Review on Agriculture and Rural Development 2024 vol. 13 (1-2) ISSN 2677-0792
DOI: 10.14232/rard.2024.1-2.24-33

HOW DOES NATURE CONSERVATION CITIZEN SCIENCE AFFECT POLICY AND DECISION-MAKING? A REVIEW

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Abstract: The necessity of expanding our understanding of how Nature Conservation Citizen Science projects contribute to decision-making is frequently emphasized in related scientific studies. A literature review was conducted about the impacts of NCCS projects on policy and decision-making. Peer-reviewed scientific papers published between 2014 and 2024 were used to identify: a) the forms that NCSS projects affected conservation policy, b) the most frequent strategies used in the studies to determine that impact and c) the common challenges encountered for affecting policy. Our results show that more than half of the reviewed publications mention that projects begin with aspirations to make a meaningful contribution to conservation policy, but they rarely share their data with official databases (e.g. official monitoring systems at the local, national, or global levels that implement governmental policy). Our results also show that NCCS projects tend to inform decision-making at early policy stages (e.g. informing policy) and are less common at later phases (e.g. formulation or implementation). Case studies and surveys were most often used to determine the effect. To truly influence national conservation policies, improving channels to communicate with decision-makers is needed and challenges with improving data quality to ensure scientific rigor also need to be addressed.

Keywords: citizen science, nature conservation, policy, decision-making, literature

1. Introduction

There is an increasing interest in the participation of citizens in nature conservation in the last few years through various forms of active citizenship, community-based resource management, activism, environmental stewardship, and citizen science (CS) (Cooper et al. 2012, Mattijssen, 2022). By engaging in Nature Conservation Citizen Science (NCCS) projects (e.g. eBird, iNaturalist) volunteers are assisting conservation researchers, natural resource and environmental managers, and other decision-makers in gathering scientific data valuable for nature conservation. Their contributions help to tackle environmental challenges, influence conservation policy and assist in meeting international environmental obligations (Danielsen et al. 2014, McKinley et al. 2017). The European Commission has officially declared the importance of CS in giving an opportunity to broaden the knowledge base (Bio Innovation Service 2018). Chandler et al. (2017) emphasize the importance of CS in conducting research in locations and at scales that would not have been possible otherwise.

NCCS projects have grown in size and scope in the last few years and have become increasingly conservation policy-relevant (Hecker et al. 2018, Fraisl et al. 2022). Policy development is a complex process, and according to Turbé et al. (2019), every stage of the policy-making process can benefit from NCCS: defining the problem through policy information, policy formulation, policy implementation and monitoring, public involvement in decision-making and evaluation of policy.

In this paper, the terms "policy and conservation policy" refer to a collection of measures implemented by a legislative body, a local government, or an organization acting on their behalf (e.g. designation of protected areas, management of species or ecosystems, restoration) (Meinard 2017).

Despite the increasing recognition of NCCS to affect policy, the literature stresses the need for a deeper understanding of the critical elements that make it possible for NCCS projects to support conservation policy and decision-making (Hyder et al. 2015, Hecker et al. 2019). Therefore, the present review aims to describe what is the evidence for the past ten years in the literature on the impact of NCCS projects on conservation policy and decision-making.

2. Materials and methods

2.1. Materials

We reviewed existing peer-reviewed literature from 2014 to 2024. We selected studies that focus on nature conservation-related citizen science projects and include the impacts of these projects on conservation policy and decision-making. In this study, both "conservation decision-making" and "conservation policy" refer to the decision processes that lead to policy impact and both terms are used as synonyms.

A thorough search was conducted using Scopus, Web of Science, and Google Scholar. The combination of terms used was ("citizen science" or "community science") and ("nature conservation" or biodiversity) and (policy or "decision-making"). By using content analysis (Krippendorff 2018), we identified a) the type of impact on conservation policy, b) the strategies used to determine the reported impacts and c) the common challenges encountered. Out of the 167 papers that were gathered, 33 were pre-selected (after reading the abstract) and 17 were selected which met our criteria.

3. Results

Projects that targeted animal species (17 studies) were more common in informing policy than NCCS projects that just targeted plant species (1 study). Five studies investigated the eBird NCCS project, which was the most often mentioned project.

NCC projects frequently start with the goal of contributing to conservation policy, but the reality is that not all of these projects share their data with official

databases. This can limit the influence of the projects and make it difficult for policymakers to use the data for decision-making.

3.1. Type of NCCS projects impact on conservation policy

The most often cited way that a NCCS project affected conservation policy was via providing information (*Table 1.*). The majority of the NCCS projects in the reviewed literature generated large amounts of data (e.g. species distribution, population trends and habitat changes) that assisted policymakers to identify areas for the protection of certain species such as birds (Sullivan et al. 2014, Saunders et al. 2021) sharks, turtles, manta rays (Butler et al. 2023) or ecosystems (coral reef) that need restoration (Butler et al. 2023).

The policy implementation was the second common form of policy impact, which was usually preceded by informing policy. For example, the German project Mückenatlas aims to map the occurrence of mosquito species and their distribution. On the one hand, the project informed conservation policy that resulted in the identification of areas in need of conservation efforts. On the other hand, the reports guided the actions of governmental institutions to control and manage invasive mosquito species (Pernat 2022).

Two studies discussed the potential of NCCS projects to affect conservation policy by analyzing a large number of NCCS initiatives from a certain country, Vann-Sander et al. (2016) covering Australia and Suškevičs et al. (2021) Estonia.

Table 1.: Summary of the analyzed studies that report NCCS projects' impact on conservation policy

Reference	**NCCS project**	**Forms of Policy Impact**	**Methods used to determine the reported impacts**
Sullivan et al. 2014	eBird	providing information, policy implementation	case study
Hyder et al. 2015	Various marine NCCS projects (e.g. Seagrass-Watch, Seasearch, Coastwatch)	providing information	case study
Vann-Sander et al. 2016	Various marine and coastal CS programs - Western Australia	potential impact	interviews, online survey
Bio Innovation	Various NCCS projects (e.g. eBird, Seasearch)	providing information	online survey

Reference	NCCS project	Forms of Policy Impact	Methods used to determine the reported impacts
Service, 2018			
Turbé et al. 2020	503 NCCS projects	providing information	online survey, case study
Yang et al. 2019	13 NCCS monarch butterfly projects	providing information, policy implementation	case study using a framework
Fritz et al. 2019	Various NCCS projects that contribute to SDG's (e.g. eBird)	providing information	review
Suškevičs et al. 2021	Various plant and animal NCCS projects from Estonia (e.g. BioBlitz, Looking for Cowslips, Observado, iNaturalist)	potential impact	case study, interviews, online survey
Wehn et al. 2021	eBird, The National CBNRM Observatory Zambia	providing information, policy implementation	case study using a framework
Saunders et al. 2021	Various ornithology CS projects (e.g. eBird)	providing information, policy implementation	case study
Finch et al. 2022	15 plant monitoring CS projects	providing information	online survey
Pernat, 2022	Mückenatlas (The Mosquito Atlas) NCCS project	providing information, policy formulation, policy implementation	case study
Price-Jones et al. 2022	103 Alien species CS projects	providing information, policy formulation, policy implementation	online survey
Lee et al. 2022	SABAP2 ornithology CS project	providing information	review
De Groot et al. 2022)	Allien species CS projects (e.g.	providing information	review

Reference	NCCS project	Forms of Policy Impact	Methods used to determine the reported impacts
	Observatree, LIFE ARTEMIS, Natuurkalender)		
Hudgins et al. 2023	Olive Ridley Project, Maldives Sea Turtle (MSTIP)	providing information, policy formulation	case study
Butler et al. 2023	Various NCCS projects	providing information, policy formulation, policy implementation	systematic literature review

3.1.1. Methods used to determine the reported impacts

Case studies were used the most often to determine policy effects, and in two of them, even an evaluation framework was applied (Yang et al. (2019) used the Telecoupling Framework, Wehn et al. 2021 (Citizen Science Impact StoryTelling Approach-CSISTA)). The online survey was also an often used strategy to detect the conservation policy impact of NCCS projects. A prevalent topic covered in the surveys was the quality and usefulness of the collected data. Surveys were conducted among NCCS project managers and coordinators reaching a larger project pool than when frameworks were used to evaluate the policy effect. For instance, Price-Jones et al. (2022) conducted an online survey that involved participants from every EU member state. They contribute to a greater awareness of CS programs focusing on alien species and report on their influence on policy. It addressed 103 initiatives in 41 countries. The survey included questions on policy-related information besides data quality, management, use and engagement of people.

3.2. Challenges

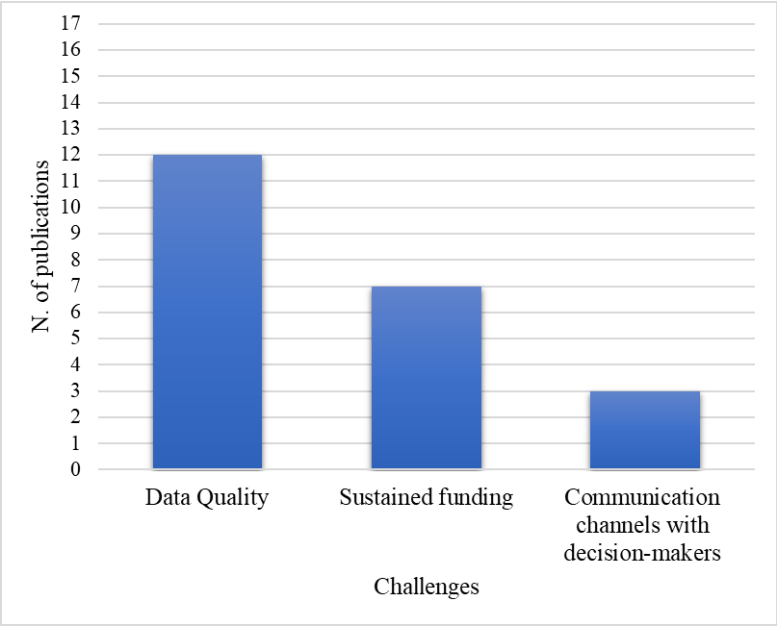
The key challenges that were more frequently mentioned to limit an actual impact on conservation policy are shown in *Figure 1*. The need to ensure data quality was the most often raised challenge. As additional methods for guaranteeing data quality are developed, the likelihood that scientists, conservationists, and policymakers will view NCCS project data as beneficial for conservation policy will grow (Price-Jones et al. 2022).

Ensuring sustained and long-term funding was the second most frequently mentioned challenge. Policymakers prefer long-term datasets that can be accomplished through long-term running with sustained funding. The analyzed projects often relied on grants (Wehn et al. 2021), sporadic public funding (Finch et

al. 2022, Lee et al. 2022), and donations (Hudgins et al. 2023), which can be unpredictable and short-term.

The third most common challenge was the requirement to improve channels for communicating with decision-makers. For example, Suškevičs et al. (2021) and Fritz et al. (2019) recommended building partnerships between CS experts and decision-makers through regular meetings or sharing NCCS project data with official databases (e.g. Global Biodiversity Information System GBIF) (Miller, 2022). This can assist in ensuring that the data and insights generated from these projects are effectively translated into conservation policies.

Figure 1.: Publication frequency, including challenges to impact conservation policy impact



4. Discussion

Previous studies indicated that CS projects were more effective in influencing the early stages of policy development, rather than the later stages (Hecker et al. 2018; Göbel et al. 2019). According to our results, the most common way that NCCS projects had an impact on policymaking was through informing conservation policy, which occurs also in the early phases of policy development.

The conservation policy can benefit greatly from NCCS programs, as noted by Tollington et al. (2017). However, our research indicates that standard procedures for enhancing data quality in NCCS projects are necessary to fully realize the field's potential at more stages of the conservation policy process.

A variety of methods and frameworks can be used to assess how CS projects affect policy. Although evaluation frameworks are widely recommended in the literature (Kieslinger et al. 2017, Liñán et al. 2022), among the reviewed papers only two case studies applied a framework for the assessment. For example, through the Telecoupling framework proposed by Yang et al. (2019), 13 NCCS projects were evaluated. It assessed how citizen science affects conservation policy by looking at the complex human-environment interactions across variable distances.

In our review case studies were commonly used to analyze the impact of NCCS programs on policy, providing a comprehensive understanding of NCCS projects' outcomes, lessons learned, limitations, and issues when addressing policy impact. Schulwitz et al. (2021) state that case study analysis of NCCS projects is crucial for creating a body of knowledge that will direct project developments and future research.

Conclusion

Evidence about the increasing influence of NCCS projects on conservation policy has been growing in the past 10 years. By engaging volunteers in scientific research, NCCS projects generate data that are mainly used to inform conservation policy and decision-making. NCCS projects must go through a significant transformation in the planning and execution process in order to be fully exploited in various stages of the development of conservation policies and decision-making. By prioritizing the resolution of frequently brought-up challenges, starting with data quality, ensuring continued funding, and improving channels of communication with key stakeholders who have policy-making influence.

Finally, we propose the establishment of a guideline for NCCS project managers to highlight the needs of policymakers at different conservation policy development stages.

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