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Linking the motivations and outcomes of volunteers to understand participation in marine community science

Ben McAteer*, Wesley Flannery and Brendan Murtagh

School of Natural and Built Environment, Queen's University Belfast

bmcateer06@qub.ac.uk; w.flannery@qub.ac.uk; b.murtagh@qub.ac.uk

* Corresponding author

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Abstract

To achieve sustained participation, community science projects aim to satisfy the motivations and desired personal outcomes of their volunteers. Evaluating participation is, therefore, crucial, with projects seeking to assess volunteers' motivations for engagement and the complex outcomes that they achieve through their participation. Many assessments have, however, ineffectively examined the relationship between volunteers' motivations and how they relate to the personal outcomes that they wish to pursue. Evaluations of the personal outcomes achieved by volunteers often fail to consider whether these outcomes were desired or if they aligned with volunteers' motivations, and tend to narrowly focus on general outcomes, such as developing scientific or environmental literacy. Failing to link motivations and outcomes can mean that participation becomes unfulfilling for volunteers, as their desires may not be achieved, lessening the likelihood of sustained engagement. If the satisfaction of volunteers is to be accurately understood, assessing the full scope of their motivations in conjunction with their desired outcomes is crucial. We address this research gap by conducting a survey ($n = 308$) with the participants of 8 marine community science projects in Ireland and the UK, critically assessing volunteers' roles, motivations, outcomes and experiences of participation through an exploratory factor analysis. We find a range of patterns amongst respondents and identify 4 types of volunteer profiles: *Activists*, *Conservationists*, *Professionals* and *Hobbyists*. We discuss how categorising volunteers in this manner can better reflect the motivations and desires of volunteers and highlight the factors that support or inhibit the realisation of these intentions within specific projects. We conclude by suggesting that projects seeking to better understand participation should broaden their evaluative scope to embrace a wider range of volunteer motivational pathways, discussing how this can improve both a project's management of volunteers and its capacity to realise both project and volunteer outcomes.

Key words

Citizen science, marine conservation, participation, volunteerism, knowledge, learning, community

1. Introduction

Community scienceⁱ, wherein members of the public work with professional scientists to produce scientific knowledge [1,2], has found increasing success in the realm of marine conservation [3-5]. The rise of community science has been framed as a response to the need for data on environmental changes [6,7], the limited scope of government monitoring programmes [8] and the desire for community participation in environmental management [9,10]. Community science has been advanced as a valuable and a cost-effective means of contributing to the evidence base that underpins marine policy [11], as well as providing management recommendations for decision-makers [12]. Community science projects are utilised as a means of gathering fine-scale data to improve knowledge and broaden the spatial and temporal scale of research [13]. Community science also creates participant outcomes amongst volunteers, which can include a sense of environmental and marine citizenship [14,15], enhanced scientific and environmental literacy [2] and better-informed engagement in decision-making processes [16]. Due to this, community science is advanced as a potential solution to governance concerns regarding the marginalisation and exploitation of local marine communities [17], and is well placed to respond to problems created by the top-down, exclusionary nature of many marine governance systems [18].

To fulfil its potential as a valuable tool for marine governance, community science projects need to foster active engagement by acknowledging and catering to volunteers' needs and motivations [19-21]. Participation processes that are tailored to suit volunteers' requirements are more likely to enhance recruitment, support good retention rates and ensure that the expectations of participants can be met [22,23]. High levels of retention can help volunteers to better understand their tasks or to broaden project engagement over time, potentially contributing to better outcomes for projects [7].

ⁱ Responding to growing concerns regarding the exclusionary nature of the phrase "citizen science", stemming from the fact that 'citizen' status is not a criterion for inclusion in participatory research activities, we utilise the term "community science" throughout this paper.

This has prompted studies to evaluate participation in community science by assessing two aspects of engagement: volunteer motivations, and the personal outcomes that they achieve through their participation. Assessment of participant motivation reveals why volunteers are driven to take part in projects and suggests what they want to achieve [24-26]. Evaluating personal outcomes focuses on the impact that participation has upon the skills, knowledge or perceptions of volunteers [27-29]. Although these two evaluative approaches have revealed important insights on participation in community science, they often fail to account for the relationship between motivations and how these shape the manner in which volunteers pursue their desired outcomes.

We reposition motivations and outcomes as implicitly related, interdependent concepts that require deeper analysis by interpreting them as a more complex set of attitudes, opinions and behaviours. Many assessments of participation in community science demonstrate limited recognition of how the obtained outcomes and experiences of volunteers may not be personally desired or aligned with their motivations. In such scenarios, as has been noted by wider research on active volunteerism [30,31], participation can be rendered unfulfilled. A failure to satisfy motivations and support volunteer needs impedes the likelihood of participants sustaining their engagement with community science and lessens their potential contribution [32,33]. Without examining motivations in relation to the desired outcomes of volunteers, evaluations can present misleading findings on the responsiveness of projects to the requirements and aspirations of their participants. This can misinform recommendations on the manner in which the intended contribution of volunteers can be maximised. Assessing volunteers' motivations in conjunction with their desired outcomes is, therefore, crucial if participation is to be accurately evaluated.

To operationalise such an approach, we conducted a survey of the participants of 8 marine community science projects across the UK and Ireland, questioning respondents about their roles, motivations, outcomes, and perceptions of participation. We utilised an exploratory factor analysis to identify

patterns amongst volunteers' responses and identified 4 profiles of marine community scientists: *Activists*, *Conservationists*, *Professionals* and *Hobbyists*. Each profile represents a grouping of participants that share similar characteristics and perceptions about their motivations for participating in community science and the outcomes that they want to achieve by volunteering. We outline how categorising volunteers in this manner more accurately reflects the factors that support or inhibit the realisation of their intentions. This leads us to suggest that community science projects should broaden their scope to embrace a wider range of volunteer motivation pathways, discussing how this can improve both a project's capacity to recruit and retain volunteers, as well as ensuring that projects realise both their outcomes and those desired by their volunteers.

In the following section, we outline our critique of the main evaluative paradigms in community science participation, clarifying how our approach can add to current approaches. We extend our discussion on the importance of identifying, measuring, and comparing the different factors that motivate volunteer participation and how these link to the realisation of participant outcomes. Our research design is then presented, including an overview of the survey instrument and data analysis procedures. The findings of our evaluations are then presented. Socio-demographic information on the survey participants is discussed, before the four extracted volunteer profiles are evaluated in detail. We then discuss how our typology reflects valuable insight on the dynamics of community science participation. We conclude by arguing for more in-depth evaluations of volunteers and present recommendations that highlight how a process of categorising community science volunteers can support efficient gains in recruitment, retention, and the collaborative generation of knowledge about the marine environment.

2. Participation in community science

Community science projects are dependent on the active engagement and collective drive of their volunteers [24]. To maximise volunteer contribution, projects must speak to the needs and concerns of their participants, with evaluative studies highlighting the importance of factoring such insights into projects [21,34-36]. Monitoring the experiences of volunteers, as well as assessing the extent and impact of their engagement, are crucial components of ensuring both high participant retention levels and the ability of community science projects to realise desired outcomes [25,37]. Most evaluations of participation in community science are conducted through two, predominantly independent, approaches. One approach involves examining the motivations that underpin volunteers' engagement and the other focuses on assessing the outcomes that volunteers obtain as a result of participating in community science projects. In community science literature, motivation has been advanced as a multi-faceted construct that describes the process of goal setting [38,39]. Assessments of participant motivations attempt to reveal the psychological factors that drive volunteers to engage with community science [26,40]. On the other hand, studies that assess volunteer outcomes examine participant experiences, their personal and learning developments, and concerns. The volunteer outcome approach examines the extent to which participation benefitted them personally, including, *inter alia*, how participation has increased the scientific and environmental knowledge of volunteers, as well as instilling environmental stewardship and feelings of empowerment [28,41].

Several approaches to categorising motivational factors have been traditionally used in the volunteering literature [42]. Pivotal studies on social participation demonstrate how motivations can be classified as either intrinsic or extrinsic [43]. Intrinsic motivations reflect desires to achieve personal gains, while extrinsic motivations are characterised by aspirations to develop outward impact. Batson et al. [44] expanded this two-pronged interpretation by suggesting that motivations can be more accurately reflected within 4 types: egoism (self-related personal goals), altruism (desires to help others), collectivism (supporting a collective group), and principlism (motivated by moral principles). Evaluations of participation in community science are largely seen to align with Batson's conceptual

model of motivational factors [38,45,46]. Although alternative frameworks have been put forward to classify the motivational factors of volunteers [42], evaluative studies [40] have highlighted how many cover similar categories or are inherently related to the categorisation put forward by Batson et al. [44]. Thus, we will lean upon these labels whilst reviewing the dominant volunteer motivations associated with community science participation. We will then revisit these motivational labels when evaluating our research findings.

Analysing volunteer motivations provides insight on what volunteers want to achieve through their participation, both regarding themselves and for others [21]. Motivations that are egoistical in nature often include intentions to develop personal knowledge and skillsets, to become more environmentally active, or to advance career prospects by gaining experience [24-26,36]. Studies have also revealed altruist motivations amongst volunteers, reflecting community science participants that have the extrinsic goal of benefiting wider society [25]. This can include volunteers who are driven to participate in community science projects attempting to tackle air and water pollution [47] or plastic litter deluges in marine environments [48], wherein participants engage with scientific endeavours that can inform conservation decision-making [49]. Community science volunteers can also be driven by ideas of being part of a collective movement that can develop the welfare of a specific group [9,10]. This can involve motivations to participate in projects that attempt to improve the environmental health of local ecosystems [13] or, more generally, as a means of socially engaging with others [26,38]. Others have noted how motivational drivers can relate to feelings of principism, presenting participation as form of self-expression [50]. Such motivations are associated with volunteers who are driven to uphold their personal principles, such as strong valuations of nature or personal identity with natural environments [46,51]. It is important to note that volunteers will not only be driven by one defined motivation. Rather, participants may be influenced by multiple motivational factors [40].

Evaluations have also attempted to understand participation in community science by evaluating the outcomes that volunteers obtain whilst engaging with projects. Outcomes reflect the extent or impact of participation [21,31]. Volunteer outcomes can be personal or social, depending on the context of participation. Personal outcomes include educational development, including environmental and scientific learning [27,52], and raising awareness or understanding of ecological systems [29]. Social outcomes can involve communal engagement with others [38] and the development of environmental stewardship [14]. Indeed, recent studies have revealed the capacity of marine projects to foster collective engagement with environmental issues, which can enhance the desire of volunteers to protect local environments [51]. Community science participation has also been seen to heighten social capital and community capacity [23,53]. This includes projects that have facilitated volunteers with a pathway to influence local council decision-making, developing the civic engagement of participants and their connection to local resources [49]. Such outcomes exemplify the potential transformative impact that participation can have upon volunteers' perceptions and actions regarding environmental conservation [27]. For instance, participation can transform the capacity of individuals to engage with civic processes and policy relevant activities, which, in turn, can instigate pro-environmental action beyond the boundaries of projects [16].

Whilst evaluations of volunteers' motivations and outcomes have generated crucial insights on the participation process, there are few studies [23,35] that critically assess the link between volunteers' motivations and their desired outcomes. The motivation-outcome nexus relates to multiple aspects of participation, not just attitudinal elements, but expectations, behaviours, and experiences. These aspects are implicitly related, interdependent concepts that require deeper analysis. We contend that many current approaches present an incomplete picture of community science participation that renders evaluations incapable of assessing the degree to which volunteers' outcomes are personally desired or in alignment with their motivations. The obtainment of outcomes that are undesired can adversely impact participants' levels of satisfaction and their willingness to extend engagement [20].

Consider a scenario, for example, where an evaluation records that a volunteer has enhanced their scientific skills as a result participation, yet fails to uncover that the volunteer did not realise their intended outcome of improving their social capital. By reporting on a restricted range of volunteer outcomes and not considering these in conjunction with motivational drivers, such an assessment presents a potentially misleading depiction of participation in community science [54].

It is necessary, therefore, to examine the various factors that motivate volunteer participation with consideration of the degree to which they link to the realisation of their desired outcomes. By doing so, it is possible to more accurately evaluate the factors that inhibit or support their engagement. We argue that the sustained participation of volunteers is influenced by the obtainment of outcomes that fulfil their motivations. Satisfied participants better understand their tasks, perform to a higher standard and are more likely to communicate positive messages to others, supporting the recruitment of new volunteers [23,35]. In a practical sense, measuring motivations in line with the desired outcomes of volunteers can function as a potential maintenance strategy for community science projects. Beyond this, it presents a more holistic examination of community science engagement that can enhance understanding of the experiences, concerns, and needs of volunteers.

3. Methodology

An online survey (see Appendix 1) was viewed as the most effective means of examining a large group of individuals and was circulated through 8 community science projects in the United Kingdom and Ireland: Seasearch's Diving Group, the Irish Whale and Dolphin Group's (IWDG) Ferry Survey, Ulster Wildlife's (UW) Sea Deep project, Keep Northern Ireland Beautiful's (KNIB) Marine Litter Survey, the Royal Society for the Protection of Birds' (RSPB) Beached Bird Survey, Cloughy and District Community Association's (CDCA) Beach Care Group, Coastwatch Ireland's (CI) Coastal Survey, and the British Trust for Ornithology's (BTO) Wetland Bird Survey (see Appendix 2 for an overview of these

projects). We decided to survey these 8 projects for two purposes. One, to allow the study to examine a range of organisationally divergent initiatives that examined issues relating to marine conservation. Two, to enhance the quantity of potential respondents. Projects were sourced through online searches and discussions with community science actors. The surveyed projects represented the main participation structures outlined in the community science literature [55], including: (i) contributory structures, wherein volunteers contribute data to projects designed by scientists; (ii) collaborative projects that are designed by scientists but with volunteers engaged with a range of tasks; and (iii) co-produced frameworks of participation, within which scientists and volunteers conduct project tasks together. We clarify the participation structure of each of the selected projects in Table 1 and relate back to this information in our findings. Coordinators of the projects sent a link to the survey via email to their volunteer base, with reminder emails sent after two and four weeks. The survey was active online for three months, between February and May 2019. In total, the survey was sent to 737 participants, with 308 volunteers responding. This gives a response rate of 41.7% (Table 1).

[INSERT TABLE 1 HERE]

The survey is comprised of four sections. The first section contains a set of closed statements regarding frequency, location, and degree of participation in community science. The subsequent section is comprised of a range of variable statements to elicit perceived motivations for participation, phrased as a list of statements to be ranked on a 5-level Likert scale ('Strongly agree' to 'Strongly disagree', with an additional sixth 'Not sure' option). The motivational model of Batson et al. [44] and the wider community science literature [24,34] were used to inform these statements. A further list of statements is then posed to assess the outcomes volunteers obtained through participation. The next section contains open-ended questions to capture any additional perceptions of community science. The final section is a list of both open and closed demographic questions. Many statements regarding volunteers' roles of participation and key motivations and outcomes were designed to mirror

questions found in previous studies [32,39,46]. Novel statements regarding the transformative scope of community science were also included to address gaps in the literature. Such statements queried if participation had led volunteers to change how they interpret, discuss, and act upon environmental issues.

Volunteer responses to the survey statements were extracted and assessed through an exploratory factor analysis. Factor analysis is a method of multivariate analysis that examines variable relationships within a specific context [56]. In this study, factor analysis was used to simplify our collected data and to both uncover and examine patterns of engagement amongst respondents. Although thematic analysis has been used in community science research to reveal interesting information on participation related issues [26,57,58], factor analysis is more aligned with our research objective of examining the interrelated bundle of causal ‘variables’ that volunteer motivations and outcomes form, and how these determine the level, type and effect of participation. Additionally, we recognised the capacity of factor analysis to account for a number of key issues related to our study. First, how the motivation-outcome nexus is not just attitudinal, but relates to expectations, behaviours and experiences that need to be unpacked in the measurement of a more complex set of variables. Second, the need to evaluate different participatory experiences in functional ways, hence why our questions aim to capture the importance of design, data collection and disseminating activities in relation to *each other*. Third, how to assess the complex and overlapping way in which variables come together, placing a weight on the contribution of each variable against other significant determinants of participation. An exploratory factor analysis deals with these complexities within a single analytical framework, not to provide a definitive answer but to reveal the multiple, complex and contradictory motivations, ethics, experiences and personal benefits of joining a particular set of marine community science initiatives.

Factor analysis encouraged the reduction of survey variables until a concise and comprehensible number of dimensions was established. This was achieved by eliminating the data associated survey statements (variables) that contained the lowest levels of explanatory power. This process was followed until we had narrowed down the variables to a range of 12 survey statements that revealed distinct associations between different groups of respondents. The 12 remaining statements covered questions on participation roles, motivations and outcomes. These variables were extracted to reveal underlying constructs of how participants perceive their engagement, what they seek to achieve and how their experiences have created personal impacts. Our factor analysis procedure then grouped together the volunteers who were conceptually similar in their responses to the chosen statements, creating 4 factors. The principal components method was applied with a varimax normalised rotation. Resultant principal factors were retained at an eigenvalue larger than 1.00, with the average variance extraction greater than 0.5. The factor scores and eigenvalues illustrate high internal consistency across items within each factor [59]. Pearson Chi-square tests were run to identify differences of significance between volunteer factors. We used the non-segmentation variables of the survey, such as demographics, to ensure that observed differences between the factors did not occur by chance [56]. To interpret the meaning of the factors, we assessed the structure matrix that shows the correlation between each statement and its factor (see Table 2). For ease of presentation, only the correlations $r > 0.3$ are shown, with correlations $r > 0.5$ in bold. Positive or negative correlation values indicate that the factor is more or less associated with the statement. In general, our study was standardised, repeatable, and representative of the current state of marine community science participation. All statistical analysis was performed in SPSS software. Prior to data collection, ethical approval for the study was granted by Queen's University Belfast, Faculty of Engineering and Physical Science's Ethics Committee (approval number EPS 18_79).

4. Results

Slightly more males (55.4%) than females (44%) responded to the survey. All respondents are above the age of 18, with the majority either aged between 35-44 (26.7%) or 45-54 (22.8%). A relatively high percentage of respondents (17.2%) noted that they are retired. Only 4.9% of respondents are aged between 18-24. The survey respondents are predominantly highly educated, with a total of 57.1% holding a university degree and 31.8% holding a higher degree (for example, Masters, PGCE, PhD). A strong majority (64.3%) stated that they are in full-time employment. Although the interests of our respondents are wide, their socio-demographic composition is limited. These findings are in line with other evaluations of the demographic status of community science volunteers [7,9]. Our findings are similar to Walajahi [60], who suggests that there is limited inclusion of lower-class, less educated or marginalised members of the public in community science projects.

Our factor analysis suggests that respondents are best represented by four factors. Cumulatively, these factors explain 59.5% of the variance within the data, which is a standard level of factor coverage [56,59]. We labelled the four factors that were extracted from the data as: (i) *Activists*; (ii) *Conservationists*; (iii) *Professionals*; and (iv) *Hobbyists*. Each factor represents a type of participant that shares similar profile in regards to their roles, motivations and desired outcomes. To sketch the profile of each factor, subsets of the participants with a high score (>0.6) in only one factor were selected as representatives of the corresponding factor. A discussion of how the 12 statements load in each factor, which illustrates the linear combination of items for each factor, is referenced within the text in parenthesis (s1, s2, s3 etc.). The overall load of each statement is given in Table 2. Quotes from the open survey questions are used to elicit the perspective underpinning each type of volunteer and to give context to their experiences. Quotes are taken from respondents with a high contribution (factor score >0.70) to the relevant factor. Table 3 synthesises the socio-demographic dynamics of the volunteers who belong to each of the 4 extracted factors.

[INSERT TABLE 2 HERE]

[INSERT TABLE 3 HERE]

Activists

The first factor, accounting for 27% of the variance, is labelled *Activists*. This type of participant engages with community science as an attempt to actively improve the quality of the marine environment by challenging environmental injustice and inequality. *Activists* desire to become more engaged with marine governance processes and feel fulfilment when their participation lobbies decision-makers or instigates management change. This interpretation of the factor stems from the participation roles that *Activists* tend to undertake. They have a stronger link to data dissemination tasks (s3) than those of collection or analysis, illustrating their desire to actively use community science knowledge as a means of supporting their movement. For *Activists*, this is advanced as a means of *“garnering public support and challenging marine management decisions”* (Female, 65+, retired) regarding specific marine-related concerns. For the surveyed participants, such concerns include tackling the impact of plastic pollution and the depletion of fragile ecosystems. Thus, participation is a continuous process and *“not an end in itself, but a means to one”* (Male, 65+, retired), as it is valued as a vehicle through which wider change can be instigated. As Table 3 illustrates, *Activists* are predominantly associated with collaborative and co-produced initiatives. This reflects their desire to operate beyond contributory roles, instead engaging with dissemination tasks, raising public awareness and utilising project knowledge as a means of calling for change.

The radical mentality of the *Activist* perspective derives from feelings of responsibility to play a part in ensuring the sustainable management of marine environments. As one *Activist* noted; *“I wanted to give something back to marine environment ... it can’t defend itself. Unless the government starts to make changes to their approach, we are in real trouble”* (Female, 35-44, teacher). There is a sense of urgency amongst *Activists*, stemming from their perception that not enough attention is paid to local

environmental issues (s9) and their belief that communities can actively instigate alternative government action (s10). Although *Activists* align with some egotistical motivations regarding knowledge development (s5), they are more prominently driven by altruistic desires to create external impact that can benefit the environment and wider society (s6, s7). This transitive relationship between learning and action is a distinguishing feature of the *Activist* typology. Educational advancement, specifically regarding the politics of the environment, is interpreted as a precursor to taking more active approaches to protecting the environment and raising the awareness of particular marine problems. These altruistic motivations link to *Activists'* desired outcomes of giving power to local knowledge (s8). *Activists* are emotionally driven to engage with community science, achieving satisfaction when “*challenging the status quo*” (Male, 55-64, senior lecturer).

Conservationists

Conservationists are participants who engage with community science to advance their interest in environmental conservation, to contribute towards ecological studies and to spend time engaging with nature. They account for 14% of the variance. *Conservationists* are deeply embedded in the practical workings of community science projects. They associate with a range of projects roles, with particularly strong links to data analysis (s2), distribution (s3) and project design tasks (s4). This diverse approach to participation relates to the egotistical desire of *Conservationists* to broaden their knowledge of environmental and scientific themes (s5). Respondents state how they “*enjoy varying the tasks on offer, as it means I always get to engage with new things that can make me a more rounded member*” (Female, 65+, retired). Additionally, *Conservationists* demonstrate how socially engaging with others is an important outcome of participation (s11), hence their desire to engage with different tasks. Volunteering with other like-minded participants is a crucial social outcome for *Conservationists*. *Conservationists* most commonly participate in collaborative initiatives, as illustrated in Table 3. This stems from their ability to conduct a range of participatory roles, not simply

contributory tasks, as well as their desire to use their experience and developed knowledge to educate others and support project organisation.

The responses of *Conservationists* suggest that community science participation is a passion and “an opportunity to get away from the stresses of daily life” (Female, 45-54, civil servant). Unlike *Activists*, they show limited association with motivations or outcomes relating to the politics of the environment. Instead, they are driven to participate in projects that offer the opportunity to practice skills and develop their environmental interests: “I am an old school environmentalist ... I get to spend time in places I love, meet new people and help others develop their skills. We aren’t changing the world, but we enjoy doing our bit” (Female, 65+, retired). We also find that *Conservationists* interpret their participation as “a long-term promise to protecting the environment” (Male, 65+, retired), enhancing both the time they spend supporting initiatives and the range of roles that they play.

Professionals

Professionals, accounting for 10% of the variance, are a type of volunteer whose participation is a means of developing or sustaining their professional interest in environmental practice. We break this type of volunteer into two separate elements, those who are motivated by career development and those that view community science as a way of utilising their skills post-retirement. *Professionals* who are driven to engage with projects as a way of assisting with career development view their participation as “a good opportunity to gain experience for running future projects, gaining contacts” (Male, 35-44, environmental warden), as well as a means of securing “crucial experience for my CV” (Male, 18-24, student). *Professionals* who are motivated to engage with community science as an opportunity to continue professional work post-retirement interpret their engagement with projects as a chance to “reengage rusty skills” (Female, 65+, retired) or to participate in projects “where my professional experience is useful” (Female, 65+, retired).

Regarding the practical role of *Professionals*, they most closely associate with data collection (s1) and project design tasks (s4). This is related to their motivation to practice ecological monitoring and measuring responsibilities that can maintain or enhance their knowledge and skillsets. For example, some *Professionals* discuss how they carry out tasks that can develop their “*knowledge of another wildlife survey technique*” (Female, 25-34, research assistant), while retired *Professionals* state that their community science duties are “*similar to what I would do anyway, but with a structured purpose and in an environment where I can help others*” (Male, 65+, retired). The desired outcomes of socially engaging with others during participation (s11) and broadening the public awareness of conservation (s12) are important for *Professionals*. Thus, participation is valued as a means of gaining contacts and enhancing social capital, as well as an opportunity to “*make people aware of issues affecting our marine life*” (Male, 65+). Community science is a personally relevant practice for *Professionals*, who are motivated by their environmental principles to participate in projects as a way of fulfilling their ecological interests. We find that respondents associated with the *Professional* profile are common in both contributory and collaborative projects (Table 3). Contributory projects offer *Professionals* the opportunity to focus on conducting entry level tasks, which can enable them to make use of their existent skills, develop their capabilities and engage with others. We suggest that this profile of volunteer is also prevalent in collaborative initiatives as projects of this nature provide scope for retired *Professionals* to educate others and to play a role in guiding the design of project operations.

Hobbyists

Hobbyists account for 8% of the variance. They are volunteers who informally engage with maritime activities that bring them pleasure and advance community science as a way of giving meaning to their hobbies. Our survey findings illustrate how respondents’ hobbies include angling (onshore and offshore), diving, bird and wildlife spotting, beach walking and wildlife photography. Community science provides a platform for *Hobbyists* to practice their pastimes in a structured, scientific environment. Thus, *Hobbyists* most strongly associate with data collection tasks (s1), as their hobbies

are practical activities. They specialise their engagement by exclusively carrying out tasks that they are already experienced in. A key feature of this type of volunteer is their motivation to give additional value to their hobbies, choosing to participate in projects that represent a “*a good fit*” (Female, 65+, retired) for their interests. For example, *Hobbyists* note how community science has “*taken my diving from a recreational activity to something that has a knowledge output and can help conservation matters*” (Male, 35-44, financial advisor). Table 3 demonstrates how *Hobbyists* are highly prevalent in contributory projects, where their engagement is unlikely to develop beyond data collection tasks.

For *Hobbyists*, scientific output is important, as it takes their hobby beyond a recreational level. Their satisfaction stems from feelings of pride, particularly as hobbies are activities of significant personal value. “*Seeing my name attached to research reports and knowing that my cetacean records have been of use for scientific matters is a great feeling*” (Male, 35-44, teacher). *Hobbyists*, therefore, gain personal satisfaction by contributing to scientific knowledge. We also find that *Hobbyists* negatively associate with the outcome of socially engaging or collaborating with others (s11). Interaction with other volunteers is interpreted as an indirect outcome of participation. They discuss how they feel “*in a world of my own when diving*” (Female, 35-44, local councillor) and are motivated to “*practice recording and monitoring skills in new surroundings ... separate from others but in a managed environment*” (Male, 25-34, civil servant).

5. Discussion

This paper has critically reviewed evaluative procedures in community science research, problematising a tendency to exclusively focus on either volunteer motivations or outcomes, and illustrating the need to assess a wider scope of the participation process. The findings of our study reveal the prominent types of individuals who engage with marine community science projects, highlighting a diverse range of participation pathways amongst respondents. These pathways are

associated with different learning and social outcomes, with volunteers desiring to achieve outcomes that are aligned with their motivations and perceptions. In the case of *Conservationists* and *Hobbyists*, these can include egotistical drivers to spend time with nature, expand personal knowledge and skillsets, contribute to scientific knowledge, and attain recognition for conservation actions. We find that *Professionals* are motivated to participate as a means of upholding their environmental principles. These volunteers also reflect collective motivations to engage with others, which is perceived as a valuable means of developing both knowledge and experience that can support career advancement. Altruistic desires to instigate wider change and to become more politically engaged are revealed as being central to the participation of *Activists*. Whilst our findings on the motivational drivers of surveyed volunteers are largely reflective of studies on volunteerism, our assessment of how these are linked to specific perceptions and outcomes of participation reveal valuable insight that adds to current thought.

We expand beyond the motivational labels of Batson et al. [44], demonstrating the value of assessing both what motivates volunteer engagement and what outcomes are required to satisfy their participation. This supports the creation of volunteer profiles that can shed light on the factors that support or inhibit the realisation of participation intentions within specific projects. It also reveals useful information on the diverse perceptions of volunteers and how these are related to specific interpretations on the value and role of community science. For instance, we find that some volunteers (*Activists*) perceive community science as a mechanism of challenging marine conservation decision-making, yet others (*Conservationists, Hobbyists*) interpret projects as means of self-expression. These findings illustrate the multi-dimensional nature of participation and such insights exemplify how a wider scope of participation can be uncovered. We recommend that this style of evaluation should be followed by marine community science coordinators, so that their projects can explicitly highlight the significance of an individual's contribution and better understand that multiple

participation pathways exist. This can help projects create engagement structures that can more efficiently mobilise volunteers by responding to their needs and requirements. As community science resources can be limited [7], projects must be designed with the intention of getting the most out of participants. Our methodology illustrates the value of examining several elements of participation simultaneously and we argue that such an approach to evaluating the capacity of volunteers can help projects to better realise their outcomes. Evaluating participation in this way can also help egalitarianism in community science participation by ensuring that different types of volunteers are supported based upon their individual motivations and desires. As community science continues to grow, engaging more diverse citizenries will be crucial if projects are to tackle concerns regarding exclusive recruitment tendencies [60].

By focusing on the complex composition of participant cohorts, the analysis also highlights the nature of the 'science' that each group is engaged with as active producers of knowledge. For *Professionals* and *Hobbyists* the depth of research is not the primary issue, yet for *Activists* and *Conservationists* it clearly is. For these two groups there is a need to move beyond 'science' as a technical project to value the *type* of knowledge that is being produced, its epistemological basis and how it is ultimately used. For *Conservationists* it is primarily about what Rydin [61] calls 'outcome knowledge' that is most important. The emphasis is on empirical accounts of particular environmental conditions. Data that does not serve that purpose or initiatives that fail to engage this particular epistemological preference, are not likely to attract or retain *effective* participants of this persuasion. *Activists* differ slightly, valuing the capacity of community science to create 'actionable knowledge'. This is knowledge that connects heterogeneous elements (social, political, environmental) in an attempt to expand existing modes of knowing and to inform future action [62]. For *Activists* the focus is on practice as a form of self-organization that is fluid, dynamic and emergent. This is not to value one type of volunteer over another, only to show that projects need to pay attention to the alignment between a potential participant and the nature of knowledge they are most interested in. Whilst the emphasis has

traditionally focused on the attributes of the volunteer, there needs to be a better understanding of how they relate to different categories of knowledge, in and of themselves.

6. Conclusions

Understanding participants' motivations in conjunction with their outcomes and broader perceptions can help project organisers decide the most appropriate approach to maximising participation. There is a 'fine line' between supporting and taking advantage of volunteers [31]. It is important not to disregard this and risk losing vital contribution by relying upon volunteer enthusiasm. We suggest that a clearer evaluation of volunteers' participation can assist how projects manage this fine line. Volunteers carry specific values, perceptions, and skills regarding marine conservation. These must be decoded by community science coordinators and should shape the design and scope of projects when possible. Satisfying volunteers' desires directly supports both recruitment and retention. The success and long-term sustainability of a project, therefore, will be dependent upon the degree to which projects are aligned with the motivations and requirements of volunteers. Although we find well defined forms of volunteers, we acknowledge that measuring the development of motivations as participation deepens is a factor that we did not examine. This is seen to be an increasingly important aspect of volunteer engagement [35,46] and we suggest that this is incorporated into future evaluations. Research has shown that community science has a strong potential to effectively contribute to marine policy and advance public participation in governance. This can only be achieved, however, if projects speak to the needs of volunteers and facilitate active participation processes. We argue that community science projects that enable volunteers to pursue their interests and feel like they are making a difference, are more likely to remain successful in the long-term.

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