to questions from the audience for one and a half hours following each show.

2.2 Nationwide citizen science nature monitoring project

The citizen science project "Denmark Explores" (Danmark Udforsker; Iwanycki Ahlstrand et al., 2022a) was designed to connect the themes of each of the beacons and engage people without a prior connection to nature. Citizens were asked to go out and observe seasonal events in nature (phenology) in spring, summer, fall, and winter months and help researchers gain insights to how differences in climate affects local nature. Over 50 phenology events such as the first observed flowers or the arrival of migrant birds in springtime, and the changing of leaf colour in autumn were selected by a team of scientists, nature guides, representatives from Danish media, etc. The phenology events were selected to make it easy for anyone to participate regardless of where they lived in the country and without any prior knowledge, experience, or training needed. The species were common, easy to find and identify, and while not of particular interest to taxon-specialists, they were selected to maximize the participation of citizens with diverse



interests. Our project was also novel because it included species/biological events on both land and in water (no location in Denmark is further than 52 km from the coast), and it importantly included several human-centric phenology events such as the first outdoor meal in spring, the first pollen allergy symptoms, and the first-time frost was seen on a car windshield. A web-based app was developed specifically for the phenology project using the domain name "www.danmarkudforsker.dk". The app allowed participants to learn basic information about the project, direct them to the phenology events that could be observed and when, and allowed participants to register their observations and interactively review the findings of others plotted on a map of Denmark (Figure 2). A more detailed description of the project, as well as detailed science information about the species and events selected for the project were prepared and made available via web pages hosted by the Natural History Museum of Denmark.

2.3 Communication

To engage and motivate citizens to participate in local events, we made use of multiple streams and levels of communication,

including the in-person activities and events planned under each beacon, DR's media programming, and the social media platforms and websites of the lead organizations. A central webpage was created and designed to be the hub for everything related to the *Our Nature* campaign including the citizen science project. A calendar of events that was searchable by theme, location, or by the varying partners involved was made available from this website. The focus on nature programming through all of DR's media channels (television, radio, web-based) provided an incredibly unique opportunity to share information about *Our Nature*, at local, regional and national scales. In particular, the airing of their BBC-quality nature documentary during prime time over 5 weeks in early 2020 provided an unprecedented opportunity to advertise the campaign's main website and the many science engagement events and activities planned.

Another step we took was to deliberately use in-person local activities to communicate information and spread the word about other activities under the *Our Nature* framework including the national citizen science project Denmark Explores. In this way, activities that appealed to new user groups could be used as a hook to engage participants in a further suite of activities. For example,

family-friendly events such as nature bingo were planned at over 20 locations across the country, and participants at these events would be introduced to the citizen science project and given a short preview of how to participate. The collaborating organizations used their own membership lists and communication channels to further share news of the activities. At the conclusion of the *Our Nature* campaign, a small conference was organized in the evening hours to allow for the presentation of results to all participating organizations. The further sharing of the final *Our Nature* results was also left up to the individual partner organizations and collaborators using their own communication channels.

Media releases and social media feeds of some of the participating organizations were used to attract participants to the citizen science project continually throughout the observation collection period (March 2020–June 2021). Individual phenology events were promoted in the days before they could be observed. Three to four phenology events that could be observed around the same time were advertised together in a single social media post; short sentences were used to communicate information about the species being observed along with an invitation to participate. With respect to dissemination, the citizen science project's results could be viewed and explored using interactive maps of citizen observations on the web-based app developed for this project (Figure 2).

2.4 Measuring the impact—extensive evaluation of the nationwide campaign

Extensive third-party evaluation of the *Our Nature* project and the partnership was carried out in 2020 and 2021 by Als Research (Als Research, 2021). The evaluation was set-up to evaluate the project deliverables and the targets set for the communication and engagement activities carried out in the project. Qualitative interviews were conducted by an external third-party company (Kantar Gallup, 2021), between 19 October and 25 October 2020. A media analysis to evaluate the success of the programming developed by the Danish Broadcasting Corporation was carried by Epicent (Als Research, 2021) over the period of April–October 2020. These analyses were supplemented by viewership statistics data from DR's media research group (Supplementary Figures S2, S3).

Due to privacy regulations in the EU, i.e., General Data protection Regulation (GDPR), only minimal data was collected about the participants who were engaged in our citizen science project. Name, address, or other contact details were not collected, and thus an in-depth evaluation with respect to our inclusivity goals for this project was limited. However, we report on available data (on participant gender and postal code), along with categorical information submitted with each observation about where a participant's observation was made, to infer more about the participants and our goals to improve the reach.

3 Results

The *Our Nature* campaign, along with the citizen science project, *Denmark Explores*, was launched in March 2020, during the week following Denmark's first lockdown due to the COVID-19 pandemic. Over 2500 public engagement activities across the country were co-created via the cross-sectoral partnership and collaborations. They

were local events offered across the country and scheduled to run throughout the year 2020. The COVID-19 restrictions unfortunately led to many cancellations, delays, and changes in *Our Nature*, including cancellations of almost all the in-person activities planned under the five beacons. This means our strategy to communicate our citizen science project and other engagement activities falling under each beacon via face-to-face events was severely compromised, and communication efforts were re-focused to using social media platforms, websites, DR's programming, and only a handful of in-person events that ran in 2020. However, because our citizen science project was designed as an activity that participants could do on their own, the citizen science project itself was unaffected. The citizen science project was extended into the early spring months of 2021 because of the COVID-19 impact.

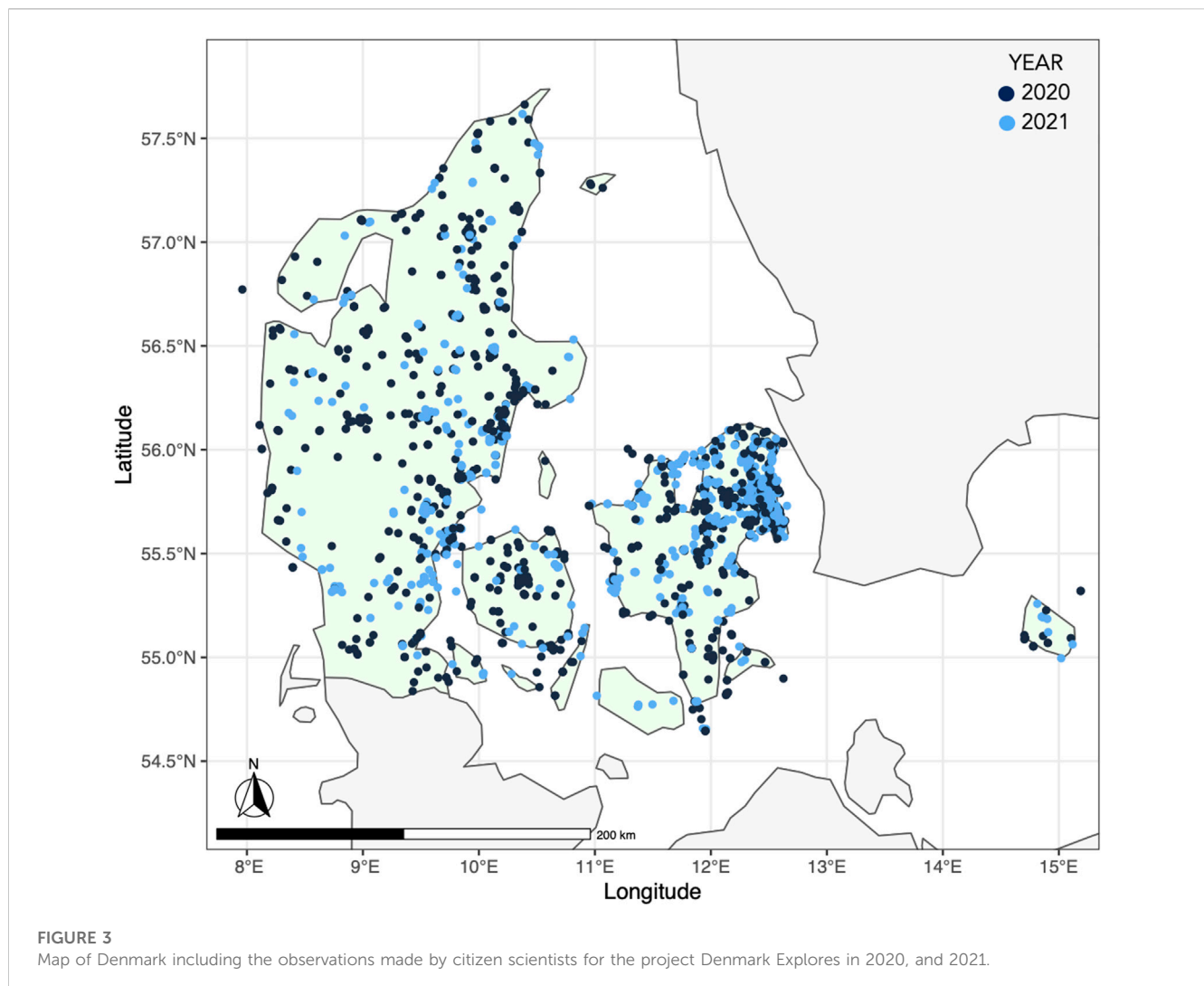
Extensive evaluation of *Our Nature*, including following up with citizens across the country, was achieved: 1092 people in Denmark over the age of 18 years responded to the web-based survey: 27% of respondents were aged 18–35 years, 41% age 36–59, and 32% 60 years of age and older. Furthermore, respondents were reached in each of the five regions of Denmark (32% in the Capital region, 14% from Zealand, 21% from South Denmark, 23% from Middle Jutland, and 10% from North Jutland (Kantar Gallup, 2021). The evaluation revealed that our communication approach was a success: approximately 60% of all Danes surveyed had heard about *Our Nature*. The nature theme offered through all of DR's media channels reached 70% of the Danes interviewed (Kantar Gallup, 2021). The series “Wild wonderful Denmark” and “Give us nature back” had very high viewing figures (data not shown), and these new nature television programmes were seen by a wide range of Danes across age, gender, and level of education (Supplementary Figure S2). Importantly, 70% of the Danes who did encounter *Our Nature* reported to have gained more knowledge about Danish nature, 64% developed a greater desire to be in nature, 58% plan to seek out nature in the future, and (16%) would engage in voluntary nature projects, to a significantly higher degree compared to those that were not reached (Supplementary Table S1).

Our citizen science project did not benefit from the same extensive evaluation largely due to GDPR. However, we can report that over a thousand participants signed up and submitted a total of 1079 phenology observations from across the entire country in 2020 and 878 observations in the spring months of 2021 (Figure 3). Regarding gender balance, 64% of the participants were female, 35% were male, and 2% identified as “other” across both years. When submitting observations, categorical data regarding the location of the observation was registered by participants, and 50% of observations were made “close to participants' homes,” 30% of observations were made “on neighborhood walks,” while only 4% were made while “out in nature.” The remaining observations were reported as recorded either “on the go” or as “other” circumstances.

4 Discussion

4.1 Partnership for nature

The multi-tiered and cross-sectoral communication approach we developed for *Our Nature* contributed to strengthening Danes' knowledge of, as well as desire to seek out and engage with, Danish



nature. The cross-sectoral partnership allowed us to co-create and implement a wide array of engagement and communication tactics to ultimately broaden the sectors of society that could be engaged. The broad media coverage of the nature theme on DR and the locally anchored activities centered around the beacons complemented each other well and would have arguably resulted in greater levels of engagement if the campaign was able to run without being subject to setbacks during the pandemic. The stipulations set by funding agencies to co-create activities that would appeal to Danes without a prior connection with nature provided excellent incentives for the participating organizations to join forces, work interdisciplinarily, think outside of the box, maximize differing strengths, and discover new synergies.

Working cross-sectorally and interdisciplinarily is critical for tackling many of the real world's "wicked" problems (McCune et al., 2021), and in our experience, regardless of the research problem being tackled, working interdisciplinarily and transdisciplinarily often requires finding a common language for what is typically very discipline-specific ways of communicating. Finding this common language between partners in the early stages of the co-creative process naturally lent itself to developing a simple language that is suitable to reach non-experts in the public, thereby reducing

possible exclusion in our science communication efforts throughout the project. Our citizen science project benefited from the use of a simplified and not overly complicated language, despite the focus being on complex processes in nature such as the response of phenology to a changing climate. While in our professional experiences as biologists and citizen science practitioners we clearly understand the value of adapting our scientific language in a way that can be understood by all, having a transdisciplinary team helped in finding new ways to communicate scientific terms such as phenology, and indeed even highlighting the value of avoiding or limiting the terms "citizen science" and "climate change." As is the case in many languages, there is no suitable term for citizen science in Danish, and the name citizen science is under debate even in English speaking parts of the world for the main reason that the name may exclude people (Cooper et al., 2021; Ellwood et al., 2023).

4.2 Beacons of public engagement

The concept of using beacons for public engagement has gained recent attention to work with audiences not previously talked to or

engaged with, including socially excluded groups. In the United Kingdom, beacons have been used to promote civic engagement in higher education and decrease the gap between university researchers and the public (Duncan and Manners, 2012), as well as to target underserved areas of society with respect to public health issues (Rashman et al., 2005). We are not aware of any other models that used the beacon approach to facilitate the creative process of discovering synergies between partner organizations and co-creating science engagement activities together. In our approach, the thematic beacons were of greatest value to the internal framework of *Our Nature* as they allowed small groups of collaborating organizations to work together across disciplines under a common theme, magnify the potential reach of the communication and engagement activities planned, and democratically select projects to fund. While it was important to have multiple organizations working together under each beacon, we found that it was highly effective to designate a lead organization to make the beacons successful. In one situation, a beacon lacked a strong leading organization, and our experience was that the momentum of this beacon lagged behind the others until a new organization joined to take the lead. Should our campaign not have been impacted by COVID-19 restrictions, the beacons could have had a greater visibility to help attract and engage participants.

4.3 Activities to appeal to the masses and stimulate engagement

Our approach recognized the need for and importance of infrastructure for face-to-face collaboration and meeting (Hildago et al., 2021), and many new and exciting ideas for cross-disciplinary activities were generated. Unfortunately, the bulk of these planned activities never came to fruition due to COVID-19 restrictions. Offering multiple entry points and more than one way to participate in a project with varying levels of commitment as options for participants are considered key to ensuring a diversity of people can be engaged (Paleco et al., 2021). The activities we planned, in particular the citizen science project, did indeed provide multiple entry points and varying possibilities to participate that could appeal to a newcomer. A citizen scientist had the freedom to determine the extent to which they were involved. They could decide to report only on a single phenology event from a single location, or multiple observations could be made either for a single species event but observed in different locations, or multiple observations could be made for several or all the phenology events included in the study. They could also browse through the web material and explore data and learn something in the process, without actually submitting data.

Admittedly, it was not always easy to break the norms with respect to engagement activities, and challenges were experienced with convincing participating organizations to modify their existing tactics to meet the campaign's goal to reach a new sector of society and engage them with nature. Our experiences revealed in some instances that a major push was needed to get groups to think outside the box, even when financial support was offered as an incentive. An overall shift in thinking and breaking down barriers between participating groups was essential, and an unbiased

facilitator could have been useful to guide participants in this direction.

An example of a new science communication activity that worked very well to bridge the gap between researcher and member of the public was the online engagement forum planned for the hour and a half following the new nature series televised on DR. Three researchers/experts in the fields of science that related to the nature stories portrayed in the documentary were available to chat and answer questions from the public. Each scientist was able to interact with at least 25 members of the public, and the public could follow the Q & A chat online. This model could be very effective in future science communication efforts. While we can report on the success of this initiative, we unfortunately do not have data to assess if a new audience was reached.

4.4 National citizen science project to attract first-time nature observers

Phenology has emerged as a key metric to study biological response to climate change and while numerous citizen science phenology projects exist (Mayer, 2010; Beaubien and Hamann, 2011), most are centered around monitoring several phenological phases on, for example, a plant or plant population. These types of citizen science projects require training and aren't always well suited to all (MacKenzie et al., 2017). Because we had the goal of involving citizens who did not previously have a connection to nature, we believe that we did encourage a greater level of inclusivity in Denmark Explores by adapting our research questions and communication strategy. We focused on species that are found everywhere (Johnson, 2016), and included phenology events that were human-centric as a hook to attract people with other interests, rather than preaching to the converted (Allf et al., 2022). Furthermore, we benefited from the cross-sectoral partnership and the efforts made to reach new participants using new channels. While from a researcher's point of view it perhaps isn't as attractive to study very common organisms, we would agree that at least in the study of phenology, so little is known about impacts of recent climate warming on even the most common species, and our project could still unravel novel scientific findings (Iwanycki Ahlstrand et al., 2022b). Finding the right balance between research questions that could both help promote inclusivity and deliver new scientific research is therefore key.

While participant interviews or other evaluation metrics were not possible, we did find that citizen science participants were predominantly female, which differs from participant survey results from other studies (i.e., Allf et al., 2022). Half of observations were made close to participants' homes, and our human-centric events were among the most popular and therefore we believe these results to be telling signs of the successful engagement of participants that are not the typical nature enthusiasts. We acknowledge though that the pandemic may have inflated the numbers of people making observations from home because of following isolation restrictions.

Several factors hindered our goals for broad engagement in our citizen science project and are worthy of mention. Our project relied solely on a digital app to report findings. While this makes it easy for everyday citizens to participate, it meant that we excluded anyone who doesn't carry a smartphone or use a computer—or is challenged

with respect to text literacy. Also, all our programming was run entirely in Danish, and although this is the official language in Denmark, some residents are not fluent in Danish, and these are likely the most excluded sectors in society and most likely not reached through this project. To truly reach these sectors, one would have to work with translators and members of the minority groups in the country, possibly by appointing community group ambassadors to help with this.

Finally, limitations with respect to privacy and GDPR meant that we could not communicate directly with individuals participating in the project. This means we did not have the opportunity to share project results along the way, provide continued motivation and/or incentives, or disseminate results of the final project with individual participants. We recognize that citizens want to hear about results, have access to the data they collected, and be acknowledged in research articles (de Vries et al., 2019). Our efforts to disseminate results was limited to using the project's webpages and through our social media platforms. It is possible, though difficult to measure, that even though we reached a limited demographic using these dissemination tactics, that these participants will bridge the gap between researchers and the other participants (Damiani et al., 2021). One solution to this dilemma in future citizen science projects would be to place an even greater involvement of citizens and citizen society organizations in the early stages of the project, allowing researchers to have a greater number of direct connections to the participants and obtain special permissions to allow for follow-up.

Our results confirmed a broad interest in participating in citizen science projects and engaging in local nature and environment, and, more specifically, to contribute to a phenology project. After the official conclusion of the *Our Nature* campaign, the Network of Natural History Museums have continued to collaborate and have further developed Denmark Explores, moving the project to the national biodiversity reporting platform "Arter" (www.arter.dk), where in 2023 more than 2000 observations were received focusing on spring time phenological events (Iwanycki Ahlstrand and Tøttrup, unpublished data).

4.5 Concluding remarks

There are many excellent reasons why inclusion and diversity—and achieving broad participation—have become trends in citizen science projects and generally in science communication (Humm and Schrögel, 2020). In our experience, it can be difficult to design a one-size-fits-all citizen science project on the first go, simultaneously incorporating measures to improve inclusion and reaching the broadest audience possible. Citizen science projects come in a diversity of forms, which vary immensely with respect to the level of citizen involvement, level of prior knowledge, specialized skills or training needed, and level of commitment (resources). However, sharing community knowledge and collaboration will enable more citizen science practitioners to improve the inclusiveness

of citizen science projects. This is naturally underpinned by the fact that all projects should provide a benefit to all individuals involved, both the professional scientist and the citizen scientists (ECSA, 2015). In the case of Denmark Explores, our goals to engage participants who did not yet have a connection to nature, are closer to the goals of science communication: to reach the broadest audience possible, and our goals for high-quality data collection came second to this. We have however demonstrated that with the right research questions and communication approach, inexperienced nature observers can contribute meaningful data, and that data from such participants balances any biases associated with participants from homogenous backgrounds (i.e., nature enthusiast) (Sorensen et al., 2019).

Not all citizen science projects are run at national levels, nor do they have access to the same level of resources as was available to support the extensive partnership and activities created through the *Our Nature* campaign. However, several principles applied in our approach could be applied to projects of varying scales, with or without the incredible momentum provided by an agency such as the largest media group in Denmark. What we believe to be key elements of success here are 1) the creation of a partnership that spans sectors and varying types of organizations, 2) having incentive to work collaboratively and interdisciplinarily to co-create ideas and tactics under thematic beacons, and 3) planning hooks to draw in target audiences such as cross-disciplinary events or activities that can serve as steppingstones to others.

Data availability statement

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

Author contributions

NIA: Conceptualization, Formal Analysis, Investigation, Methodology, Visualization, Writing—original draft, Writing—review and editing. APT: Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Visualization, Writing—review and editing.

Acknowledgments

We would sincerely like to thank the funding agencies that made the *Our Nature* (VoresNatur) campaign and Denmark Explores (Danmark Udforsker) possible: Nordea Fonden, 15 Juni Fonden, and Aage V. Jensen Naturfond. We also acknowledge the tremendous number of hours and creative processes resulting between all partners and collaborators, as well as the thousands of citizens that contributed to the success of the *Our Nature* activities. Finally, we thank and acknowledge the Kantar Group and Als Research for conducting evaluations and providing results of *Our Nature*.

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.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated

organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fenvs.2023.1254047/full#supplementary-material>

References

- Allf, B. C., Cooper, C. B., Larson, L. R., Dunn, R. R., Futch, S. E., Sharova, M., et al. (2022). Citizen science as an ecosystem of engagement: implications for learning and broadening participation. *BioScience* 72 (7), 651–663. doi:10.1093/biosci/biac035
- Als Research (2021). *Evaluering af VoresNatur. Udarbejdet af als research for VoreNatur (friluftsrådet, Danmarks radio, naturstyrelsen of Danske Naturhistoriske museer)*. B. Forfattet af Følner and A. Y. Ploug (København).
- Beaubien, E. G., and Hamann, A. (2011). Plant phenology networks of citizen scientists: Recommendations from two decades of experience in Canada. *Int. J. Biometeorology* 55 (6), 833–841. doi:10.1007/s00484-011-0457-y
- Bonney, R., Phillips, T. B., Ballard, H. L., and Enck, J. W. (2016). Can citizen science enhance public understanding of science? *Public Underst. Sci.* 25 (1), 2–16. doi:10.1177/0963662515607406
- Chesser, S., Porter, M. M., and Tuckett, A. G. (2020). Cultivating citizen science for all: Ethical considerations for research projects involving diverse and marginalized populations. *Int. J. Soc. Res. Methodol.* 23 (5), 497–508. doi:10.1080/13645579.2019.1704355
- Cooper, C., Hawn, C. L., Larson, L. R., Parrish, J. K., Bowser, G., Cavalier, D., et al. (2021). Inclusion in citizen science: The conundrum of rebranding. *Science* 372, 1386–1388. doi:10.1126/science.abi6487
- Damiani, R., Krieger, J., Treise, D., Walsh-Childers, K., Fisher, C., Bloodworth, S., et al. (2021). Learning the language of science: A pilot study exploring citizen scientists' identity and communication with researchers. *J. Clin. Transl. Sci.* 5 (1), E208. doi:10.1017/cts.2021.847
- Dawson, E. (2018). Reimagining publics and (non) participation: Exploring exclusion from science communication through the experiences of low-income, minority ethnic groups. *Public Underst. Sci.* 27 (7), 772–786. doi:10.1177/0963662517750072
- de Vries, M., Land-Zandstra, A., and Smeets, I. (2019). Citizen scientists' preferences for communication of scientific output: A literature review. *Citiz. Sci. Theory Pract.* 4 (1), 2. doi:10.5334/cstp.136
- Duncan, S., and Manners, P. (2012). "Embedding public engagement within higher education: Lessons from the beacons for public engagement in the United Kingdom." in *Higher education and civic engagement*. Editors L. McIlrath, A. Lyons, and R. Munck (New York: Palgrave Macmillan). doi:10.1057/9781137074829_14
- ECSA (European Citizen Science Association) (2015). *Ten principles of citizen science*. Berlin. doi:10.17605/OSF.IO/XPR2N
- Ellwood, E. R., Pauly, G. B., Ahn, J., Golembiewski, K., Higgins, L. M., Ordenana, M. A., et al. (2023). Citizen Science needs a name change. *Trends Evol. Ecol.* 38, 485–489. doi:10.1016/j.tree.2023.03.003
- Hickey, G., Richards, T., and Sheehy, J. (2018). Co-production from proposal to paper. *Nature* 562, 29–31. doi:10.1038/d41586-018-06861-9
- Hildago, E. S., Perello, J., Becker, F., Bonhoure, I., Legris, M., and Cigarini, A. (2021). "Participation and co-creation in citizen science. Chapter 11," in *The science of citizen science*. Editor K. Vohland doi:10.1007/978-3-030-58278-4_11
- Howlett, R., Sitbon, L., Hoogstrate, M., and Balasuriya, S. S. (2021). "Accessible citizen science, by people with intellectual disability," in Presented at the 23rd International ACM SIGACCESS Conference on Computers and Accessibility, Virtual Event. doi:10.1145/3441852.3476558
- Humm, C., and Schrögel, P. (2020). Science for all? Practical recommendations on reaching underserved audiences. *Front. Commun.* 5. doi:10.3389/fcomm.2020.00042
- Iwanycki Ahlstrand, N., Larsen, J. C., Lillemark, M. R., and Tøttrup, A. P. (2022a). "Denmark Explores: Engaging citizen scientists nation-wide to monitor phenology," in Proceedings of Science, Engaging Citizen Science Conference 2022, 25-26 April (Aarhus University). doi:10.22323/1.418.0071
- Iwanycki Ahlstrand, N., Primack, R., and Tøttrup, A. P. (2022b). A comparison of herbarium and citizen science phenology datasets for detecting response of flowering time to climate change in Denmark. *Int. J. Biometeorology* 66, 849–862. doi:10.1007/s00484-022-02238-w
- Johnson, K. A. (2016). Real life science with dandelions and project BudBurst. *J. Microbiol. Biol. Educ.* 17, 115–116. doi:10.1128/jmbe.v17i1.1064
- Kantar Gallup (2021) Kantar gallup 2021 for friluftsrådet. Undersøgelsen er gennemført 19/10 – 25/10 2020, 16.
- Kantar Group (2020). *Kantar group for friluftsrådet. Gallup PR-bus om VoresNatur. Undersøgelsen om VoresNatur 2020*. Projekt 64615.
- Kidney, C. A., and McDonald, K. E. (2014). A toolkit for accessible and respectful engagement in research. *Disabil. Soc.* 29 (7), 1013–1030. doi:10.1080/09687599.2014.902357
- Lee, O., Miller, E. C., and Januszzyk, R. (2014). Next generation science standards: All standards, all students. *J. Sci. Teach. Educ.* 25 (2), 223–233. doi:10.1007/s10972-014-9379-y
- MacKenzie, C. M., Murray, G., Primack, R., and Weihrauch, D. (2017). Lessons from citizen science: Assessing volunteer-collected plant phenology data with mountain watch. *Biol. Conserv.* 208, 121–126. doi:10.1016/j.biocon.2016.07.027
- Mayer, A. (2010). Phenology and Citizen Science: Volunteers have documented seasonal events for more than a century, and scientific studies are benefiting from the data. *BioScience* 60 (3), 172–175. doi:10.1525/bio.2010.60.3.3
- McCune, V., Tauritz, R., Boyd, S., Cross, A., Higgins, P., and Scoles, J. (2021). Teaching wicked problems in higher education: Ways of thinking and practising. *Teach. High. Educ.*, 1–16. doi:10.1080/13562517.2021.1911986
- Paleco, C., García Peter, S., Salas Seoane, N., Kaufmann, J., and Argyri, P. (2021). "Inclusiveness and diversity in citizen science," in *The science of citizen science* (Cham: Springer). doi:10.1007/978-3-030-58278-4_14
- Pateman, R. M., Dyke, A., and West, S. E. (2021). "The diversity of participants in environmental citizen science," in *Citizen science: Theory and practice*.
- Rashman, L., Downe, J., and Hartley, J. (2005). Knowledge creation and transfer in the beacon scheme: Improving services through sharing good practice. *Local Gov. Stud.* 31 (5), 683–700. doi:10.1080/03003930500293732
- Richter, A., Comay, O., Svenningsen, C. S., Larsen, J. C., Hecker, S., Tøttrup, A. P., et al. (2021). Motivation and support services in citizen science insect monitoring: A cross-country study. *Biol. Conserv.* 263, 109325. doi:10.1016/j.biocon.2021.109325
- Senabre Hidalgo, E., Perelló, J., Becker, F., Bonhoure, I., Legris, M., and Cigarini, A. (2021). "Participation and co-creation in citizen science," in *The science of citizen science*. K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, and M. Ponti Editors (Cham: Springer). doi:10.1007/978-3-030-58278-4_11
- Sorensen, A. E., Jordan, R. C., LaDeau, S. L., Biehler, D., Wilson, S., Pitas, J.-H., et al. (2019). *Reflecting on efforts to design an inclusive citizen science project in west baltimore*. Papers in Natural Resources, 860. Available at: <https://digitalcommons.unl.edu/natrespapers/860>.
- Worm, B., Elliff, C., Fonseca, J. G., Gell, F. R., Serra-Goncalves, C., Helder, N. K., et al. (2021). Making ocean literacy inclusive and accessible. *Ethics Sci. Environ. Polit.* 21, 1–9. doi:10.3354/esep00196