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Exploring the transformative potential of citizen science in marine governance processes

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EXPLORING THE TRANSFORMATIVE POTENTIAL OF CITIZEN SCIENCE IN MARINE GOVERNANCE PROCESSES

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Abstract

This study takes a critical approach to examining the participatory research practice of citizen science, examining the potential that it has to transform two key challenges facing regimes of marine governance: (i) knowledge rationalisation and (ii) the marginalisation of local communities. Citizen science stands apart from other participatory approaches to research due to its ability to actively engage volunteers in the generation of scientific knowledge, to instil learning outcomes within them and to encourage their heightened participation in civic processes. Although participatory research is far from a new process of producing environmental knowledge, with research by volunteers having been carried out in numerous fields for centuries, key social and transformative aspects of citizen science remain relatively under examined. Indeed, this study's literature review highlights how transformation - a fundamental form of change that instigates a significant reordering and challenges existing structures - is misunderstood in current citizen science research. Mainly, this is due to a lack of theoretically-informed studies on the relationship between power and knowledge, two crucial elements of any transformative process.

To develop a better comprehension of how transformation can occur within the realm of citizen science, and to reveal the barriers and challenges that can prevent transformative outcomes from occurring, this study develops a conceptual framework based upon Michel Foucault's theory of power/knowledge. This concept discusses how power and knowledge are inherently linked to one another, illustrating how any study on social relations that ignores the workings of power and knowledge can only be interpreted as an abstraction of reality. Foucauldian thinking also outlines how power, which should be interpreted in both productive and regressive manners, is not a zero-sum game. Power can be challenged and, through such contestation, arrangements of power can be transformed and new realities can develop. Learning from the employment of the power/knowledge concept in other fields of research, as well responding to limitations of the theory, this study creates a Foucauldian-informed framework for analysing the transformative potential of citizen science in marine governance processes. To achieve this, two key examinations were conducted. First, assessing the organisational dynamics of projects, exploring the relationship between practitioners and governance actors, and evaluating the manner in which knowledge is produced, used and has impact. This was achieved by carrying out semi-structured interviews with a range of key citizen science actors. Second, by critically examining the

participation processes that projects facilitate and considering how the barriers that prevent volunteer input from being maximised can be challenged. This was realised by way of conducting an online survey with the volunteers of several citizen science projects.

Whilst analysing the organisational and political elements of how citizen science projects function, this research uncovered how uneven balances of power between practitioners and governance actors are embedded within projects. These unequal arrangements are seen to enable governance actors to overpower practitioners and to influence both the evolution and potential output of projects. The findings of this study illustrate how particular measures are used by governance actors, including the setting of project objectives, employment of strict regulations and standards, and short funding timeframes, to shape the manner in which projects develop and to guide them toward specific, pre-determined ends that align with policy problems. As a consequence of these restrictive measures, which are revealed as being an attempt to professionalise citizen science, the scope of what projects can achieve and their capacity to instigate transformative change is significantly narrowed. This is made clear when assessing both the knowledge that projects can produce and the structure of participation processes. In regard to knowledge, citizen science projects are seen to be pushed toward producing knowledge that aligns with policy problems, with projects operating in line with a range of predetermined objectives set by governance actors. This commonly leads projects to generate knowledge for 'understanding', in other words, knowledge that can strengthen the *status quo* of marine governance. In relation to the participation process of citizen science projects, the engagement of volunteers is revealed as being carefully regulated with projects often unresponsive, or prevented from reacting, to the needs and requirements of volunteers. Aspects such as the motivations, desired outcomes and nature of knowledge that volunteers are most interested in, are revealed as being key factors for the engagement of volunteers, although it is evident that these are not consistently responded to.

Decoding the collected information, this study puts forward a range of practical and theoretical recommendations that suggest how citizen science, by being (re)politicised, moving beyond one-dimensional flows of knowledge production, supporting a broader range of participation pathways and facilitating learning amongst all actors in the field, can strengthen its capacity to act as a solution to the issues of knowledge rationalisation and the marginalisation of local communities, that commonly underpin marine governance

processes. It is clear that citizen science, due to the active form of participation that it facilitates, has a strong transformative potential. This potential is, however, constrained by regressive power/knowledge arrangements. Learning from an examination of these arrangements, this study argues that it is possible to challenge them and to instigate change to how citizen science operates within marine governance processes. By becoming power-aware and conscious of the barriers to transformation that exist, citizen science projects can develop new approaches and grow to be more efficient and effective in their attempt to actively tackle governance problems.

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Abbreviations

BTO – British Trust for Ornithology

CDCA – Cloughey and District Community Association

CI – Coastwatch Ireland

DAERA – Department for Agriculture, Environment and Rural Affairs

EBM – Ecosystem Based Management

EEZ – European Economic Zone

EU – European Union

GES – Good Environmental Status

HLF – Heritage Lottery Fund

ICMZ – Integrated Coastal Management Zone

IWDG – Irish Whale and Dolphin Group

KNIB – Keep Northern Ireland Beautiful

MCZ – Marine Conservation Zone

MPA – Marine Protected Area

MSP – Marine Spatial Planning

NGO – Non Governmental Organisation

NIEA – Northern Ireland Environment Agency

NRM – Natural Resource Management

RSPB – Royal Society for the Protection of Birds

SAC – Special Area of Conservation

UK – United Kingdom

UN – United Nations

UW – Ulster Wildlife

1

INTRODUCTION

1.1 Background and research aim

Collectively, we are facing a global environmental challenge that stretches across regions, borders and cultures. To avert from catastrophic global warming and widespread ecological collapse, there is an urgent need to stabilize our damaged climate and to support the active conservation of the natural environment. The oceans are a fundamental part of climate regulation and they have particular ecological, economic and social importance for humans (Gee, 2019). This has been reflected in the increasing push for active marine management approaches that prioritize the sustainability of the oceans, whilst ensuring strong engagement with local communities (Curtin and Prellezo, 2010; Sievanen et al., 2013). To be effective, the management of the marine environment requires a range of institutional bodies and policies that are based on the principles of deliberation, transparency, consensus-building and participation (Douvere, 2008). There are widescale concerns, however, that many management efforts are falling short in their attempts to embed these principles in their systems of governance, meaning that the long-term sustainable development of marine environments remains in danger (Jones et al., 2016; Smith and Jentoft, 2017).

Evidence suggests that regional ocean areas continue to face a wide range of anthropogenic threats; from overfishing and pollution, to ocean acidification, loss of marine biodiversity, resource extraction and accelerating climate change (Crain et al., 2009; Gelcich et al., 2014). There is an evident need, therefore, to instigate change to governance processes and to create more responsive, collective and long-term approaches for sustainable marine management. We have reached a stage whereby, should the future of humanity and nature be secured, collective action must be drastically enhanced. The United Nations' (UN) 'Decade of Ocean Science for Sustainable Development', widely known as the UN Ocean Decade, was initiated in 2021 and is advanced as a concerted effort to ensure ocean sustainability into the future. Key to the initiative is collaborative action across sectors, disciplines, nations, communities, and generations. Its success is dependent upon the inclusion of a diverse array of voices that can design and execute the inclusive ocean knowledge that is needed for long-term sustainability.

This social scientific thesis examines the manner in which participatory research, and in particular the practice of citizen science[1], can contribute to the task of instigating change to marine governance processes by engaging environmentally interested citizens in scientific processes. Citizen science offers volunteers opportunities to learn more about their natural and ecological surroundings, as well as supporting the potential to empower local knowledge and enable heightened civic participation in policy-relevant processes (Bonney et al. 2009a; Turrini et al., 2018). Although participation, and indeed the utilisation of participatory research, are long standing principles of marine governance regimes, a multitude of participatory strategies have been revealed as being overwhelmingly top-down and exclusive (Flannery et al., 2018). In fact, studies have argued that the use of participatory research in governance processes is commonly defined by an information or knowledge-deficit approach to solving environmental problems (Gaventa and Cornwall, 2001). In such scenarios, participation is utilised as a means of responding to specific policy concerns and, consequently, is regularly incapable of doing more than reinforcing the existing approach of management (Khanlou and Peter, 2005).

The approach of citizen science represents a more active form of participation at the grassroots and local community level. Citizen science, due to the participation processes that are facilitated and the manner in which projects actively produce policy relevant data, presents a more empowering means of using volunteers to contribute to social justice, better democracy and more sustainable solutions (Ferreira et al., 2021). Importantly, studies have revealed how citizen science, by facilitating commitment amongst groups of engaged citizens into subjects relevant to marine conservation, can facilitate environmental monitoring and research in a diverse number of ways. Projects can build trust between volunteers, practitioners and governance actors, as well as creating opportunities for outreach, education, stewardship and mutual understanding (McAteer et al., 2021). This provides the context for higher levels of citizenship and democracy building that are needed should truly

[1] This study acknowledges 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. However, the term citizen science is used throughout this thesis for two reasons. First, it represents the most predominantly used phrase for current participatory research initiatives, as well as being the field of academic literature that this research critically investigates and seeks to instigate change to. Second, the initiatives examined by this study are defined as citizen science by the practitioners, coordinators and volunteers, that are associated with them. Nevertheless, effort is made to ensure that the analysis and discussion of this study is relevant to those scholars and practitioners that make use of the label community science, as well as those in the broader fields of co-production and participatory research.

participatory approaches to tackling the problems associated with the marine environment be adequately tackled. By collecting local knowledge and harnessing community action, citizen science can help to develop a better understanding of the marine environment and, in turn, function in a transformative manner to improve the management and regulation of these crucial ecosystems.

In this study, 'transformation' is defined as a fundamental form of change that is greater than progressive or incremental shifts. Transformation is described as a significant reordering, one that challenges existing structures to produce something fundamentally different (Blythe et al., 2018; Geels et al. 2017). The idea of transformation has contributed to an emerging body of research and practice that explores how things can be done fundamentally differently, fostering systemic reform, and establishing genuinely alternative futures (Kates et al. 2012; O'Brien 2013; Westley et al. 2013). The momentum building around the possibility for paradigm shifts at multiple levels, and the manner in which these shifts are imagined and supported, creates an interesting opportunity for social scientists to contribute towards more sustainable and equitable trajectories (Hulme 2015; Inderberg et al. 2014). Focusing specifically on marine governance transformation, scholars have outlined how change is dependent upon paradigm shifts within existing structures of governance (Olsson et al., 2014). Discussing how to prepare for transformative change, Blythe et al. (2020: 261) state the importance of "the identification of a governance related challenge, growing social support for governance change and the communication of compelling narratives". Yet while deliberate transformation may be necessary in many contemporary contexts, essential elements of the nascent field remain underexplored and warrant critical attention (Brown et al. 2013). Citizen science has the potential to facilitate many of the required conditions for marine governance transformation to be instigated, specifically because of the active participation that it supports and the diverse range of knowledge that it can produce, yet there remains a need to comprehensively explore this capacity.

The aim of this study, quite simply, is to explore the full potential that citizen science has to contribute to the active conservation of the marine environment. It is the intention of this thesis to present crucial and important information on the way in which citizen science, through the knowledge that it produces and action it supports, can function as a means of transforming the current limitations and failures of marine governance processes. By moving beyond existing research on citizen science, particularly that which assumes only one-

dimensional flows of knowledge within and beyond projects, this thesis will present the findings of a critically and conceptually-informed study that examines the politics of citizen science. Currently, there is an under-appreciation within the citizen science literature of how transformative change must involve actions that challenge dominant power relations. In response, this study demonstrates how a more explicit interpretation of the relationship between power and knowledge is required. By assessing how flows and arrangements of power influence the manner in which citizen science knowledge is produced, used and has impact upon governance decision-making, this research reveals the opportunities and challenges to creating truly transformative citizen science.

It is evident that achieving socially and environmentally just management in the marine realm will depend not only on the ability of social scientific research to reveal the limitations of governance processes, but to explore alternative options and to find solutions that can inform different pathways going forward. Indeed, it has been argued that social science, rather than attempting to emulating natural science, should function as a "practical, intellectual activity aimed at clarifying the problems, risks, and possibilities we face as humans and societies, and at contributing to social and political praxis" (Flyvbjerg, 2001, p. 4). In other words, social science should seek to inform practical reason, which Flyvbjerg (2001) asserts is only possible when focusing on values and power. This thesis, therefore, endeavours to critically assess how citizen science can operate as a practical solution to the problems facing marine governance processes by following a power-aware research design. This study will demonstrate this case, with learning lessons representing both theoretical and practical advancements of knowledge for the fields of participatory research and marine governance. Although this research focuses its investigation on the operation of citizen science with specific regard to the coastal nation of Northern Ireland, as will be explained and justified, the findings and progressive recommendations are applicable to a much wider scope.

1.2 Conceptual framework

The research design and objectives of this study are informed by a conceptual framework that is built upon a discussion of the theory of power. In particular, an examination of the relationship between power and knowledge forms the core of this framework. Power and

knowledge are the central means through which decision-making regimes are shaped (Flyvbjerg, 1998). Therefore, any assessment of how citizen science can instigate transformative change to governance decision-making requires a sound conceptual basis to both develop from and relate back to. Drawing specifically on participatory and deliberative governance literatures, this study positions power as a key factor in the shaping of citizen science processes and outcomes, arguing that the transformation of knowledge must be understood in terms of how it is shaped by and produces power. This argument is built upon the premise that power and knowledge are co-constitutive, hence the terminology of power/knowledge introduced by French philosopher Michel Foucault, meaning that they are inextricably linked to each other and cannot exist independently (Foucault, 1980). Power/knowledge relations are seen to define what is important and what is possible in the realm of action, supporting particular developments while suppressing others (Sheridan, 1977).

Although studies have begun to critically analyse the role of power in the realm of knowledge co-production, revealing crucial insights about transformation barriers that participatory interventions can encounter and how they can paradoxically reinforce dominant structures (see Turnhout et al., 2010; Lemos et al., 2018; Oliver et al., 2019), power remains a relatively underexplored topic in citizen science literature. To correct for this limitation, this study employs the Foucauldian concept of power/knowledge to inform its investigation and analysis of marine citizen science. Following a critical review of literature, this study contends that the participatory research approach of citizen science, if it is to function in a transformative manner and instigate change to how local knowledge is integrated into governance processes, must acknowledge the array of power relations that define which knowledge is important and how it is used in the realm of marine governance. It is important to note that, central to the concept of power/knowledge, is the appreciation that power is not a zero-sum game. Power can be challenged, resisted and changed by developing other power/knowledge relations (Foucault, 1980). Power/knowledge arrangements can, therefore, both limit and enable action. By being conscious of the duality of power/knowledge, this research attempts to develop a greater capacity to understand how and why attempts to instigate transformation fail, and how such barriers can be overcome. When operating in a power-aware manner, citizen science can become increasingly capable of realising its potential to transform regimes of marine governance into more democratic

and transparent processes, that facilitate knowledge contestation and alternative pathways of knowing (Serrano et al., 2014).

Furthering calls for co-production processes to become '(re)politicized' (Turnhout et al., 2020), this study establishes a conceptual framework that embeds power analysis into its design structure. This thesis, whilst reviewing current literature, illustrates how citizen science research, when blind to the avenues through which power operates, risks reinforcing existing relations that have been seen to limit the ability of participatory research to successfully contribute to societal transformation and to enhance the influence that citizens have over governance processes (Lemos et al., 2018). The imperativeness of responding to these concerns is clear and this study, when discussing its findings, demonstrates how such challenges can be overcome. *Chapter 3* presents the full conceptual framework of this study in detail. A critical review of the power/knowledge concept is offered, with limitations to the theory noted and responded to. Insight on the manner in which power/knowledge has been used in other realms of research, including the fields of political science and environmental management, is presented, before a critical discussion on the applicability of the theory for citizen science research is shared. This conceptual framework is deeply embedded within this research and shapes multiple aspects of how the study has been conducted. In the latter chapters of this thesis, research findings are related back to the key conceptual points raised in *Chapter 3*. This ensures that findings have conceptual value and robustness, as well as enhancing the capacity of this study's conclusions to inform both theoretical and practical recommendations on the future of citizen science.

1.3 Context and research design

The examinations of this study were, primarily, conducted within the context of the coastal European nation of Northern Ireland. As *Chapter 4*, the methodology and research design chapter of this thesis, explains, some analysis of citizen science in the United Kingdom (UK) and Republic of Ireland was also conducted. As well as being the geographical location of the institution from where this research is based, Northern Ireland offers a compelling context to investigate the current standing and potential future of marine citizen science. Citizen science in Northern Ireland is well established, with a multitude of projects operating across both terrestrial and marine environments. Indeed, the island of Ireland has a strong history

of engaging members of the public with scientific programmes and the expanding number of citizen science initiatives in Northern Ireland is in keeping with developments seen in other European countries (Roche et al., 2021).

In Northern Ireland, despite the existence of several independent and governmental data-gathering initiatives, the information required to inform good decision-making is currently lacking and is not readily accessible (Cooper and Jackson, 2018). This has encouraged the notion that citizen science, which is capable of acting as a cost-effective means of surveying vast stretches of coastal and offshore areas, can play an important role in the future governance of Northern Ireland's marine environment. Whilst the majority of current projects are locally coordinated by Non-Governmental Organisations (NGOs), there are several emerging examples of national initiatives that are funded and co-produced by government departments. This shift from local to national citizen science, and the sudden commitment of government to become engaged with projects, is an interesting and potentially significant development. Whilst it may signal a strengthened link between initiatives and policy circles, it may also reveal other issues of importance and highlight differences of opinion in relation to the role and value of citizen science. Thus, Northern Ireland has been identified as a significantly relevant and appealing context to analyse.

To effectively examine citizen science in Northern Ireland, and to reveal insight on the transformative potential of initiatives, this study has created a research design that has been informed by the theory of power/knowledge. To operationalise this design, two key examinations were conducted. First, an assessment of the organisational dynamics of projects, exploring the relationship between practitioners and governance actors, and evaluating the manner in which knowledge is produced, used and has impact. This was achieved by carrying out 29 semi-structured interviews with a range of key citizen science actors, including practitioners (project coordinators and managers, NGO officers) and governance actors (funding commissioners, government managers, planning officers). Second, by critically examining the participation processes that projects facilitate and considering how the barriers that prevent volunteer input from being maximised can be challenged. This was realised by way of conducting an online survey with the volunteers of several citizen science projects in Northern Ireland, some of which overlapped with UK and Irish initiatives. In total, 8 marine projects were selected to be surveyed, with 308 respondents returning completed surveys. A range of data analysis procedures were then

followed to decode the research findings, with key themes and points of interest flagged and examined further. Although these findings are contextually related to citizen science in Northern Ireland, they represent information that is applicable on a universal level.

1.4 Research objectives

This study critically reviews the field of marine governance processes, problematising specific limitations relating to the rationalisation of knowledge and the marginalisation of local communities. Citizen science is advanced as a potential solution to these problems and, by creating a research design that is conceptually-informed by the theory of power/knowledge, this study establishes the aim of exploring the opportunities and barriers to the transformative potential of citizen science being realised. It is in this context that the leading research objectives for this research have been developed. They are listed as follows:

1. **Review the field on marine governance**
    a. To understand how literature discusses the evolution of marine governance processes;
    b. to consider the major limitations of current approaches;
    c. and to assess how potential solutions can correct for these.

2. **Assess the academic framing of citizen science**
    a. To comprehend current conceptualisations of citizen science;
    b. to identify gaps of knowledge within the field;
    c. and to critically assess how transformation is interpreted.

3. **Analyse the organisational dynamics of citizen science projects**
    a. To reveal the politics of citizen science;
    b. to learn how projects are rationalised and used by marine governance actors;
    c. and to explore how the scope, evolution and outputs of projects are shaped.

4. **Evaluate knowledge use and production in citizen science**
    a. To understand the types of knowledge(s) that projects produce;

b. to assess where knowledge goes to and how it has impact;
c. and to learn how it relates to arrangements of power.

5. **Assess the participation process of citizen science**
    a. To reveal what the key motivations, outcomes and perceptions of volunteers regarding participation are;
    b. to establish what types of volunteers participate;
    c. and to learn how their contribution can be maximised.

6. **Consider how the transformative potential of citizen science can be realised**
    a. To reveal the factors that inhibit and support transformative citizen science;
    b. and to learn how projects can follow alternative pathways of evolution.

Each of these objectives are responded to in different chapters throughout this thesis. The response to research objective one and two, regarding a literature review of marine governance and citizen science, is presented in *Chapter 2*. *Chapter 5* presents research findings that answer research objectives 3 and 4, with the results of semi-structured interviews with citizen science actors revealing crucial insight on the organisational dynamics and knowledge production capacities of projects. Research objective 5 is responded to in both *Chapter 6* and *Chapter 7*. The former chapter presents insight on the motivations, outcomes and perceptions of volunteers, whilst the latter illustrates the different profiles of volunteer that exist and how the analysis of participation pathways reveals important information on how volunteer contribution can be maximised. Finally, research objective 6 is responded to in *Chapter 8* of this thesis. This discussion chapter brings the cumulative research findings together to consider what they tell us about the opportunities and barriers to transformative citizen science.

1.5 Structure of thesis

The structure of this thesis can be divided in three sections. Part one, encompassing chapters 1-4, outlines the context of research. Part two, incorporating chapters 5-7, presents the

analysed research findings. Part three, covering chapters 8 and 9, illustrates the interpretations and conclusions of the study. *Chapter 1* has introduced the research, providing insight on the context of the study and discussing the research aim and objectives. A review of literature is presented in *Chapter 2*, where the topics of marine governance and citizen science are critically assessed and problematised. Limitations of current literature are revealed and it is outlined how this study will attempt to correct for these. The conceptual framework that underpins this study is presented in *Chapter 3*. This chapter introduces the Foucauldian theory of power/knowledge, discussing how it has been used in other fields of research and justifying why it represents a useful means of conceptually informing this study's exploration of the transformative potential of citizen science. *Chapter 4* outlines the methodology and research design of this study, discussing the data collection and analysis procedures that were followed. This chapter rationalises the two methodological instruments that were used for data collection, semi-structured interviews and an online survey, and explains the value of the analytical processes that were employed.

The research findings are then presented, with *Chapter 5* demonstrating information regarding the organisational dynamics of citizen science projects and offering insight on the manner in which knowledge is produced, used and has impact. These findings, drawn from semi-structured interviews with key citizen science actors, provide evidence of the flows of power that operate within the field and explain how the transformative capacity of projects are shaped by specific power/knowledge arrangements. Following this, the findings of an online survey carried out with citizen science volunteers is presented. This information is split into two separate chapters. *Chapter 6* assesses the motivations, outcomes and perceptions of volunteers, whilst *Chapter 7* assesses profiles of volunteers and examines participation pathways. These chapters present crucial insight on the opportunities and barriers to maximising the contribution of volunteers, and explain why projects must create participation processes that are responsive to the needs and requirements of their participants. *Chapter 8* brings these findings together to discuss what they mean for the wider research aims of this study and for the gaps of knowledge that exist in current literature. The chapter highlights the additions to current thought that this study makes in relation to the politics of citizen science, the nature of citizen science knowledge and the importance of reframing how the transformative potential of projects is conceptualised. Learning lessons on how citizen science can enhance its effectiveness and capacity to act as a solution to marine governance problems are also presented.

Chapter 9 concludes the study and considers the impact of this research. This includes a discussion of how the research objectives of this study have been realised and what future research directions should be followed in the field of marine citizen science. Although this study responds to limitations of current research and investigates previously neglected aspects of citizen science, there remains a need to further examine a number of key areas relating to its transformative potential. By continuing to assess this topic, both citizen science theory and practice can learn how to overcome challenges and to create projects that can consistently support the sustainable governance of the marine environment. A full list of references used throughout this thesis is presented in the pages following *Chapter 9*, with a number of appendixes also attached. These include participant information sheets and consent forms that were shared with participants of this study, as well as a sample of an interview transcript and a copy of the online survey that was shared with citizen science volunteers. This study's notice of ethical approval is also attached.

2

REVIEW OF MARINE GOVERNANCE AND CITIZEN SCIENCE LITERATURE

2.1 Introduction

The role that the sea has played in the growth of the modern world-system cannot be understated. It has been inherently aligned to the development of human history. The oceans have provided food and commerce, given passage to exploration, inspired tradition, art and curiosity. Despite its apparent limitlessness, the ocean is not invulnerable, and much of our relationship with it has been built on exploitation (Robinson, 2021). Humans have been crafting their livelihood from the sea since well before any records began, yet studies in recent decades have begun to illustrate the toll that human action has taken on the waters (Crain et al., 2009). Assessing the aggregate impact of the multiple and diverse human threats currently facing the oceans, and finding solutions to them, is a challenging task that remains heavily dependent upon spatial analysis. A range of emerging and established conservation and spatial management initiatives that facilitate integrated, holistic or multisector approaches to marine management, hold significant promise for the sustainable future of marine systems (Potts et al., 2012). The general public's enhanced ecological understanding, added to their heightened awareness of the threats facing ocean environments and the desire of coastal communities to become actively engaged with conservation endeavours, render it a critical moment for advancing the implementation of management processes that can actively improve our stewardship of such crucial ecosystems. Many approaches have, however, been in operation for up to two decades now, with concerns persisting about the need to find new pathways to marine sustainability (Álvarez-Fernández et al., 2020; Ban et al., 2010; Kelly et al., 2019a).

This chapter presents a review of how the general topic of marine governance is discussed in current literature. This involves a consideration of the evolution of marine management approaches *(2.2)*, examples of how governance processes have supported sustainability within the oceans and how, according to scholars and practitioners, they have, in some scenarios, hindered progression toward truly inclusive, environmentally-focused sustainability. Key problematisations of existent marine governance models are made *(2.2.2)*, supported by an array of literature sources, with particular concerns raised regarding the tendency of governances processes to rationalise specific types of knowledge and to marginalise local communities *(2.2.3)*. These concerns are expanded upon in detail in the following sections, before space is given to acknowledge the growing range of calls for a radical reconfiguration of marine governance processes *(2.2.4)*. A critical turn in marine

governance research is noted, with a range of recommendations and potential future pathways toward ocean sustainability presented. The potential of participatory research efforts to act as one pathway forward, with the approach of citizen science advanced as a specific example worthy of investigation, is then explored.

An introduction to citizen science is provided in *section 2.3* of this chapter, with a critical review of literature informing an assessment of the current understanding and conceptualisation of the role, purpose and scope of citizen science *(2.3.1)*. Citizen science is then discussed with specific reference to its use within a marine context *(2.3.2)*, before a critique is made on the value of models of citizen science *(2.3.3)*. The transformative potential of citizen science is then examined *(2.3.4)*. This is a topic that has grown in prominence within literature in recent years and represents a vital component to assess when considering how citizen science can instigate change to marine governance. Current interpretations of what the transformative capacity of citizen science is are critically analysed. This involves an examination of how projects are said to be capable of realising their transformative potential and a consideration of what this could mean for future governance processes. Ultimately, this review reveals how the manner in which literature has conceptualised and assessed the transformative potential of citizen science remains limited. There is an under-appreciation of how transformational change must involve actions that can shift power balances, facilitate learning amongst all citizen science actors, and empower volunteers to be more than mere data collectors. *Section 2.4* of this chapter then concludes this literature review and suggests that a more explicit comprehension of power, and how it relates to knowledge, is required to fully understand the transformative capacity of citizen science in marine governance processes.

2.2 Marine governance

The link between societal development and the sea has been an issue of great conceptual interest. "Human relationships with the sea have been considered from angles as different as philosophy, geography, military studies, navigation and seafaring, natural sciences, political sciences, and social sciences" (Gee, 2019, p. 23). Broadly speaking, social scientific research on human-marine interactions has followed three distinct perspectives. One, viewing the sea as a provider of resources. Two, the sea as an arena for commercial

transportation. Three, the sea as a military battleground (Steinberg, 2001). More recent research has called for evaluations of the history of the uses, representations and regulations of the sea to be done through a territorial political economy lens. Central to this approach is the discipline of planning. A much more recent addition to the realm of the marine environment, planning has sought to develop administrative boundaries in the sea and, more generally, enable the sea to be subjected to political rationale (Collie et al., 2013; Flannery et al., 2019; Santos et al., 2019).

What is clear, is that the manner in which a government conceptualises the sea directly influences the way in which they plan for its management (Jay et al., 2012). There exists a major trade-off between approaches that understand the sea as a site of resources and economic potential, and those which view it as an assemblage of environmental ecosystems to be conserved and sustainably managed (Gee, 2019). In turn, a duality has developed between an environmental perspective and that of an industrial, exploitative viewpoint. Added to this, there are social, legal, political and cultural dynamics that operate within the realm of marine management (Pyć, 2019). This creates a complex arena of diverse interpretations regarding the manner in which marine sectors, and marine space more generally, should be governed. Accordingly, marine planning initiatives have been advanced by many coastal nations as practical means of implementing holistic regimes, which can rationally organise marine environments into governable spaces (Ehler and Douvere, 2009).

The movement toward marine planning has been understood as a 'spatial turn' in marine governance, whereby space, like in models of terrestrial planning, is managed through the zoning measures and the outlining of preferred geographical patterns of uses within a particular region (Gazzola and Onyango, 2018). This has resulted from, among other things, increased competition for space amongst maritime sectors (Jay, 2010). Marine planning initiatives have been advanced as a movement away from sectoral management approaches, so that marine space can be governed in a collective, homogenous manner. However, questions remain about the capacity of marine planning initiatives to democratically reform marine governance processes (Ritchie and Ellis, 2010; Flannery and Ó Cinnéide, 2012; Jones et al., 2016; Smith and Jentoft, 2017; Trouillet, 2020). There are growing concerns that marine planning is being implemented as a means of opening up new governable spaces to rationalise particular ways of governing; which benefits some sectors, while detrimentally hampering the capacity of others (Flannery et al., 2016). The aim of the following sections is

to explore these arguments further. By introducing and critically problematising models of marine planning, the current failings of marine governance regimes are clarified. Central to this is the manner in which knowledge is used, produced and rationalised within marine planning regimes. To conclude, this section will develop upon recent calls for a radical change in marine governance practice, before advancing an alternative future for the field.

2.2.1 Making marine space governable

Multiple and interacting anthropogenic drivers of change are continuing to influence the structure and function of marine ecosystems. At the same time, globalisation, weak governance and the increasing industrialisation of the seas is having a substantial impact on the sustainability of many types of marine resource (Neori et al., 2010; Bavinck, 2011). Added to this, the increasing demand for marine space amongst a growing list of activities and industries – aquaculture, fishing, shipping, energy, recreation – has resulted in conflict amongst stakeholders and lead to socio-spatial consequences (Flannery et al., 2016). The management of marine spaces, therefore, has become a major environmental planning priority for coastal nations (Halpern et al., 2008). Initial interest in rethinking maritime space and the need for it to be managed was, largely, born out of a realisation that our oceans are not relentlessly resilient (Steinberg, 1999).

Traditional marine management approaches focused on individual sectors, meaning that decision-making processes were often highly fragmented and contested, with rival discourses competing for legitimacy (Flannery et al., 2016). These pressures, aligned with the rapid degradation of marine ecosystems, have given rise to major challenges for the conservation and democratic governance of such environments (Merrie and Olsson, 2014). In response to these problems, a range of integrated management solutions have been promoted as potential solutions. These include a suite of ecosystem-focused approaches, such as Ecosystem-Based Management (EBM) and Marine Spatial Planning (MSP), which are premised as paradigmatically different approaches to problem solving in the realm of marine management (Kelly et al., 2018a). By promoting a holistic approach, whereby the needs and desires of marine sectors are managed in an integrated manner, these approaches have attempted to instigate change to marine governance processes (Buhl-Mortensen et al., 2017).

The importance of developing integrated models of governance have become even more important in the wake of the rapid rise of Blue Growth. Blue Growth is understood as a strategy, rationalised by many coastal nations across the globe, as a means of sustainably managing the growth and development of marine environments. It has quickly grown to become one of the most prominent discourses apparent within legislative marine policy and has been seen to significantly influence how systems of marine governance operate (Jentoft, 2017). However, rather than conceptualising it as a process which genuinely supports the sustainable use of marine space, scholars have discussed the discourse of Blue Growth as a process that centres around the notion of exploiting the monetary potential of marine spaces (Koundouri and Giannouli, 2015). More generally, it has been understood as a model of marine development in which oceans become frontier space for accumulation (Silver et al., 2015). Scholars have sought to conceptualise Blue Growth, as well the more general concept of the Blue Economy, as a "complex process of knowledge production, negotiation, and economy making that acknowledges a multiplicity of actors and activities, rearranging them to create new institutions" (Choi, 2017, p. 37). In turn, it has led to the production of new spatial rationalities, which have profoundly altered the way in which we perceive marine space. In particular, scholars have asserted that Blue Growth has assisted in the rationalising of governance processes which seek to achieve 'efficiency' and 'prosperity' (Choi, 2017). This closely links to the French philosopher Michel Foucault's characterisation of the economy; "managing people and resources so as to prosper" (Foucault, 1982, p. 782). Evidently, it is not the natural resources or attributes of the ocean that processes of Blue Growth change. Rather, it is the relations between the natural world and the economy which it alters (Koundouri and Giannouli, 2015).

Following a Blue Growth rationale, many coastal states have appeared increasingly eager to expand their Blue Economy via the promotion of 'sustainable industries' (Choi, 2017). This approach has been taken in an attempt to create stability between marine conservation and development (Winder and Le Heron, 2017). Examples of sustainable industries have been recognised in the realms of energy (Vergara et al., 2012) and tourism (Jonson, 2002). However, scholars have questioned the genuine sustainability of such approaches. It has been suggested that, in many cases, sustainable industries are nothing more than illusory discourses (Choi, 2017). Blue Growth rationalities have been seen to underpin the development of sustainable processes, meaning that economic expansion can continue to

overpower concerns regarding marine conservation (Winder and Le Heron, 2017). It is important to recognise how this example signifies a new process of governing, where coercive force is not necessary to instigate change.

As a result of the spread and growing influence of Blue Growth rationale, there is a lack of meaningful discussion regarding alternative functions of marine governance systems – environmental justice, coastal poverty alleviation, stakeholder engagement and participation (Flannery et al., 2016). Generally, governance regimes have become overwhelming fixated upon the rationale of viewing marine environments as spaces of market-led exploitation. This, in turn, has had an exceedingly detrimental impact upon the aspiration of creating a balance between development and conservation. "There are simply too many concerns, interests, and values involved to expect that Blue Growth will be the win-win ideal it is proposed as being" (Jones et al., 2016, p. 262). Blue Growth has facilitated the creation of decision-making systems where powerful actors can continue to influence the structure and development of governance regimes. As Flannery et al. (2016, p.122) argue, this is "obfuscating the real politics of development and the environment". It is crucial, therefore, to examine Blue Growth not solely as an economic project, but as a complex, governmental mechanism (Choi, 2017). In this light, we can begin to understand how relations of power are uncritically focusing on the construction of technical fixes for multifaceted socio-political concerns (Tafon, 2017).

2.2.2 Models of integrated marine governance

To gain a broader understanding of how processes of marine governance operate in reality, it is useful to examine integrated initiatives in detail and to examine their strengths and limitations. Integrated models of managements have been employed as core components of many contemporary marine governance regimes, rationalising new approaches to the management of marine space (Kelly et al., 2018a). They influence the manner in which knowledge is used and produced, consultation is conducted and general objectives are set and followed. The following section will begin with a review of the development and evolution of EBM, before a similar assessment of MSP is presented.

Ecosystem-based Management

EBM is understood as 'integrated' due to the fact that it considers the entirety of marine ecosystems, including the role of humans, in a collective manner (McLeod et al., 2005). Particularly in the European context, EBM has been outlined with the accompanying aim of achieving Good Environmental Status (GES). This is set up to be achieved through the carefully considered protection of maritime biodiversity (Buhl-Mortensen et al., 2017). Examples include the EU published Integrated Maritime Policy, the Habitats Directive and the Marine Strategy Framework Directive. When discussing the context and use of EBM, it is crucial to mention the aspect of place. Marine ecosystems exist in various different scales, ranging in location from the seafloor, to the water column and on the surface. Principally, in accordance with EBM, it is their biological and physical conditions that bind them together (Crowder and Norse, 2008). Added to this, a range of other factors – cultural, social, political, economic – interact with these 'biophysically' defined places (Crowder and Norse, 2008). To successfully employ EBM, therefore, it is crucial to follow processes which integrate understandings from both the social and natural sciences regarding the management of place at sea.

Whilst an increasing number of coastal nations have statutorily incorporated EBM approaches into their marine governance regimes, there is a lack of clarity regarding what this necessitates in both a theoretical and practical manner (de la Mare, 2005). This has created significant complexity and resulted in the implementation of a range of disparate EBM mechanisms. For instance, scholars have discussed how some nations appear to rationalise EBM approaches as a means of managing ecosystems, while others conceptualise it as a process of managing human activity which affects marine ecosystems (de la Mare, 2005). Kelly et al. (2018a), criticise EBM approaches for their lack of structural organisation. In turn, this deficit is limiting the capacity of EBM initiatives to contend with and sustainably manage complex and competing marine interests (Kelly et al., 2018a). Likewise, scholars have problematised how EBM approaches lack the knowledge datasets, as well as communication arrangements, necessary to legitimately alter the undemocratic aspects of current marine governance regimes (Leslie and McLeod, 2007; Marshak et al., 2016).

Ultimately, EBM approaches, in and of themselves, are unlikely to operationalise significant transformation to existent governance regimes, unless they engage with and bring about

broader institutional change. As Kelly et al. (2018a, p. 27) conclusively assert, "the development of shared visions and mental models at the political level is fundamental for successful implementation of EBM. This requires leadership and communication skills as well as social and behavioural changes". As EBM approaches are currently operationalised, there is little evidence to suggest that they are challenging the status quo of marine governance decision-making regimes. Instead, scholars continue to criticise EBM's supposed integrated approach, highlighting how it aligns with top-down, hierarchical systems of governance and facilitates the continued use of decision-making models that benefit some sectors to the detriment of others (de la Mare, 2005). Learning from research, EBM, as it is currently framed and operationalised, appears to be amounting to little more than empty rhetoric.

Marine Spatial Planning

MSP has come to prominence as a new and integrative approach that can contribute to the sustainable economic, environmental and social governance of the seas and ocean (Jay et al., 2013). Many of MSP's principles have been built on terrestrial spatial planning practices, instigating a spatial turn in marine governance and regulation (Gazzola and Onyango, 2018). MSP is operationalized through the implementation of plans that guide marine management, as well as the utilization of specific instruments and regulations, including setting out preferred geographical patterns of sea uses within particular spaces. In accordance with the principles of neutrality and accessibility, MSP is required to operate with the optimum arrangement of interests in mind. Engaging with a broad range of actors and perceptions can help to prevent conflicts between marine sectors and activities, ensure that marine resources are used in the most efficient manner, and protect valuable or threatened marine ecosystems (Schaefer and Barale, 2011). As an operational framework, MSP is a multi-faceted approach that can simultaneously support the conservation of a nation's marine environment, enable the realization of its economic potential, and facilitate more integrated patterns of sea use among actors (Pomeroy and Douvere, 2008). The multi-faceted nature of MSP has resulted in it being championed by academics and practitioners as an advancement upon traditional marine management systems, which, until recently, were guided by ad hoc and sectoral approaches (Jay et al., 2013).

MSP has a strong association with marine nature conservation and has been interpreted as an extension of the logic of creating Marine Protected Areas (MPAs) (Pomeroy and Douvere, 2008). The zoning system implemented in Australia in the 1980s, to facilitate the sustainable

management of the Great Barrier Reef Marine Park (GBRMP), is commonly referenced as a pioneering example of MSP (Day, 2002). Further initiatives in North America, such as the National Marine Sanctuaries Program, were also strongly led by environmental concerns and represented initial movement toward an Ecosystem-based Management (EBM) approach for marine areas. These successful examples encouraged the adoption of an ecosystem approach to MSP thinking, whereby management interventions are sensitive to ecological constraints, leading the early MSP literature to closely align with EBM (Crowder and Norse, 2008). However, the uptake of MSP over the last two decades, especially in Europe, has been characterized by a broader range of objectives than mere conservation. Principally, these include desires to maximize the economic opportunities presented by the sea via the better organization of maritime activities (Jones et al., 2016). Realizing these opportunities involves the management of both traditional sea uses, including fishing and trade, as well as newer or emerging activities, such as aquaculture and marine renewable energy. MSP seeks to balance the competing objectives of marine activities through an integrative approach to management, creating policy that cuts across sectors, borders and a diverse range of change drivers. Indeed, the European Union's (EU) Integrated Maritime Policy (IMP), created in 2007, was designed as a system for coordinating different policy goals in the maritime arena. The IMP positioned MSP as a fundamental tool for the sustainable development of the economic potential of the EU's marine and coastal regions. In the United States (U.S.), the Obama administration introduced a Memorandum on National Policy for the Oceans, Our Coasts, and the Great Lakes in 2009. The memorandum established a unifying framework under a national policy that included a comprehensive EBM framework for the long-term conservation and use of marine resources in the U.S., as well as creating an Interagency Ocean Policy Task Force that was to develop a recommended system for effective MSP.

By 2008, MSP was discussed as an idea 'whose time has come' (Douvere, 2008, p. 762). Although numerous attempts had been made to define both the scope and nature of MSP, relatively few had discussed how to put it into practice. A special issue in the journal *Marine Policy* in 2008 (Douvere and Ehler, 2008), as well as the publication of an associated UNESCO guidance document in 2009 (Ehler and Douvere, 2009), popularized and defined the concept of MSP more clearly. The UNESCO guidance document presented a 'step-by-step approach' to demonstrate how MSP could be established and applied through a logical sequence of comprehensive guidelines that would enable desired goals and objectives for marine areas to be achieved. Specific steps included establishing a planning authority, obtaining financial

support, organizing pre-planning and stakeholder participation, as well as the need to monitor plan performance post-implementation. The promotion of MSP as a structured and logical approach to marine management has led to intergovernmental bodies, non-governmental organizations (NGOs), stakeholder organizations, and marine scientists and managers championing the approach. Such cross-cutting interest has contributed to MSP's rapid growth across the globe, with coastal nations being encouraged to embrace MSP as a means of both managing current maritime conflict and preparing for future complexities.

The global spread of MSP has led to the emergence of different administrative patterns. For example, some regional sea organizations such as the Baltic Marine Environment Protection Commission (also known as HELCOM), have advocated for a collaborative approach to MSP between members. Furthermore, encouragement by the EU for all relevant member States to establish MSP systems has been interpreted as an attempt to develop greater cooperation between nations that share regional ocean areas. Emphasis has also been increasingly placed on the need to link MSP with Integrated Coastal Zone Management (ICZM) initiatives and existing terrestrial planning arrangements. In addition to these wider management strategies, it is also clear that MSP uptake is being driven by specific spatial needs, such as to permit the development of offshore wind energy schemes and to protect highly valued habitats from harm.

Reviews have revealed how MSP, in reality, is often focused on achieving specific sectoral objectives, related to nationally important strategic priorities, and, in some contexts, can be driven by Blue Growth objectives (Jones et al., 2016). Subsequent studies have revealed how MSP is conditioned, and constrained, to represent contrasting values and sensitivities in both biophysical and socio-political dimensions (Flannery et al., 2020). There remains limited evidence, however, of how MSP can successfully balance such demands. Initial literature and policy on MSP fail to account for these challenges and demonstrate a limited consideration of the regional factors that can hinder a nation's development of MSP. Indeed, early MSP studies tend to be promotional in nature, with little evidence of questioning the assumed benefits of MSP or of considering the complexities of putting it into practice. Until recently, more critical contributions were restricted to analytically assessing procedural aspects, such as developing improved methods of data management, stakeholder engagement or evaluation of plans. Although valuable, this work operates largely within its own terms and does not engage with wider, socially-oriented conceptual frameworks (Kidd and Ellis, 2012).

In response to these limitations, calls for deeper engagement with social processes, such as power, justice, distributional impacts, and the potential for progressive forms of MSP have been made (Flannery et al., 2019). The elusive ideal of MSP facilitating both conservation and development has been interpreted as a discrepancy between theory and practice, with a growing body of literature illustrating the need for crucial choices to be made by legislative bodies to ensure that MSP does not become an "illusion behind which other agendas lie" (Trouillet, 2020, p. 441). Smith and Jentoft (2017) argue that power, quite simply, was not adequately problematised when the conceptual foundation of MSP was set. As with any governance system; unequal or top-down arrangements of power can have a limiting impact upon stakeholder engagement and public participation processes. Scholars have emphasised how decision-makers can use the 'illusion of inclusion' (Purcell, 2009) to apply a mirage of democratic validity to a process which, at its core, is fundamentally undemocratic (Flannery et al., 2016). Recent evaluations of participation in MSP portray the process as being implemented in a tokenistic manner; wherein local actors struggle to be valued within the decision-making process (Jentoft, 2017; Jones et al., 2016). Added to this, it has been shown that as stakeholders become more aware of the fact that engagement processes are shaped by the aspirations of government actors, their willingness to get involved significantly decreases. Thus, additionally restricting the voice of stakeholders in MSP decision-making. As Flannery et al. (2018, p. 32) discuss, "there is growing concern that MSP is not facilitating a paradigm shift towards publicly engaged marine management, and that it may simply repackage power dynamics in the rhetoric of participation to legitimise the agendas of dominant actors".

Ultimately, MSP, as it is currently operationalised, appears neither a neutral nor objective instrument to decide about conflicting claims. While it has been presented as a means of implementing 'good governance' (Ehler and Douvere, 2009), MSP, like many other governance systems that measure and organise socio-political spaces, appears to facilitate a model of governance which benefits some to the detriment of others (Jentoft, 2017; Trouillet, 2020). In other words, making smaller stakeholders feel powerless against governance decisions. Neoliberal logic and the rationalisation of specific forms of scientific knowledge are central to maintaining a rigid and constraining decision-making framework (Flannery et al., 2016). Tafon (2017), among others (see Toonen and van Tatenhove, 2013; Boucquey et al., 2016), subsequently argue that it would be more appropriate to discuss

MSP, and integrated marine management more generally, as sites of politics. In such arenas, relations of power purposefully marginalise particular groups of marine actors and "herd their participation and ways of knowing toward achieving limited policy outcomes" (Tafon, 2017, p. 1). Thus, MSP may turn into a 'zero-sum game', therefore failing to accomplish its supposed goal of good governance (Jones et al., 2016). If MSP is to truly realise its democratic capabilities, it is clear that it must enable meaningful processes of stakeholder engagement, support a wider range of knowledge sources and develop an awareness of how to limit the issues of power and exclusion (Flannery et al., 2018).

2.2.3 Use and production of knowledge

In the general realm of planning, discourses of 'technical' or 'expert' knowledge are often utilised as a means of authorising or legitimising the principles outlined within relevant planning technologies (Flyvbjerg, 1998; Rydin, 2007). It is within these discourses and forms of knowledge that the exercise of power is conceptualised (Rose and Miller, 1992). It is also the use and rationalisation of specific forms of knowledge that seek to direct governance regimes towards particular, predetermined ends. By examining the use and production of knowledge in planning processes, we can begin to pick apart and understand how specific arrangements of power and knowledge dictate the decision-making of governance regimes. Largely, the focus upon technical solutions in planning procedures has resulted in the empowerment of scientific expertise and a growing level of ignorance shown toward local, social scientific knowledge (Flyvbjerg, 1998).

To fully comprehend the role of knowledge in the realm of marine governance, and to understand why it is important to examine its use and production, it is vital to clarify the different types of knowledge that exist. Aristotle's concept of Phronesis represents a valuable framing that considers how knowledge can be scientific, non-scientific and technical. By classifying knowledge into three defined categories – episteme, techne, phronesis – the theory clarifies how, if the supposed truth is to be reached, knowledge must involve both practical and theoretical insight (Kinsella and Pitman, 2012). The combination of theory and practice, in turn, can facilitate the development of practical wisdom over a specific domain. The concept of Phronesis also indicates how true knowledge requires conscious deliberation regarding the workings of societal systems and an understanding of

how particular goals or aims are reached (Jentoft, 2006). Episteme, translated as 'to know', is related to scientific knowledge and understanding. It is 'the theory of something' and presents information about the world and how it works. It is understood as being a form of transmittable, explicit knowledge. The word techne translates to all kinds of 'craft' and 'artistic knowledge'. People are often unaware of the techne that they possess and fail to comprehend how it can be of value to others. Techne is not a form of knowledge that is easy to share and, instead, must be learnt through practice. As Kinsella and Pitman (2012) explain, phronesis is understood as 'practical wisdom'. Aristotle discusses phronetic knowledge as a term stemming from the two types of wisdom in philosophical thinking: (i) Sophia – the ability to think about the nature of the world and to find universal truths; and (ii) Phronesis - the ability to realise how a specific goal or value is reached. Phronesis includes aspects of a situation, critical analytical reflection and scrutinizing knowledge systems, practices and the impacts of goals that are taken for granted.

Aristotle's model makes clear that knowledge can comprise of both codified and experience-based components. This interpretation of knowledge can, more broadly, be used to highlight how knowledge can be both scientific and non-scientific. Scientific knowledge is that which has been acquired using scientific method. This can include the findings of quantitative or analytic studies, where results can be tested and reproduced. Non-scientific knowledge, on the other hand, is the other sphere of human knowledge. This involves beliefs, indigenous knowledge and philosophical ideals. Non-scientific knowledge is less open to testing and, although it can be questioned, any challenges are less likely to be conducted in line with inductive reasoning or experimentation. Historically, social scientific knowledge has often been deemed as being non-scientific and, thus, less valued than natural scientific knowledge in the realm of governance (Kinsella and Pitman, 2012). To challenge this, Jentoft (2006) argues that the contribution of the social sciences to fisheries resource management must be 'phronetic' (phronesis), in contrast to the 'scientific' (episteme) contribution of the natural sciences. Jentoft (2006: 671) suggest that "phronesis is basically what the notion of governance adds to management. Governance is the broader concept, inviting a more reflexive, deliberative and value-rational methodology than the instrumental, means-end oriented management concept". Therefore, it is crucial to recognise that there are multiple forms of knowledge, including natural and social sciences, that have an important contribution to make to marine governance. Particularly when attempting to solve socially relevant maritime problems, such as the need to sustain both marine resources and coastal

communities, governance must be open to combining different forms of knowledge that cover both social and natural scientific insights. As this study will discuss, citizen science has been advanced in literature as having the potential to create a space where scientific and non-scientific knowledge can co-exist and reinforce one another (Bela et al., 2016). This suggests that citizen science can be of significant benefit to marine governance and can be utilised to tackle important maritime problems. It is vital, however, to critically examine this potential and to uncover the opportunities and barriers that impact how it can be realised.

In the realm of marine governance, there are growing concerns regarding the rationalisation of specific scientific knowledge that underpins plans and initiatives, with plural and complex knowledge regularly disregarded. Said and Trouillet (2020, p. 347) assert that "the construction, management, validation, and marginalisation of different types of knowledge stemming from different stakeholders or disciplinary approaches is at the heart of policy and planning processes". The rationalisation of knowledge appears to somewhat undermine the social, political and cultural concerns of marine environments and is often framed on unarticulated values and ideals (Flannery et al., 2016). Similarly, scholars argue that the utilisation of technical data as a means of justifying decisions made about issues which, at their core, can only be understood in a social context, is an inappropriate approach (Flannery et al., 2016). For instance, it is not possible to conclusively, or democratically, settle conflicts between local fishers and the developers of a proposed offshore wind farm by solely drawing upon technical datasets.

The overuse and over-empowerment of technical knowledge in policy and decision-making is increasingly seen to be creating significant inequalities amongst marine stakeholders. This is specifically impacting smaller actors, communities and local or small-scale sectors. In the realm of fishing, MSP processes are seen to streamline bio-economic metrics and fall short of including or empowering the local or cultural knowledge that comprise fisheries (Said and Trouillet, 2020). In simple terms, this renders the MSP decision-making processes incomplete. Additionally, the mixture of coastal stakeholders that seek to inform decision-making inevitably raises issues of power relations and disputes about whose knowledge counts as most valid (Jentoft, 2017). The struggle of less powerful actors to get their knowledge and views incorporated into the decision-making process, such as local or small-scale fisheries, appears indicative of the exploitive and neoliberal nature of marine governance processes following Blue Growth rationales. There is limited scope for genuine

engagement with local stakeholders, with continued support given to actors in economically expansive sectors (Choi, 2017). This is not to suggest that such arrangements cannot be altered, however. "Ideally, stakeholders should come to the table early when the guiding principles, goals and objectives are set (known as 'front loading' the process), and be involved regularly along the way to creating, implementing, and monitoring a marine plan" (Smith and Jentoft, 2017, p. 33).

While stakeholder knowledge production and early engagement are outlined as fundamental aspects of integrated models of marine governance (Gilliland and Laffoley, 2008; Ehler and Douvere, 2009), in reality, recent evaluations appear to paint a more uneven picture (Jones et al., 2016; Jentoft, 2017). Public participation in marine governance processes often results in little more than tokenistic gestures of information sessions and workshops (Smith and Jentoft, 2017). Frustratingly, these are rarely given much prominence by decision-makers. There remains little scope for the knowledge and views of local stakeholders to be incorporated into policy processes, resulting in the continued spread of inequality. Marine governance regimes have been seen to present a rhetoric of participation which, in no uncertain terms, chiefly legitimises the agendas and knowledge of dominant actors (Flannery et al., 2016).

Evidently, there is no easy fix for issues regarding limited stakeholder engagement and recognition of local knowledge in marine governance processes. There are many reasons as to why current participation conditions remain unchallenged. First, it is imperative to recognise how the concept of defining stakeholders is regularly oversimplified. The reality of who a stakeholder is and why their participation is important is exceedingly complex. Stakeholders are regularly "painted with a broad brush", thus disregarding their "diversity and differential capacities" (Smith and Jentoft, p. 33, 2017). Secondly, all actors carry different approaches to knowing and understanding the world (Kumar and Paddison, 2000). As a result, it is important for stakeholders to be empowered, not just engaged, to ensure that their participation is worthwhile (Pomeroy and Douvere, 2008).

For integrated models of marine governance to achieve their broad objectives of democratizing systems of marine governance, it appears obvious that new approaches to participation and knowledge incorporation must come to fruition. Indeed, Said and Trouillet (2020) suggest that MSP, if it is to account for the diverse range of fisheries knowledge that

exists, must expand its vision through 'Deep Knowledge'. This is explained as "a process which is informed by an assemblage of technical and socio-political knowledges of any kind that allows any group to be involved in democratic decisions at a highest level of participation" (Said and Trouillet, 2020, p. 350). This suggests a critical change of direction for MSP and calls for a reflexive approach to data collection to be utilised, whereby MSP is encouraged to question the foundation aspects of knowledge production. Ultimately, by being able to access knowledge – or by being able to participate in knowledge production, distribution or use – local actors can shape conceptualisations of problems and solutions (Gaventa and Cornwall, 2001).

2.2.4 Calls for a radical change

Developing upon the recent emergence of critical assessments of marine governance, a number of scholars have begun to call for a radical turn in the workings of regimes. Specifically, there has been an increasing number of appeals for enhanced recognition and critical evaluation of the role and influence of power (Jentoft, 2006; Ritchie and Ellis, 2010; Flannery et al., 2016). As of yet, it appears that these calls have not become fully ingrained within research, nor have they instigated practical changes to regimes. As the conceptual foundation of marine governance frameworks are laid, particularly in the case of the apparent 'integrative' models, the topic of power is seemingly not 'sufficiently problematised' (Smith and Jentoft, 2017).

Marine governance processes have become arenas where specific and multiple instances of power manifest themselves (Tafon, 2017). This, in turn, is regularly facilitating the creation of top-down models of governance, where specific arrangements of power and knowledge are used to construct systems which benefit some actors at the expense of others. Building on these interpretations, scholars assert that a theoretically-driven approach to marine governance research could lead to a radical turn in regards to how it is conceptualised and, in time, operationalised (Flannery et al., 2019; Clarke and Flannery, 2019). By following theoretically-informed approaches to research, we can begin to understand how the concept of power is functioning in marine governance processes and, importantly, how it can be challenged. Central to calls for a radical turn in marine governance processes advocate for

the generation of a more democratic, equity-based decision-making and knowledge production process.

Appeals for reconfigured marine governance processes centre around three central objectives: (i) to improve the relationship between marine and terrestrial planning, (ii) to enhance the contribution of the social sciences and (iii) learning from Transition Management, to improve our understanding of the key institutional challenges to integration. Firstly, regarding the relationship between marine and terrestrial planning, it is clear that there has been a distinct lack of critical engagement from within the field of marine planning, particularly in regards to interacting with wider policy debates (Jones et al., 2016). As a result of this negligence, it has been suggested that the field of marine governance can benefit from tapping into the long tradition of critical reflection within terrestrial planning (Kidd and Ellis, 2012). There is, evidently, a wide base of terrestrial planning literature which critically debates the issues of rationality, sectoral integration and participation within urban and rural governance. These issues, of course, are keenly felt in marine governance processes as well. Surely then, "the traditions of reflection, critique, and debate – that are a feature of land-based planning – can inform the development of richer theoretical underpinnings of marine planning" (Kidd and Shaw, 2014, p. 1535).

A second aspect that is common within academic research that searches for radical reconfigurations of marine governance regimes, is a call for the increased contribution of the social sciences (McKinley et al., 2019). The rationalism of natural scientific knowledge within regimes of marine governance does little to alleviate stakeholder conflicts, prompting calls for more input from the social sciences. Jentoft (2006, p. 671), while discussing a new frontier in fishing management, claims that "the contribution of the social sciences to fisheries resource management must essentially be 'phronetic' (after Aristotle's phronesis, i.e. practical wisdom), in contrast to the 'scientific' (Aristotle: episteme) contribution of the natural sciences". This links to suggestions that social science can be used to plug gaps where natural science is weak (Flyvbjerg, 1998). When having the needed 'episteme' and 'techne' (craft/knowledge) of a specific domain, it becomes possible to develop the 'right answer' via 'phronesis' (Birmingham, 2004). Without an understanding of the relevance of phronesis, no practical discussion of decision-making regarding social matters can take place (Birmingham, 2004). An increased focus upon socio-political issues within marine governance

arrangements could play a significant role in creating genuine win-win marine planning approaches.

While not exclusively discussing the field of marine management, Flyvbjerg (2004) presents a theoretical model – phronetic planning research – which was largely constructed around a contemporary interpretation of the classical phronesis concept. Principally, the theory of phronetic planning research provides a framework for examining how 'power and values' operate in planning processes. By following the framework, it then becomes possible to locate who is affected by specific power arrangements and to what consequence (Flyvbjerg, 2004). With emphasis placed upon this understanding of the subsequent impacts of power, the theory highlights how values and relations carry the potential of being changed to work with alternative ramifications.

> "Insofar as planning situations become clear, they are clarified by detailed stories of who is doing what to whom. Clarifications of that kind are a principal concern for phronetic planning research and provide the main link to praxis" (Flyvbjerg, 2004, p. 284)

Such an approach critically examines the 'value-rationale' of a specific domain, prompting questions such as 'who gains and who loses'. The intention of querying such issues is not to specifically produce undisputable 'knowledge', instead, it is to fuel discussion and debate (Flyvbjerg, 2004). This is of particular relevance for concerns such as power, participation and decision-making in marine governance processes and is increasingly recognised by scholars within the field (Ritchie and Ellis, 2010; Jay et al., 2012; Smith and Jentoft, 2017; Tafon, 2017; Bavinck et al., 2018).

A third approach to reconfiguring marine governance processes regards a critical evaluation of the key institutional challenges that face integrated models of governance. While integrated models of marine management have been seen to carry significant potential, the adoption of tokenistic participatory measures and little attention paid to distributional outcomes is allowing more powerful actors to continuously dominate governance processes (Qiu and Jones, 2013). For integrated models to be successfully employed, there must be recognition of the unequal power relations and social injustices which occur amongst stakeholders (Tafon, 2017). Crucially, instances of inequality must be addressed. To be successful, therefore, integrated governance mechanisms will involve transformative change

of institutions, values and practices. “While integrated management approaches have a normative capacity to fundamentally transform marine governance, the failure to understand the institutional dynamics that may impede effective implementation, leaves much of the research in this field naively impotent” (Kelly et al., 2018a, p. 24). There is a need, therefore, to develop a more realistic understanding of the context in which transformative change takes place. Transition management has been put forward as one potential means of both conceptualising and operationalising strategies which address these barriers based on a long term perspective using a participatory process of visioning and experimentation (Kelly et al., 2018a).

Building on the above calls for radical change in the workings of marine governance processes, specifically focusing on the manner in which they use and produce knowledge and support participation, this study proposes the increased use of participatory research. While research must “analyse how certain knowledges are produced and rationalised by powerful actors”, it should also “explore avenues for the production of alternative knowledge and how it may be used to counter hegemonic thinking” (Flannery et al., 2019, p. 211). As such, this study examines the practice of citizen science to understand what transformative potential it has to recast marine governance processes. Generally, citizen science is advanced as a participatory research approach that can open up science and facilitates individuals with an opportunity to meaningfully engage with knowledge production processes (Wiggins and Crowston, 2011). The practice has been advanced as a means of empowering the knowledge of local people, which can challenge as well as augment the knowledge of scientific experts (Irwin, 2002; Elliott, 2017). While citizen science, as with any form of participatory knowledge production, is not without criticism, its transformative conditions make it an interesting avenue of investigation. The remainder of this chapter seeks to problematise citizen science. By critically examining its transformative components, we can begin to understand the role which critically conscious citizen science projects can play in reconfiguring processes of marine governance.

2.3 Citizen science

"with or without an invitation, citizen science exists. There is an urgent need to make a place for it in the scientific community"

(Lauro et al., 2014, p. 2)

While public participation with environmental research has existed in one way or another for centuries, more recent advancements have been spearheaded by the rise of citizen science (Shirk et al., 2012). Broadly defined, citizen science is a means of participatory research, wherein members of the public voluntarily work with professional scientists, to produce scientific knowledge in a contributory, often collective, manner (Cohn, 2008; Bonney et al., 2009b). These programs offer volunteers opportunities to learn more about their natural and ecological surroundings (Lauro et al., 2014). They also assert claims to empower local knowledge and enable civic participation in policy-relevant processes (Turrini et al., 2018).

The limited scope of government monitoring programmes to efficiently deal with complex ecological challenges (Sharpe and Conrad, 2006), due to resource, time and cognitive constraints (Bennett, 2016; Conrad and Daoust, 2008; Vercammen and Burgman, 2019), has fostered citizen science to be recognized as a valuable and a cost-effective means of improving knowledge (Jambeck and Johnson, 2015), broadening the spatial and temporal scale of data collection processes (Jarvis et al., 2015), and providing management recommendations (Bone et al., 2012; McKinley et al., 2017). There is growing evidence to show that such a model of science, when set up in the right circumstances and underpinned by thoughtful study design, can work on a massive scale (Trumbull et al., 2000). Not only through the production of high quality, reliable scientific data, but also through the generation of unanticipated insights and innovations (Wiggins and Crowston, 2011).

It is the active and collaborative characteristics of citizen science that distinguish it from other forms of participatory research. As such, it has overtaken many of its counterparts – including citizen participation, deliberative governance, empowered participatory governance and collaborative policy dialogues – in terms of interactive knowledge production (van Tatenhove et al., 2010). Instead of simply participating as subjects within research studies, citizen scientists play integral roles in the development and successes of

projects (Wiggins and Crowston, 2011). Citizen science supports a conceptualisation of science that can be responsive to the concerns of citizens and can legitimately engage them with scientific knowledge production. Accordingly, research has advanced citizen science as a means of transforming processes of conservation management into more transparent, socially relevant and democratic endeavours (Conrad and Hilchey, 2011). Thus, citizen science is a participatory research practice with wide-ranging outcomes. It can benefit both those directly involved with projects, as well as society as a whole.

2.3.1 Current understanding of citizen science

The lack of a formalised definition of citizen science is reflective of the practice more generally. It operates in a wide variety of manners, covering many different disciplines and diverse situations (Hecker et al., 2018). While citizen science appears suitable to a wide range of research areas, it has most commonly been employed as a tool to tackle environmental conservation concerns (Pocock et al., 2017). In such settings, it has been advanced as a means of gathering fine-scale data and incorporating diverse local knowledge (Jarvis et al., 2015). This includes work in both terrestrial and marine environments, with most projects encompassing methodologies which focus on practically monitoring and recording species and habitats (Silvertown, 2009). Added to this, advancements in the use and availability of technology have resulted in the creation of interactive citizen science projects. These are science-oriented schemes, which are entirely 'ICT-mediated' and involve no physical elements of participation. Examples of virtual citizen science projects include research in the fields of palaeontology and astronomy (Wiggins and Crowston, 2011).

Recent research studies have shown how a key knowledge output of many citizen science projects is the generation of large amounts of spatial and temporal data, which has previously proved laborious or even impossible to obtain (Dickinson et al., 2012; McKinley et al., 2017). In this light, scholars have asserted how citizen science knowledge brings to light local level concerns, which can develop understandings of broader geographic issues (Conrad and Hilchey, 2011). The knowledge-based outputs of citizen science, therefore, can be seen to directly benefit both the citizens themselves, as well as wider society (Bonney et al., 2014). This develops upon seminal research on citizen science (see Cohn, 2008; Bonney et al., 2009b), which assert that the broad objective of citizen science is to engage members of the

public with scientific research regarding their surrounding environments. In other words, a way of bridging and creating partnerships between science and society (Jordan et al., 2012). Indeed, scholars have asserted that the recent rise of citizen science appears as part of a participatory turn in the realm of science and society (Jasanoff, 2014). The catchwords of 'civil', 'civic', 'stakeholder' and 'citizen' science signify the rise of this democratic paradigm. As Martin et al. (2016) acknowledge, citizens can and, in accordance with the pillars of a democratic society, must contribute to scientific knowledge production, especially for matters relating to their local environments. The following sections will review current understanding of three key components of citizen. First, the production of knowledge. Second, the development of learning and social outcomes. Third, the participation process. Following this, an assessment of the major limitations of citizen science are considered.

Production of knowledge in citizen science

As more research is done to evaluate the scope of citizen science, more is learnt about the knowledge outputs and practical impact of projects. Conrad and Hilchey (2011), whilst reviewing community-based environmental monitoring, discuss how citizen science possesses the unique capability of surveying sites that have been traditionally impossible to sample extensively via conventional research models. One of the first citizen science projects that made significant contributions to scientific knowledge was the National Audubon Society's Christmas Bird Count, run in the United States of America on an annual basis since 1900 (Silvertown, 2009). In the published findings report for 2017, figures show how tens of thousands of observers counted a total of over 63 million birds. The monitoring data has continuously been used to inform conservation policy and shape practical preservation measures. In a UK context, the work of the British Trust for Ornithology (BTO) is regularly noted as the country's most successful citizen science organisation. Set up in 1932, the Trust continues to work towards its core objective of harnessing the work of amateur observers for the benefit of science and nature conservation. The majority of the organisation's collected data, which recent publications suggest now includes over 31 million records of over 27,000 species of animals and plants, directly contributes to the UK's National Biodiversity Network (Silvertown, 2009).

An important topic to mention whilst discussing the knowledge production capacity of citizen science, is technology. Scholars have acknowledged how advancements in technology have made a significant difference in regards to the levels of engagement that members of the

public can now have with research studies (Newman et al., 2012; Curtis, 2015). The use of smartphone apps has broadened the scope of citizen science by making it possible to engage volunteers regardless of their physical location (Hyder et al., 2016). Added to this, the manner in which the internet has become a central component of everyday life for millions of citizens has, in turn, enhanced the visibility and accessibility of citizen science projects (Bonney et al., 2014). It requires relatively little time for interested volunteers to locate a citizen science project via an online search, which they can then proceed to practically engage with. Additionally, recent years have seen the rise of 'virtual' citizen science projects. These are participative schemes which are entirely carried out online and involve little to no physical elements (Wiggins and Crowston, 2011). A noteworthy example of this in practice is the website 'Zooniverse' (Simpson et al., 2014). The platform provides infrastructure to construct and administer citizen science projects, which can then be accessed by individuals across the globe. This includes access to technical tools for collecting, analysing and disseminating collected data. As Cavalier and Kennedy (2016, p. 14) discuss, "it's a short leap from supporting science to participating: enabled by technology and empowered by social change, curious laypeople are transforming the way science gets done".

While noting the above conceptualisations on the production of knowledge within citizen science, there is distinct trend amongst much of the literature to narrowly consider citizen science as a means of contributing to existent knowledge production and governance pathways. This linear model of knowledge production frames citizen science as the unidirectional flow of information, wherein knowledge is generated by volunteers and then communicated to coordinating scientists and government end users (Cohn, 2008; Devictor et al., 2010). This type of citizen science is concerned with producing knowledge 'for knowing'. Knowledge, in this sense, is produced to fill specific gaps of information in research or management frameworks (Jambeck & Johnsen, 2015), directly answering predefined questions (Rotman et al. 2012). Thus, processes of citizen science knowledge production can be interpreted as a way of strengthening understanding of particular issues and adding valuable insight to datasets (Jarvis et al. 2015). Framed solely in this manner, citizen science appears to be limited to generating knowledge that fits within existent decision-making standards and supports the extension of the current status quo of management processes (Ottinger 2010).

Focusing only on the attainment of knowledge in this one-dimensional manner neglects the broader transformative capacity of citizen science (Couvet & Prevot, 2015). It reflects a limited appreciation of the potential transformative actions that can arise from knowledge production, both within and beyond the boundaries of projects. The knowledge for knowing framing ignores the manner in which some transformation requires the production of alternative knowledge that reconfigures prevailing logics (Turnhout et al., 2020). Similar critiques of this framing of citizen science are also outlined by Bela et al. (2016), who emphasise that an accurate evaluation of citizen science's transformative capacity requires a more expansive analysis of the dynamic character and outcomes of projects. Whereas Bela et al. (2016) realise this objective by focusing on learning mechanisms within citizen science, there is also a need to conduct more critical examinations of citizen science knowledge and the capacity it has to transform ways of thinking about and managing conservation matters.

Although there appears to be an adequate focus within citizen science literature placed upon analysing how knowledge is generated and what it consists of – be it species or ecological recordings, habitat surveys, stakeholder mapping – there is less evaluation of how knowledge is used beyond one-directional flows to end users. There is little analysis or measurement of the impact of citizen science knowledge, with no critical assessments conducted on the processes that support or impede the advancements of citizen science knowledge to a level where it can create transformative change. Such insights would considerably add to the discussion of citizen science and present a wider review of the practice; in terms of its shortcomings, successes and how it can be made to do more in its pursuit of achieving transformative change. Before delving further into this argument, however, it is important to also debate the development of learning and personal outcomes within citizen science.

Learning and social outcomes of citizen science

While the production of knowledge is one mechanism through which citizen science can create outcomes, it is also important to recognise the role that the development of learning outcomes can play. Due to the nature in which citizen science engages with individuals, there have been significant documentation of how participation leads to enhancements in both a personal and collective manner. This involves the development of both educational and social outcomes. The processes of developing educational outcomes through citizen science is, largely, similar to traditional education programs (Turrini et al., 2018), whilst social

outcomes stem from collective engagement and participation in collaborative processes (Shirk et al., 2012). To shed light on some of the outcomes associated with citizen science participation, scholars have demonstrated how engagement with projects can act as a means of instilling educational advancements within volunteers (Ruiz-Mallén et al., 2016; Ballard et al., 2017), inducing stewardship (Merenlender et al., 2016), influencing attitude and behavioural change (Toomey and Domroese, 2013), generating empowerment (Newman et al., 2012), fostering social licence (Kelly et al. 2018b), and instigating civic participation (Turrini et al., 2018). Added to this, Conrad and Hilchey (2011, p. 282) demonstrate how learning outcomes generated through citizen science can range from "scientific literacy, social capital and citizen inclusion in local issues". Such learning outcomes also feed into enhancements of community capacity building (Conrad and Hilchey, 2011).

Assessments of the learning and social outcomes of citizen science participation provide an illustration of how projects offer a platform where active engagement, a willingness to become immersed within the study and a desire to make a difference are key ingredients of a successful project (Cavalier and Kennedy, 2016). Bennet et al. (2018), among others (see Krasny and Tidball, 2012; Merenlender et al., 2016), further develop the discussion of learning outcomes within citizen science by debating the topic of environmental stewardship. Environmental stewardship is discussed as the actions taken by volunteers, regardless of skill level or personal motivation, to care for the responsible use of the environment in pursuit of sustainable social and environmental outcomes (Bennett et al., 2018). By engaging with citizen science projects and becoming more aware of the environmental challenges that local environments face, there are growing suggestions that a degree of stewardship can be instilled within volunteers (Krasny and Tidball, 2012). In other words, participation in citizen science can influence changes within the actions and environmental ethics of volunteers.

Despite the growing array of literature assessing the learning and social outcomes of participation, there remains important issues that appear to be lacking in current debates. One such issue is the lack of awareness of how it is not only the volunteers who can develop educational developments through citizen science. Rather, all actors who are involved with projects, from volunteers, to practitioners and governance actors, are capable of receiving such outcomes. What is already clear is that citizen science does not have unidirectional impacts (Toomey and Domroese 2013). To varying degrees, citizen science operates in a

multidimensional manner and actively engages all those who interact with projects. However, there is a lack of research that critically examines how learning occurs within projects beyond the volunteer level. Indeed, only a select group of scholars have conducted comprehensive evaluations of who benefits from citizen science, in a learning capacity, and to what extent (Bela et al. 2016). Bela et al. (2016) expand upon this issue and, by demonstrating how learning is inherently uneven in participatory research, highlighting the importance of evaluating the nature of learning. Research would benefit, for instance, from examining the capacity of projects to instil learning outcomes within governance actors and to assess how this may lead to shifts in the conceptualisations held by such actors. To understand the full scope of learning within citizen science, therefore, evaluations need to be extended beyond the volunteer level.

Measuring participation in citizen science

Literature has argued that the success of citizen science is dependent on the active engagement and collective drive of their volunteers (Alender, 2016). By maximising volunteer contribution, the potential output and impact of projects can be enhanced. This has encouraged studies to suggest that citizen science projects must speak to the needs and concerns of their participants, with evaluative studies highlighting the importance of factoring such insights into the evolution of projects (Phillips et al., 2019; Shirk et al., 2012; Tang et al., 2019). 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 citizen science projects to realise desired outcomes (Davies et al., 2019). Most evaluations of participation in citizen 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 citizen science projects. In citizen science literature, motivation has been advanced as a multi-faceted construct that describes the process of goal setting (Ganzevoort et al., 2017). Assessments of participant motivations attempt to reveal the psychological factors that drive volunteers to engage with citizen science (Jennet et al., 2016). 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 (Dem et al., 2018; Jackson et al., 2020).

Several approaches to categorising motivational factors have been traditionally used in the volunteering literature (Clary et al., 1998). Pivotal studies on social participation demonstrate how motivations can be classified as either intrinsic or extrinsic (Ryan and Deci, 2000). Intrinsic motivations reflect desires to achieve personal gains, while extrinsic motivations are characterised by aspirations to develop outward impact. Batson et al. (2002) 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 citizen science are largely seen to align with Batson's conceptual model of motivational factors (Curtis, 2018; Larson et al., 2020; Rotman et al., 2012). Although alternative frameworks have been put forward to classify the motivational factors of volunteers (Clary et al., 1998), evaluative studies (Asingizwe et al., 2020) have highlighted how many cover similar categories or are inherently related to the categorisation put forward by Batson et al. (2002).

Analysing volunteer motivations provides insight on what volunteers want to achieve through their participation, both regarding themselves and for others (Shirk et al., 2012). 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 (Alender, 2016). Studies have also revealed altruist motivations amongst volunteers, reflecting citizen science participants that have the extrinsic goal of benefiting wider society (Geoghegan et al., 2016). This can include volunteers who are driven to participate in citizen science projects attempting to tackle air and water pollution (Ottinger, 2010) or plastic litter deluges in marine environments (Jambeck and Johnsen, 2015) wherein participants engage with scientific endeavours that can inform conservation decision-making (Cross, 2019). Citizen science volunteers can also be driven by ideas of being part of a collective movement that can develop the welfare of a specific group (Pandya, 2012). This can involve motivations to participate in projects that attempt to improve the environmental health of local ecosystems or, more generally, as a means of socially engaging with others (Jennett et al., 2016). Others have noted how motivational drivers can relate to feelings of principlism, presenting participation as form of

self-expression (Bruyere and Rappe, 2007). 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. 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.

Evaluations have also attempted to understand participation in citizen science by evaluating the outcomes that volunteers obtain whilst engaging with projects. Outcomes reflect the extent or impact of participation (Measham and Barnett, 2008; Shirk et al., 2012). Volunteer outcomes can be personal or social, depending on the context of participation. Personal outcomes, as discussed, include educational development, including environmental and scientific learning. Social outcomes can involve communal engagement with others and the development of environmental stewardship. Indeed, recent studies have revealed the capacity of marine citizen science projects to foster collective engagement with environmental issues, which can enhance the desire of volunteers to protect local environments (Dean et al., 2018). Citizen science participation has also been seen to heighten social capital and community capacity. 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 (Cross, 2019).

Whilst evaluations of volunteers' motivations and outcomes have generated crucial insights on the participation process, there are few studies (see Phillips et al., 2019; Wright et al., 2015) 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 (McAteer et al., 2021). These aspects are implicitly related, interdependent concepts that require deeper analysis. This leads this study to contest that many evaluative approaches present an incomplete picture of citizen science participation, with many assessments failing to examine 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 (Druschke et al., 2012). 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 citizen science.

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 (McAteer et al., 2021). There is a high likelihood that the sustained participation of volunteers is influenced by the obtainment of outcomes that fulfil their motivations. Indeed, studies have demonstrated how 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 Phillips et al., 2019; Wright et al., 2015). In a practical sense, measuring motivations in line with the desired outcomes of volunteers can function as a potential maintenance strategy for citizen science projects. Beyond this, it presents a more holistic examination of citizen science engagement that can enhance understanding of the experiences, concerns, and needs of volunteers (McAteer et al., 2021).

Limitations of citizen science

While much of this chapter has examined the potential of citizen science and debated the positive change it is already creating, the importance of acknowledging the shortcomings of the practice is crucial. In addition to the problematisations of citizen science that have already been outlined, it is important to discuss further concerns that scholars have asserted. One of the most recognised criticisms of citizen science relates to data quality and validity. Whilst discussing the sheer volume of knowledge which citizen science projects are creating, Bonney et al. (2014) highlight how the practice is far from being universally recognised as a reliable and accurate means of scientific investigation. The potential for error, inaccuracy and subjective partiality in projects remains a perennial danger. Participant bias, both conscious and unconscious, can lead to varying perceptions and accounts of events and observations (Gonsamo and D'Odorico, 2013). Consequently, this presents challenges in regards to the consistency and reliability of their data. Follett and Strezov (2015) go as far as suggesting that some participants are purposefully engaging with citizen science projects with the sole intention of advancing their political objectives. Using the example of fracking, they assert how opponents to development may emphasise possible pollution in order to

gather evidence of its harmful effects and deter its implementation. While this is criticised for not following a purely scientific objective, this study acknowledges it as an interesting example of the aforementioned activist-led citizen science. Haklay (2013) further questions the validity of citizen science studies by insisting that research must critically question the ability of the practice to legitimately answer scientific questions. To do so, Haklay (2013) suggests analysing a project's data collection procedures, their volunteer recruitment and training processes, and the general scientific ability of project participants.

While strict research methods have been seen to be crucial to enhancing the validity of citizen science data, it can limit the agency and scope of projects. Initiatives regularly lack an experimental design when initially set up, which may also play a part limiting the scope of citizen science (Conrad and Hilchey, 2011). Scholars are noting how the increased use of citizen labour in participatory research is regularly resulting in the creation of mundane methodologies, where volunteers are essentially carrying out the role of 'data drones' (Hemment, Ellis and Wynne, 2011). The trade-off represents a major limitation of citizen science as a transformative research practice. However, it is important to question how innovative approaches may provide avenues around such issues. Shirk et al. (2012) further add to concerns regarding citizen science participation by suggesting that it is not only the degree of participation – the quantifiable level of volunteer research effort, duration and diversity – that is important, but likewise the quality of participation – the subjective dimensions of credibility, fairness, trust, responsiveness and agency. As Shirk et al. (2012) emphasise, to sufficiently generate genuine volunteer engagement, it is not enough to simply incorporate the discourse of participation within the promotion and management of projects. There is a crucial difference between participation which acts as 'buy-in' to recruit volunteers and participation that facilitates social transformation. Further to this concern, scholars have also critiqued the ethical use of volunteers' labour, as evaluations have demonstrated how particular projects have advanced individual scientific gain over group success (Crain et al., 2014).

The challenge of creating conformity and identifying a common purpose in citizen science, while also supporting expansion and creativity, is no easy feat. While some schemes are set up to facilitate citizens with the ability to understand and participate in 'traditional' scientific practices, others are designed to disrupt professional science by challenging and questioning traditional assumptions (Elliot, 2019). Learning from Epstein's (1996) study of AIDS activists,

it is clear that tensions can commonly develop amongst members of the same group. This is particularly the case when some grow closer to the mainstream scientific community, while others maintain a more oppositional stance (Epstein, 1996). Limiting conflict amongst volunteers adds further complexion to project management and is a key limitation of current projects.

2.3.2 Citizen science in a marine context

With huge numbers of citizens already in some way engaged with their marine activities – an estimated 14 million adults regularly participate in recreational maritime activities in the United Kingdom alone (Arkenfold, 2013) – the potential to utilise them as a resource for citizen science is evident. For instance, recreational users have been seen to be important sources of information regarding local environmental conditions and species behaviour, principally stemming from the high volume of time they spend in such environments (Hyder et al., 2015). There is a need, therefore, to understand how best to use citizen science in the marine context. Whether it is on the premise of generating marine evidence which can lead to changes of practice or decision-making (Roy et al., 2012; Shucksmith et al., 2014; Jarvis et al., 2015; Nursey-Bray et al., 2018) or to utilise it as a means of instilling learning outcomes (McKinley and Fletcher, 2012; Dean et al., 2018). While discussions on the propensity of citizen science to influence maritime policy continue to grow, few marine governance processes have been seen to consistently encourage the two-way exchange of information advocated by citizen science.

Much like its terrestrial counterpart, there is great diversity in marine citizen science. "The aims of projects can be as diverse as the marine systems themselves, and can focus on marine and coastal flora and fauna, marine pollution or beach litter, local ecosystems, fishing, water properties and many other physical features" (Carcia-Soto and van der Meeren, 2017, p. 4). The conservation of maritime areas continues to be hit by problems provoked by human activities – overfishing, pollution, habitat loss and the introduction of invasive alien species – and the speed at which the health of such environments are declining

is particularly worrying. What is clear is that scientists cannot get to the bottom of these issues alone. Current knowledge about marine environments is relatively limited and it has even been suggested that more is known about space than about our oceans (Copley, 2014). The key difficulty of measuring and learning about marine environments centres around the accessibility, or lack thereof, of such arenas. It is unrealistic to think that scientists can gather sufficient data to develop comprehensive understandings of our oceans and marine areas, particularly in light of the growing urgency for such knowledge. In turn, this has led to calls for further exploration of the potential of marine citizen science and the increased engagement of members of the public with marine environments more generally (Martin et al., 2016).

While the topic of citizen science feeding into policy has been discussed already in this chapter, it is useful to briefly debate its ability to specifically shape policy in a marine context. As Hyder et al. (2015) discuss, the monetary backing required to support monitoring schemes that can underpin marine legislation is, unsurprisingly, considerable. It is, therefore, widely understood that more cost-effective methods of collecting marine data are necessary (Tulloch et al., 2013; Delaney et al., 2008). Citizen science certainly operates as one alternative and while it is acknowledged that it does not have the capacity to replace traditional marine research efforts, it is important to recognise the role which it can play in future evidence provision. One successful example of marine citizen science in this realm is the OSPAR beach litter project; which is an EU-wide scheme aiming to fill gaps of knowledge regarding the level of marine litter and how they change over time (OSPAR, 2010). Further examples include the Sea Watch Foundation's cetacean monitoring schemes, which have been used to underpin the UK's Biodiversity Action Plan, as well as Seasearch's diving surveys, that have been used by government bodies in support of designating Marine Conservation Zones and identifying priority species (Hyder et al., 2015). Beyond this, however, examples of policy-relevant marine citizen science projects are limited.

The challenges for citizen science to consistently contribute to policy – quality of data, funding, volunteer numbers, skill level of volunteers, politics and power – are difficult to overcome. The above examples hint towards the capacity the practice has, however, and as Hyder et al. (2015, p. 112) assert, "citizen science has good potential to contribute to marine policy … but only if outputs from citizen science projects are judged individually on quality. If this is the case, citizen science has an important role in delivery and understanding of

future marine policy, but is only one part of an integrated solution". By analysing the organisational dynamics of marine citizen science projects, this study will present insight on the barriers to projects influencing policy and, subsequently, will assess opportunities of how such barriers can be overcome.

2.3.3 Models of citizen science

To fully comprehend the diversity of projects and how volunteers can engage in different capacities, it is useful to reflect upon the most commonly referenced models of citizen science. Bonney et al. (2009b), whilst discussing the wider topic of public participation in research, provide a general classification of the three separate types of citizen science initiatives. There are: (i) contributory projects, (ii) collaborative projects and (iii) co-created projects. In this interpretation, it is suggested that citizen science projects differ between each other based upon the degrees of control that participants have over the development of the relevant scheme. This three tiered classification is frequently referenced in academic papers discussing citizen science (see Rotman et al., 2012; Roy et al. 2012), and can be understood as representing an elementary overview of how the engagement level of participants can be used to define a project. Contributory projects appear as the most common model of citizen science, with Krasny and Bonney (2005) suggesting that only select projects involve volunteer participation beyond data collection tasks. Most commonly, participants deliver their collected data to scientists, who then use it in their own research (Rotman et al., 2012). To gain a deeper understanding of the differences between each model, the below segments debate them in more detail.

Contributory citizen science

Within this first meaning, the role which participants play in citizen science is generally understood as a service to scientists (Bonney et al., 2009). Projects are set up, designed and coordinated by scientists or experts, with volunteers carrying out contributory roles. Largely, this involves participants collecting data, while the research question and objectives are constructed by coordinators. Such projects are most commonly large-scale efforts, whereby participant numbers can reach into the hundreds, and often cover wide geographic areas over long spans of time. One of the first examples of such a project, and indeed one of the first recognised citizen science schemes, was the Audubon Society's Christmas Bird Count.

Contributory citizen science projects are best understood as 'researcher-driven' schemes, which primarily focus on the generation of knowledge (Bonney et al., 2009b). There is limited scope for the development of learning and social outcomes in this model, as the objectives of such projects are, primarily, focused on the advancement of research.

Collaborative citizen science

Similar to contributory approaches, collaborative citizen science projects are designed by experts and scientists. However, rather than solely restricting the contribution of participants to solely data collection procedures, participants can also help to refine design issues, analyse data and disseminate findings. The collaborative model presents a significantly more open and inclusive approach for citizen science. An example of such a project is The Salal Harvest Sustainability Study, coordinated by University College Berkeley and the Northwest Research and Harvester Association (Bonney et al., 2009a). The project ran from 2001 to 2004 and set out to determine the effects of different harvest intensities, in an attempt to inform and improve management practices. Importantly, all participants depended upon harvesting salal for employment or livelihood purposes. Following a range of training courses led by coordinators, participants were tasked with carrying out site assessments, research design refinements and data collection. In general, the project is considered collaborative as the participants played a role in the logistical, empirical and conceptual aspects of the scheme. Whitelaw et al. (2003) discuss how many volunteer monitoring schemes operate under such conditions. Such efforts are marked out from contributory projects, where volunteers play less dynamic roles. Generally, collaborative citizen science is understood as an approach to participatory research which values the active involvement of both volunteers and coordinators. While coordinators still organise and drive the projects, volunteers have much more scope to engage with the topic under examination and experience a much broader range of research tasks.

Co-created citizen science

A co-created project is an approach to citizen science where scientists and members of the public work in tandem. Participants are actively involved in all steps of the scientific process. As Bonney et al. (2009b) explain, co-created citizen science is understood as an expansion upon contributory and collaborative approaches, where citizens are recognised as equally reliable producers of scientific knowledge as experts. "In co-created projects, members of the public come up with a question or issue, often a community concern … and then work

with scientists to answer the question and suggest solutions" (Bonney et al., 2009, p. 18). An example of a co-created project is the Reclam the Bay scheme. Set up as an educational project by the New Jersey Ocean County Cooperative Extension office, the project began in 2005 and seeks to engage local community members in restoring shellfish and maintaining clean water in the Bargnegat Bay. The project can be viewed as a co-created citizen science scheme due to the fact that ownership was officially handed over to the participants in 2006. While expert coordinators initiated training courses at the beginning of the project's trajectory, participants have been deeply engaged in all aspects of the scheme. As well as setting up research questions and parameters, the participants carried out all data collection procedures and, as alluded to, then took control over the project's development. Tasks such as analysing data, drawing conclusions and assessing impact are primarily carried out by participants, while assistance from experts operates at a much smaller level than before.

The model of Bonney et al. (2009b) provides a basic overview of how practically diverse participation in citizen science can be. Their classifications neatly clarify the scope of the practice and explain how projects can differ from one to another, depending on the context they are operating within. The differentiations between each model relate to the varying engagement levels of volunteers and the correspondent flows of knowledge which are inherent within such projects. While their model are regularly referenced in citizen science research, they fall short of providing a comprehensive overview of how projects operate in an organisational and political sense. The model suggest that the degree of volunteer knowledge production is the only factor that defines a citizen science project. In reality, this is a one-dimensional interpretation of the practice. Whilst this study does not seek to create a new model of citizen science, the framework of Bonney et al. (2009b) is useful to link back to when the findings of this research are analysed. By discussing the range of the factors that are seen to influence the transformative potential of projects, this three types of citizen science model can be critiqued and alternatives suggested.

A further model of citizen science is provided by Conrad and Hilchey (2011). Their framework develops on the work of Bonney et al. (2009b) by debating the governance structures of citizen science projects. They outline three separate structures: (i) consultative/functional governance, (ii) collaborative governance and (iii) transformative governance. These build upon wider discussions regarding citizen participation in environmental decision-making, with the practice of citizen science used as a case of examination. The three tiered

governance structure reconfigures the work of Lawrence (2006), who classifies four separate levels of participation in environmental governance processes – consultative, functional, collaborative and transformative. Recognising that citizen science generates internal values – "contributions of the participatory process to personal learning and development and relationship to nature" – and external values – "public utility of data for decision-making purposes", Conrad and Hilchey (2011, p. 276) do not suggest that there is an either or situation with participation. Neither do they suggest that citizen science projects neatly operate under one or the other of their governance categorisations. Rather, they emphasise the importance of recognising the governance arrangements that projects interact with. In turn, an awareness of these boundaries is proposed as a means of helping to reveal the potential which a project has, or has not, to create outwardly benefit society. This is the key value of the model put forward by Conrad and Hilchey (2011).

Consultative/functional governance

In a consultative and functional level of participation, it is implied that members of the public are responding to requests of government or that government are making decisions before engaging with them (Lawrence, 2006). In this sense, the *status quo* remains unchallenged and participation is initiated through existing structures of governance. As Lawrence (2006) discusses, this does not necessarily result in participation being limited to small-scales, but it does operate in top-down manners. In a practical sense, consultative/functional monitoring often involves citizens presenting initial measurements of issues of environmental concern, which are then professionally examined by experts (Whitelaw et al., 2003). Conrad and Hilchey (2011) provide an example of consultative governance by linking to the idea of citizens carrying out 'watch-dog' services. For instance, in countries where endangered species are at risk of illegal poaching, consultative monitoring schemes have been established where citizens provide information for government. Such information can generate long-term data sets, upon which decisions can be based. Evidently, this links closely to what Bonney et al. (2009b) describe as contributory citizen science. Citizens are restricted to carrying out data collection roles and have little influence in regards to shaping their participation. Likewise, there is less scope for engagement between volunteers and the topic of investigation, or for the development of educational learning outcomes. The impact of citizen science projects that have consultative/functional governance structures can be significant in the short-term, but rarely do such approaches continue once the original objectives are reached or once funding ceases (Conrad and Hilchey, 2011). Importantly, as

Mullen and Allison (1999) point out, consultative/functional governance structures commonly involve a limited amount of stakeholder groups. For instance, a project examining an aspect related to fishing, which only involves fishers themselves.

Collaborative governance

A second level of governance that is said to underpin citizen science projects is termed collaborative. Such projects, as Conrad and Hilchey (2011, p. 277) explain, "are often governed by a board or group representing as many facets of the community as possible: private landowners, the general public, businesses, government, universities". Evidenced by its title, participation involves much more of a collaborative approach, where stakeholders have a greater influence upon decisions made regarding the set up and development of the project. For this reason, Whitelaw et al. (2003) suggest that it is an approach to participatory research that is on the rise. To exemplify this level of governance, Conrad and Hilchey (2011) discuss community based co-managed fisheries in Bangladesh. The example discuss how multi-stakeholder management approaches, more so than bottom-up schemes, have generally led to enhanced social, economic and environmental benefits. "Fisher-led management groups were sometimes economically unrepresentative — with richer, more influential fishers more prevalent than more economically underprivileged fishers. In the multi-party co-management groups, these poorer fishers felt more represented — and less intimidated" (Conrad and Hilchey, 2011, p. 277). It is clear that collaborative governance is similar to the collaborative model of participation presented by Bonney et al. (2009b). It operates in between contributory approaches, where volunteers play limited roles, and co-produced schemes, where volunteers are central to the development of projects. Interestingly, Conrad and Hilchey suggest that bottom-up models may struggle to exert the same levels of influence as collaborative approaches. Coordination with experts who may already have strong links to decision-makers and funders is key for collaborative endeavours, yet this is something that bottom-up models may take time to establish.

Transformative governance

This is a governance structure that is often termed as bottom-up or community-based. Stemming from the nature of participation in such projects, they are regularly born out of crisis and tend to focus on tackling particular local issues that have been ignored or only partially examined by government. Similar to the co-produced model discussed by Bonney et al. (2009b), transformative citizen science projects are less likely to have private sector or

government support at their initiation (Whitelaw et al., 2003). This regularly results in funding support, as well as leadership and organisation, deriving from local communities and project participants (Mullen and Allison, 1999). In a conceptual sense, Bradshaw (2003) recognises how the transfer of decision-making authority to the local public has the potential to create a more sustainable style of governance. However, there are several limitations of bottom-up projects. These can stem from weak organisation and coordination credibility, as well as the fact that projects often examine issues that have traditionally received little policy support (Conrad and Hilchey, 2011). The obvious benefit of a transformative governance structure in a citizen science project is the ability of participants to engage with all stages of research, analysis and dissemination. Volunteers have a strong capacity to creatively shape the project and actively involve themselves with its development. Coordinators and scientists in transformative structures plays more of an advisory role, guiding participants as opposed to setting their agenda. An example of a transformative community monitoring initiative, as discussed by Conrad (2006), is the Bucket Brigade of Halifax, Novia Scotia. Initiated in 1995, the group acted as a response to a lack of government action over air-quality concerns. The group set up their own monitoring systems, which were then submitted to and validated by the Canadian Environment Protection Agency. The transformative model takes further steps up the ladder of participation, although the benefits of this must be weighed against its potential limitations.

Like the work of Bonney et al. (2009b), the governance model presented by Conrad and Hilchey (2011) centres around knowledge production processes and a project's structure of participation. They discuss how "it may be that certain governance structures suit different monitoring situations (and communities)" (Conrad and Hilchey, 2011, p. 279). However, governance structures do not conform to or develop around the context of a citizen science project. Rather, citizen science projects develop around governance structures that are shaped by the power of more powerful actors; funding commissioners, policy-makers. Using the example of government funded citizen science, it appears crucial that research must examine how the governance actors can instruct the level of volunteer engagement and the types of knowledges that are produced by projects. Being driven by oriented objectives set by governance actors may explain why many citizen science schemes fail to generate transformative change. However, this is an issue of governance that the Conrad and Hilchey (2011) model, as well as wider research on the practice, does not consider. Accordingly, it is an important aspect of how this study examines citizen science.

2.3.4 (Re)framing the transformative potential of citizen science

The emergence of citizen science has come to light with promising opportunities for the management of the marine environment (Carcia-Soto et al., 2017). Marine citizen science has been advanced as a cost-effective means of producing knowledge to inform marine policy (Hyder et al., 2015; Schläppy et al., 2017), to broaden the engagement of communities with governance processes (Turrini et al., 2018) and to instil scientific and environmental learning developments amongst participants (Haywood, 2016). This growing recognition has led to the framing of citizen science as a participatory approach that can transform conservation management into more transparent, socially relevant, and democratic processes (Cross, 2019; Serrano et al., 2014; Couvet & Prevot, 2015; Turrini et al., 2018). In response to studies that have revealed how marine governance regimes commonly problematise issues in line with hegemonic agendas (Flannery & McAteer, 2020), rationalise specific ways of knowing (Jentoft, 2017; Said and Trouillet, 2020), and fail to actively involve members of the public in planning processes (Flannery et al., 2018), citizen science presents itself as an interesting approach that has the potential to function as a solution to some of these challenges. However, as this chapter has revealed, the manner in which citizen science research conceptualises transformation remains limited. There is little evidence amongst research to suggest that projects are consistently contributing to societal or scientific transformation.

Although studies have revealed significant insight into transformative learning (Bela et al., 2016; Ruiz-Mallén et al., 2016), it appears that a more explicit interpretation of the relationship between power and knowledge is required to fully comprehend how citizen science can help to transform the major challenges regarding knowledge use and participation facing marine governance processes. In particular, this review has revealed how there is an under-appreciation within the citizen science literature of how transformative change must involve actions that challenge dominant power relations. An inattention to power issues is a common issue with transformative practices (see Blythe et al. 2018; Bennett et al. 2019; Kelly et al. 2019; Morrison et al. 2019) and it appears to be inhibiting examinations of how citizen science can become a truly transform approach. Although studies have begun to critically analyse the role of power in the realm of knowledge co-production, revealing crucial insights about transformation barriers that participatory interventions can encounter and how they can paradoxically reinforce dominant structures

(see Turnhout et al. 2010; Lemos et al. 2018; Oliver et al. 2019), power remains a relatively underexplored topic in citizen science literature. *Chapter 3* of this thesis, discusses and explains these conceptual topics in greater detail, clarifying how they can inform the reframing of the transformative potential of citizen.

Particularly when assessing how citizen science literature interprets the production and use of knowledge, this review sheds light on how a high majority of projects generate contributory knowledge. This, in effect, is limiting the capacity of citizen science to mitigate, as opposed to reproduce, unequal power relations. At the basis of these limitations, lies a strong tendency to depoliticise citizen science and ignore the productive capacity of projects. When solely framing knowledge as a contributory force and restricting evaluations of learning and action beyond the volunteer level, much of the citizen science literature is unable to fully examine how projects can most effectively generate transformative outcomes. Ultimately, there is an evident need to reframe the misunderstood potential of transformation in citizen science. In its current operation, citizen science is unlikely to truly respond to the major challenges facing marine governance processes or to instigate change to management approaches. It is the role of research to critically uncover the barriers that are preventing transformative citizen science and to reveal the opportunities through which projects can reclaim this potential.

2.4 Conclusions

This chapter has reviewed the fields of marine governance and citizen science, critically assessing their association to one another. By problematising the manner in which marine governance regimes rationalise knowledge and constrain public engagement in policy processes, the capacity of citizen science to act as a solution to these concerns is assessed. Citizen science literature, however, has revealed little on the ability of projects to instigate transformation. Instead, there are distinct examples of how research is misrepresenting the potential of citizen science, with studies doing little to call for a radical reframing of the approach. This literature review sets the context for this thesis. It reveals specific gaps of knowledge and limitations amongst research and, subsequently, presents insight on how alternative pathways of study could be followed. Building on the information revealed in this chapter, *Chapter 3* moulds a theoretical framework that conceptualises the field of citizen

science and informs this study's approach to exploring how the transformative potential of projects can be maximised.

3

POWER/KNOWLEDGE

3.1 Introduction

"[A]ny geography mobilised in a governance context carries power"

(Healey, 2007, p. 231)

At the core of this study's conceptual framework is the theory of power. Both in a theoretical and practical manner, power remains a contested topic. Understood as a force of domination and resistance by some, and as a process of collaboration and transformation by others. The lack of conceptual unity is a reflection of the diverse nature of power more generally. There is, however, a clear understanding that, in social science research at least, it cannot be ignored, nor dismissed. "To live in society is to live in such a way that action upon other action is possible – and in fact ongoing – because power is ever present in social relations and a society without power relations can only be an abstraction" (Foucault, 1982, p. 222). Effectively then, any case of social relations under analysis that does not recognise or account for the role and influence of power, will fail to provide a true representation of how the relevant field operates in practice. This renders it crucial that citizen science research must cater for the role and influence of power whilst attempting to interpret the transformative potential of the practice. In particular, research must question how and why projects are shaped as they are – in regards to their objectives, knowledge production processes, levels of engagement, funding stipulations and organisational structures – and examine the arrangements of power that facilitate such conditions. With this understanding, it can then become possible to consider how to challenge such arrangements.

This chapter is divided into three sections. The first begins by examining the topics of power *(3.1.2)* and knowledge *(3.1.2)*. An overview of the different types and interpretations of power is presented, before social theoretical explanations of what knowledge is are assessed. This sets the tone for this study's conceptual framing, clarifying both the complexities of power and knowledge, and how they relate to one another. The second section *(3.2)* of this chapter focuses exclusively on Foucault's thinking of power and knowledge. Specifically, his theory of the power/knowledge nexus is explored. Insight on the method and operations of power/knowledge is presented *(3.2.2)*, before a justification is put forward to explain why the work of Foucault is a neat fit for this research. This segment concludes by considering the limitations of the power/knowledge nexus *(3.2.3)*. The third section of this chapter assess how the theory has been used in other fields of study *(3.3)*. Its

utilisation within the realms of political science and environmental management is reviewed *(3.3.1)*, before a discussion on the relevance of power/knowledge for this study's exploration of the transformative potential of citizen science is presented *(3.3.2)*. The chapter then concludes by outlining how these theoretical teachings relate back to this study's literature review, as well as informing the research design of that is to be followed *(3.4)*.

3.1.1 Power

References to power permeate everyday communications, with associations made between power and the topics of creation, repression, conflict, negotiations, winning, losing, and change. The dictionary definition of power distinguishes between the agency of an actor to act and their capacity to influence others. This distinction between acting individually and instigating collective action raises fundamental challenges for social research. Social theorists also seek to describe both the power of social actors and the ways in which power, and hence resources, are concentrated, dispersed and routed through social structures or networks (Lukes, 1986). Given the diverse way in which power is discussed and assessed, it is unsurprising to learn that, in philosophical terms, there is no conclusive or universal definition of power. It is an essentially contested topic. Demonstrated as a something that operates in both practical and psychological manners, scholars continue to call for power to become the conceptual focus of research that attempts to interpret and critically evaluate systems of governance. Indeed, as Lasswell and Kaplan (2013, p. 75) competently note that, "the concept [power] is perhaps the most fundamental in the whole of political science: the political process is the shaping, distribution, and exercise of power". Due to its centrality, researchers have conceptualised all forms of social relations in a multitude of different ways. Each conceptualisation of power is, perhaps, most accurately defined as a "local language game" (Wittgenstein, 1967, p. 32). In other words, a sub-language within the greater debate.

Added to divergent interpretations of power, complexity also arises due to the different forms, or types, of power that theorists discuss. Assessing these different forms supports a base-level understanding of how power functions and is exercised within social arrangements. Drawing on VeneKlasen and Miller's (2002) discussion regarding the four forms of power – 'power over', 'power to', 'power within', and 'power with' – what becomes

clear is that power is not simply a negative or constraining force, but also a productive force that can create new arrangements, forms of knowledge and rationalities that influence social behaviour. The four forms of power are briefly outlined below.

Power over

The most generally recognised expression of power. A form of power that is linked to the possession of control, authority and influence. This form of power is, therefore, presented as a constraining arrangement. Gaventa (2006) discusses the expression as a form of power that revolves around the idea of domination. Power is taken from the relatively powerless and used as a means of exerting authority and control over them. In turn, this restricts the ability of the oppressed to gain power and reconfigure the relations which continuously structure their lives. A simple example of a power over relationship in practice is the link between political decision-making and citizens. A traditional political-citizen relationship is, commonly, presented as an arrangement between those who have power regulating the actions of those without. VeneKlasen and Miller (2002, p. 39) expand upon this, illustrating how "when people are denied access to important resources, like land, healthcare, and jobs, 'power over' perpetuates inequality, injustice and poverty".

Power with

In this arrangement, power is constructed through mutual agreement amongst divergent interests (Gaventa, 2003). In a general sense, this then creates a collective power, which is significantly stronger than that of a contributing individual. VeneKlasen and Miller (2002) discuss how a power with arrangements can assist in the process of building relationships between a range of actors, which, in turn, can benefit all those who participate. A discussion regarding the creation of coalitions – adjoining political parties, networks of research projects, business mergers – can prove a useful example of explaining how power with arrangements operate in practice. A successful coalition finds common ground among different interests and is based on mutual support, solidarity, and collaboration. In the right circumstances, such collective approaches can function as a means of transforming or reducing conflict, and opening up new avenues to challenge existent relations or promote more equitable alternatives. Any project that seeks "to move citizen voice from access, to presence, to influence" will draw upon collective resources in an attempt to reach its objective (Gaventa, 2006, p. 24).

Power to

In this form, power is conceptualised as "the unique potential of every person to shape his or her life and world" (VeneKlasen and Miller, 2002, p. 39). The term empowerment is regularly linked to the expression of power to, due to the manner through which it attempts to acquire power, rather than exercising it. While power over is understood as a means of exercising power so as to limit to the degree to which particular subjects can obtain power, a power to relation is understood as the opposite. It revolves around the idea that a subject, even when seemingly constrained by the arrangements of more powerful actors, has the potential to challenge and make a difference (Gaventa, 2006). A 'power to' relationship can be exemplified through the case of citizen education schemes, where individuals are provided with arrays of knowledge that can enhance their practical and mental abilities to conceptualise and initiate change.

Power within

While largely linking to the notion of power to, power within slightly expands upon the capability of subjects to "imagine and have hope … [and] affirms the common human search for dignity and fulfilment" (VeneKlasen and Miller, 2002, p. 39). The capacity of 'power within' largely links to changes within the consciousness of subjects and is often referred to when discussing agency in the realm of social change. As VeneKlasen and Miller (2002, p. 39) explain, "'power within' has to do with a person's sense of self-worth and self-knowledge. It includes an ability to recognise individual differences". Importantly, gaining a sense of self-identity, which can be understood as a means of building confidence and strengthening awareness, is a prerequisite for action (Lukes, 1986). It could be argued that power from within is the most empowering of all forms, as it strides for individual development.

In addition to the conceptualisation of different forms of power, a long-standing debate within the power field relates to the dimensions of how power operates. This began with Dahl's seminal framework that defined political power in terms of a relation between people. Dahl's symbolic model of the power of 'A over B' advocated that "A has power over B to the extent to which A can get B to do something which B would not otherwise do" (Dahl, 1957, p. 203). Following this, Bachrach and Baratz (1962) responded to Dahl's one-dimensional model by introducing the notion of non-participation and exclusion, a theory that would go on to be regarded as the two faces of power approach. Lukes then presented the concept of

ideological power. A response to the limitations of the two faces of power model, Lukes (1986) contribution is understood as the third dimension of power and highlights how the effects of power cannot solely be understood as processes of decision-making and agenda setting, but also as something that operates at a deeper, more intangible level. Whilst this three-dimensional perspective of power has provided a useful way of interpreting power, it has not existed without disapproval. Principally, the framework is critiqued for its limited interpretation of power as a negative power over arrangement. There is little recognition of the productive capacity of power, something that is central for transformative social change to occur. To compensate for this shortcoming, the work of Foucault has regularly been put forward as a means of moving beyond the three-dimensional view of power. For Foucault, power does not only function in select situations. Rather, it is something inherent in all social relations (Foucault, 1982). In this sense, power becomes “a multiplicity of force relations”, which is diffuse in nature and inherently bound to all social interactions (Foucault, 1979, p. 72). This, evidently, counters the three dimensional argument that power is exerted by particular individuals over recognised issues. Instead, Foucault presents power as something that must be understood as an endlessly functioning network. Rather than exerting power, subjects are constituted through power. Quite simply, their actions contribute to the operation of power (Foucault, 1980). Similarly, rather than portraying power as a commodity that could be acquired or possessed, Foucault describes power as a heterogeneous ensemble of strategies and techniques. Such techniques then function in the character of a network; where their threads extend everywhere (Layder, 2005). As Foucault (1979) explained:

> "Power is everywhere: not because it embraces everything, but because it comes from everywhere. Power is not an institution, nor a structure, nor a possession. It is the name we give to a complex strategic situation in a particular society" (p. 93)

While actors do exert power, they are constantly embedded in historically and socially constructed arrangements. For example, institutions and discourses (Foucault, 1982). These structures constitute the identities of actors, enabling and constraining certain types of behaviour over others. As such, power is not related to the role of the individual *per se*. Rather is a function of one's place or position within networks (Foucault, 1979). The positionality of an actor within a particular network is vital in regards to the power in which they can feasibly exercise. Such assertions of power, as presented by Foucault, represent a movement away from more humanistic stances, which were criticised for vastly over

exaggerating the freedom of individuals (Layder, 2006). Foucault is keen to emphasise how "the human subject is not inherently free; but, instead, hedged in on all sides by social determinations" (Layder, 2006, p. 117). However, this is not to suggest that power cannot be challenged. Foucault is clear that power must also be interpreted as a productive force. It can create new realities and new ways of knowing. As such, it must not be considered as a zero-sum game.

3.1.2 Knowledge

Knowledge, in a theoretical and practical sense, represents a widely debated topic in classic and modern philosophy. Similar to understandings of power, there remains no exclusive definition of what knowledge is. An individual's definition of knowledge will inherently link to their understanding of power, hence why the scholars within the three-dimensional model of power and beyond present varying interpretations regarding the function of knowledge. What is definitive, however, is the importance placed upon the topic of knowledge in social theory. The study of knowledge is referred to as epistemology, which presents a more general concept of how an individual examines the nature, justification and rationality of knowledge. One classical definition of knowledge, presented but seemingly not fully endorsed by Plato, specifies that for a statement to be legitimately understood as knowledge; it must be justified, true and believed. This 'justified true belief' account of knowledge has become an influential view in the field of epistemology. Developing upon it, the work of Nozick, Kirkham and Wittgenstein represent advancements to the field. Nozick (1981) argues for a requirement that knowledge 'tracks the truth' and calls for a switch from causation to a counterfactual analysis of knowledge. Adding to these assertions, Kirkham (1984) stipulates that a subject's definition of knowledge postulates that the evidence for the belief necessitates its truth. Wittgenstein (2010) argues that it is not the mental state of the speaker that dictates the knowledge which they discuss, but the activity in which they are engaged.

To fully comprehend the topic of knowledge, it is crucial to examine how it is practically exercised. There are various forms of knowledge that are referenced by social theorists. *Table 3.1* illustrates some of the most commonly discussed forms and defines their meaning. Some classifications directly relate to other forms, while some appear as standalone

interpretations of knowledge. Perhaps the two most notable types of knowledge are explicit and tacit knowledge. The former refers to codified knowledge, such as that found in documents, while the latter refers to personal or experience-based knowledge. Although the conceptualisation of explicit and tacit knowledge has become a cornerstone of the knowledge debate, Botha et al. (2008) wisely note that the relationship between the two types should be understood as a spectrum, as opposed to definitive points.

Table 3.1 – *Forms of knowledge*

A priori	Translates to "from what is before". *A priori* knowledge depends upon what a person can derive from the world without needing to experience it. In other words, knowledge which can only be drawn from reason.
A posteriori	A reference to experience. The term translates to "from what comes after." It is a form of knowledge that uses a different kind of reasoning, inductive, to gain knowledge. This kind of knowledge is gained by first having an experience and then using logic and reflection to derive understanding from it. In philosophy, this term is sometimes used interchangeably with the term empirical knowledge.
Explicit knowledge	This is understood as formal knowledge. It is knowledge that is recorded and communicated through mediums. Botha et al. (2008) discusses how explicit knowledge is regularly found in databases, memos, notes or documents. Generally, the specifics of what is contained is less important than how it is contained. The defining feature of explicit knowledge is that it can be easily and quickly transmitted from one individual to another.
Tacit knowledge	Tacit knowledge must be acquired to a degree that goes beyond theory. It can only be communicated through consistent and extensive relationships or contact. It closely resembles *A posteriori* knowledge, as it can only be achieved through experience. Due to the contextual dependence of tacit knowledge, it can be difficult to comprehend how and when it can be made useful.
Embedded knowledge	Embedded knowledge refers to the knowledge that is locked in processes, products, culture, routines, artefacts, or structures. For instance, knowledge can be embedded through a management initiative to formalise a certain routine. Similar to tacit knowledge, embedded knowledge can be difficult to understand and evaluate. It can also prove

	difficult to change such knowledge when it is embedded within long-standing practices.

Furthermore, the recognition of Aristotle's concept of phronesis adds an important conceptual framing of knowledge. Aristotle believed that the concepts and knowledge that underpin an individual's life are, ultimately, based upon perception. By classifying knowledge into three defined categories – *episteme, techne, phronesis* – the theory simplifies the knowledge debate. Aristotle's model clarifies how, if the supposed truth is to be reached, knowledge must involve both practical and theoretical insight. The combination of theory and practice, in turn, can facilitate the development of practical wisdom over a specific domain. Additionally, the concept of phronesis indicates how true knowledge requires conscious deliberation regarding the workings of societal systems and an understanding of how particular goals or aims are reached.

Table 3.2 – *Aristotle's interpretation of knowledge*

Episteme	Translated as 'to know', *episteme* is related to scientific knowledge and understanding. It is 'the theory of something'. It presents information about the world and how it works. Crucially, it is understood as being a form of transmittable, explicit knowledge. The word epistemology, it is important to realise, derives from the term *episteme*.
Techne	The word translates to all kinds of 'craft' and 'artistic knowledge'. People are often unaware of the techne that they possess and fail to comprehend how it can be of value to others. Principally, this is because it is personal knowledge and not necessarily something understood through formal education. Most importantly, it is not a form of knowledge that is easy to share and must be learnt through practice.

Phronesis	*Phronesis* is understood as 'practical wisdom'. Aristotle discusses phronetic knowledge as a term stemming from the two types of wisdom in philosophical thinking: **(i)** *Sophia* – the ability to think about the nature of the world and to find universal truths; and **(ii)** *Phronesis* - the ability to realise how a specific goal or value is reached. *Phronesis* includes aspects of a situation, critical analytical reflection and scrutinizing knowledge systems, practices and the impacts of goals that are taken for granted. When having the needed episteme and techne of a specific domain, one can develop the capability to find the 'right answer' via *Phronesis*. It builds upon relationships of theory (*episteme*) and practice (*techne*).

Developing upon Plato's classical account of 'justified true belief', as well as modern retorts such as Wittgenstein's relational understanding, this study comprehends knowledge as a social construct that reflects prevailing power relations and is inherently shaped by societal arrangements. Additionally, by reviewing the forms of knowledge that are presented in the above tables, it is clear that knowledge comprises of both codified (technical) and non-codified (experience-based) components. Aristotle's model of *Phronesis*, in particular, clarifies this. Aristotle interprets true knowledge as something that is based upon both theoretical and practical wisdom. This also involves critical reflection upon reality and the structures that dictate systems of decision-making. To fully comprehend knowledge, therefore, it is crucial to conceptually relate it to power. Although knowledge is only one of many resources in the power field, it, more than any other, "determines what is conceived as important, as possible, for and by whom" (Gaventa and Cornwall, 2001, p. 72). Accordingly, an understanding of how knowledge is produced and used in relation to power is crucial in any study that attempts to pick apart social and governance structures.

3.2 The power/knowledge nexus

The concept of power/knowledge was constructed throughout the 1970s, during a time when Foucault's work began to explore the topics of disciplinary power and sexuality. Although Foucault's earlier focus centred on historical studies of the manner in which knowledge had been reconfigured over time, this period of research demonstrated how knowledge is inherently intertwined with arrangements of power (Rouse, 1994). This shift of interest signalled a movement away from exploring the epistemic context of knowledge, towards a process of understanding the productive capacities of power and knowledge (Gutting, 1989). The development of Foucault's approach between these two periods is regularly referred to as his transition from archaeological to genealogical research (Shiner, 1982). In the decades that have followed, Foucault's interpretation of the relationship between power and knowledge has developed into a central component of contemporary social theory. Influencing research on a vast array of disciplines – from political science to environmental management – the concept of power/knowledge has revealed crucial insights regarding the manner through which our understanding of reality is shaped by specific arrangements. Similarly, social scientific research has advanced the utilisation of the power/knowledge nexus as a means of picking apart governance regimes and exploring how undemocratic conditions can be altered.

To fully comprehend the concept of power/knowledge, it is important to consider a number of key questions. First, what Foucault is telling us about the relationship between power and knowledge? Second, how does power/knowledge forces us to consider other aspects of his work? Third, is power/knowledge applicable to contemporary research? Beginning with a review of Foucault's discussion of discourse, disciplinary power and the creation of norms, the following section examines Foucault's historical understanding of power and how knowledge relates to these assumptions. After this, the topic of sovereign and state power is debated, due to its important discussions of power and knowledge. It is crucial to critically explore this period of Foucault's research and to comprehend what the movement beyond sovereignty can tell us about the process of challenging power. Briefly, the much debated methodological approach of Foucault is also reviewed. This presents further insight on the understandings of power/knowledge and how their teachings can be practically operationalised in research. Finally, space is given to debate the many criticisms of the power/knowledge concept. This debate is broken down in three particular critiques.

Crucially, this section will also examine how such supposed limitations can be overcome. Reviewing Foucault's response to his opponents will be critical to this and will, simultaneously, highlight the contribution which power/knowledge makes to the power debate.

3.2.1 Foucauldian thinking

The work of Foucault is, perhaps, most appropriately defined as an examination of the history of thought (Gutting, 1989). Indeed, almost all of Foucault's major pieces of work are, in one way or another, historical examinations of specific domains. Stemming from the topics of liberation and individual autonomy, which feature heavily in Enlightenment discourse, Foucault's work opened up new understandings regarding the structure of society and how knowledge is used to shape human agency (Rouse, 1987). Indeed, the topic of knowledge was of analytical interest to Foucault well before an explicit association to power was made (Flynn, 1994). Following an archaeological approach to research, Foucault's earlier work sought to examine the manner through which knowledge can become intelligible and authoritative over time (Rouse, 1994). Key to this was the evaluation of discourse. Foucault demonstrated how historical shifts in discursive formations were evident in many domains – including madness, language and disease – and used these insights to conceptually explain the meaning of similar shifts in contemporary society. In this sense, Foucault examined knowledge not for its own sake, but as a means of revealing truths which, when presented, could challenge the dominant relations which underpin society (Gaventa and Cornwall, 2001). Foucault's exploration of human thought, as such, can be understood as following two objectives. First, to demonstrate how humans can be constrained by knowledge. Second, to conceptually map out how such constraints can be challenged and overcome. While these objectives largely remained at the core of Foucault's approach to examining human thought, there was significant change to the manner in which he conceptualised and examined knowledge (Jones and Porter, 1994).

The mid-1970s saw the introduction of disciplinary power to Foucauldian thought. Generally, this extended the scope of Foucault's research on the workings of knowledge and presented new insights to the power debate. Whilst exploring transformations of the human sciences throughout the eighteenth-century, Foucault (1975) charted the reorganisation of the power

to punish. This discussed the development of various bodies of knowledge that reinforce and interact with disciplinary power, producing specific punitive approaches (Flynn, 1994). While an analysis of discursive formations remained of interest in this phase, Foucault's (1975) focus shifted away from the manner in which discourse is reconfigured. Instead, emphasis was placed upon the analysis of how new forms of knowledge were developed and how they inform alternative discourses. In this light, it is possible to work out how new kinds of knowledge can construct fresh ways of shaping social control (Gutting, 1989). To exemplify this change of direction in Foucault's thinking, it is useful to acknowledge how he demonstrates transformations in the scale and longevity of disciplinary power. While exertions of punitive power in medieval times were regularly referenced as large-scale, yet relatively rare occurrences – public executions, as one example – more refined and subtle approaches to disciplining social behaviour became apparent in later centuries. For instance, long-term practices of disciplinary processes became common where the intention was to reconstruct 'the body', so that new kinds of citizens could be constructed (Rouse, 1994). As Foucault (1975, p. 138) asserts:

> "The human body was entering a machinery of power that explores it, breaks it down and rearranges it ... It defined how one may have a hold over others' bodies, not only so that they may do what one wishes, but so that they may operate as one wishes, with the techniques, the speed and the efficiency that one determines. Thus discipline produces subjected and practiced bodies, 'docile' bodies"

This modern regime of disciplinary power that Foucault discusses – termed as 'bio-power' – is based on the organisation of bodies in time and space, according to strict technical programmes and schedules (Gutting, 1989). Bio-power operates as a force that targets whole populations, rather than select individuals, subjecting and ordering their participation through the rationalisation of specific knowledge arrangements (Gaventa, 2003). In other words, the use of knowledge through technical discourse to shape the conduct of citizens. Such discourses normalise certain practices and routines, whilst creating perversions out of those that they exclude (Layder, 2006). These technical exercises serve "to economize the time of life, to accumulate it in a useful form and to exercise power over men through the mediation of time" (Foucault, 1975, p. 162). These processes of subjection also function in indirect manners, wherein spaces of human activity are reconstructed to subconsciously advance specific forms of activity (Rouse, 1994). Ultimately, Foucault demonstrates how bio-

power is measured against a norm. It forces individuals to regulate their behaviour according to particular interpretations of how individuals should act (Layder, 2006).

Pulling together these insights on discipline, bio-power and the creation of norms, it is clear that Foucault is making an important point regarding the productive capacity of power. Rather than a force which operates solely as a means of domination, as contributors to the three-dimensional model of power assert, Foucault demonstrates how power/knowledge can create new approaches to subjecting citizens through 'regimes of truth' (Gaventa and Cornwall, 2001). This shifts the question of "who exercises power over whom", which the three-dimensional model poses, to "how do persons exercise power over other persons" (Ingram, 1994, p. 253). The concept of power/knowledge, as such, clarifies Foucault's rejection of power as something that certain subject possess. So, while Lukes (1986, p. 230) posts that "we are forced to produce the truth of power that our society demands", Foucault presents truth as a power/knowledge construct that can only be produced by virtue of constraint. In other words, Foucault demonstrates how truth is not some property of statements or beliefs that exists separately to arrangements of power. Rather, it is both constituted by and constitutive of power (Ingram, 1994). "There is no power relation without the correlative constitution of the field of knowledge, nor any knowledge that does nor presuppose and constitute at the same time power relations" (Sheridan, 1977, p. 22). Ultimately, the power/knowledge concept presents power as a means of policing the boundaries around the categories that knowledge defines (Rutherford, 2007).

Conversely, scholars have questioned how the tone of Foucault's genealogies of power appear to advocate for opposition against the modern forms of power/knowledge that he presents (Rouse, 1994). While Foucault provides no explanation as to how resistance to power/knowledge arrangements could be operationalised, there is a clear association made in his writings to critical knowledge. Indeed, some have interpreted Foucault's work on power/knowledge as a theoretical recommendation of the manner in which critical thought can be extended into other fields of research (Ingram, 1994). Such critical knowledge, as Rouse (1994, p. 99) asserts, has the capacity to "speak the truth to power, exposing domination for what it is, and thereby enabling or encouraging effective resistance to it". As this study is conceptually interested in exploring the potential of citizen science to produce critical knowledge as a means of challenging dominant power/knowledge arrangements, this is a crucial component of the Foucauldian debate to consider. More generally, this review

illustrates how power/knowledge can be used to conceptualise the field of citizen science, inform us of how and in what way power and knowledge arrangements predominantly function within and amongst projects, and demonstrate how citizen science can be reconfigured so that projects can overcome barriers to transformation.

3.2.2 Method and the operations of power/knowledge

To add a practical lens to this conceptual understanding of power/knowledge, it is important to examine how Foucault discusses the operations of the nexus. In other words, it is necessary to review the analysis procedures that Foucault uses whilst evaluating power/knowledge arrangements. The very nature of Foucault's understanding of power develops the foundation from which new interpretations of the relationship between knowledge and power can be charted. As demonstrated, this brings us to the conclusion that power and knowledge are analytically and politically inseparable; they constitute, imply and determine one another (Foucault, 1975). Foucault uses these assertions to make sweeping conclusions about the investigation of truth and power. It is important to take note of how Foucault discusses the operations of power/knowledge, as it presents important insights to his methodological approach. While there is an evident reluctance on Foucault's behalf to explicitly discuss the methodological procedures that underpin his work – indeed Foucault's work is said to "displace the traditional quest for method" – scholars have often associated Foucault with structuralist and post-structuralist movements (Shiner, 1982, p. 385). Much of Foucault's early writings, such as his work on the origins of modern medicine and the history of the human sciences, was influenced by the structuralist discourse of de Saussure and Lacan. However, Foucault himself rejected any link to structuralism. Instead, he used his archaeological and genealogical approaches, shifting from the former to the latter over time, to form the foundations of his analysis. As Foucault's work began to specifically employ a genealogical approach, scholars suggested that it offered a new philosophical foundation for the human sciences (Shiner, 1982). By critically evaluating the practicalities of Foucault's genealogical method, specifically in regards to the operations of power/knowledge, we can better understand how the concept can be operationalised within this study. To achieve this, it is important to clarify some core components of Foucault's assertions. Discussing the operations of the power/knowledge nexus, Foucault (1975, p. 27) demonstrates how:

> "These 'power-knowledge relations' are to be analyzed, therefore, not on the basis of a subject of knowledge who is or is not free in relation to the power system, but, on the contrary, the subject who knows … In short, it is not the activity of the subject of knowledge that produces a corpus of knowledge, useful or resistant to power, but power-knowledge, the processes and struggles that traverse it and of which it is made up, that determines the forms and possible domains of knowledge."

Quite simply, Foucault demonstrates the need to move beyond the notion of examining truth as a property of knowledge that a specific debate attempts to achieve. Instead, emphasis is placed upon conceptualising truth as a historical concept, one that is inherently bound to relations of power (Foucault, 1975). In turn, truth is framed as being 'of this world' (Rabinow, 1991). In other words, its roots and innate history can be examined in a genealogical manner, similar to the fields of punishment and sexuality (Foucault, 1975; 1980b). Whilst advancing this, Foucault brings us to the conclusion that truth can only be produced by virtue of multiple forms of constraint (Rabinow, 1991). Expanding upon the above quotation, we can understand how Foucault's genealogical method focuses on questioning three important issues. Primarily, the power-knowledge arrangements that underpin the 'knower'; secondly, the topics that are supposedly 'known'; and finally, the manner in which power-knowledge arrangements can constitute domains of knowledge (Foucault, 1975). Effectively, this calls for a shift to the manner in which we evaluate truth. Rather than querying *what* the things are which we believe to be true, Foucault feels the focus should be on examining *how* such things have developed to the level where they represent the truth. To legitimately comprehend how truth is developed, therefore, Foucault's genealogical method pushes us to examine the power arrangements that constitute the 'knowers', the 'known' and the domains of knowledge themselves (Shiner, 1982). Ultimately, what we can learn from Foucault's method is the need to interpret and investigate truth as an effect of power. Foucault emphasises how we must move beyond examining the 'essence' or 'true nature' of a specific truth, by instead decoding the arrangements of power that it is determined by. While this will not explicitly lead us to the uncovering of truth, it will reveal crucial insights about the operation of truth within particular domains and discourses.

Foucault's work has been termed as a collection of political critiques that confront both the 'liberal-humanist' separation of knowledge and power, as well as the Marxist conceptualisation of power as a means of economic and societal manipulation (Thiele, 1986).

In other words, "Foucault is not looking for a method which will be superior to other methods in objectivity and comprehensiveness but is forging tools of analysis which take their starting point in the political-intellectual conflicts of the present. Foucault's method is an anti-method in this sense" (Shiner, 1982, p. 386). Foucault's approach to method, therefore, is most appropriately understood as a means of eradicating the notion that it is possible to research in an apolitical manner. What is clear is that it is far from a standard methodological approach; hence the many objections and criticisms levied against it. What Foucault does reflect, however, is an alternative approach. His genealogical method widens the scope of the power debate; clarifying the operations of power and knowledge, and informing a political critique-infused approach to challenging regimes of dominance.

3.2.3 The limitations of power/knowledge

As a result of Foucault's radical departure from traditional approaches of interpreting and analysing power and knowledge, critics have continued to question the legitimacy of his genealogies. It is important to acknowledge these critiques, as they provide crucial insights to the manner in which power/knowledge has been employed beyond the realm of Foucault's own work. In particular, they demonstrate the limitations of following Foucault's proposed method of examining how power and knowledge relate to one another. This will, evidently, be useful information to draw upon when operationalising this study's conceptual framework. By evaluating the credibility of the apparent limitations of the power/knowledge concept, and seeking out philosophical responses to them, this study will be able to construct a more rounded, dynamic framework.

Scholars have suggested that Foucault's conceptualisations shoehorn us into understanding both power and knowledge as inherently 'bad' or 'evil' (Taylor, 1984). However, Foucault himself responded to assertions of this type, highlighting how the term bad is not necessarily reflective of how he understands power and knowledge. Instead, as he clarifies, "my point is not that everything is bad, but that everything is dangerous, which is not exactly the same thing. If everything is dangerous, then we always have something to do" (Foucault, 1984, p. 343). Effectively, this links to Foucault's wider conceptualisations regarding the positive and negative capacity of power, which emphasise how societal arrangements do not have to be bad – in the sense that they constrain or dominate – to instigate control over others. In

support of these assertions, May (1993) explains how Foucault is simply demonstrating how the difficulties of understanding power have been present for quite some time in political thought. While Foucault may have demonstrated how power operates within all social relations, there has, evidently, never been a consistent train of thought regarding its exercise. Specifically dealing with the claim that all forms of Foucauldian power are bad, May (1993, p. 113) questions: "does this mean that we are to reject any knowledge that proves to be enmeshed in relationships of power? No. To be in a relationship of power is not a mark of immediate rejection, but an invitation to a vigilant investigation". In effect, this demonstrates how all societal practices can be understood as dangerous when we consider the fact that power relations operate everywhere.

A further issue that scholars hold against Foucault's power/knowledge conceptualisations relates to its failure to construct a coherent theory of knowledge. Whether or not this was Foucault's intention, there is limited information to suggest that it was, Rorty (1986) asserts that its absence is a major limitation of Foucauldian thought. Linking to the work of Nietzsche, which informed large parts of Foucault's thinking, Rorty claims that genealogical approaches need to be underpinned by principles of objectivity to construct theoretical assumptions of knowledge. "As far as I can see, all he [Foucault] has to offer are brilliant (re)descriptions of the past, supplemented by helpful hints on how to avoid being trapped by old historiographical assumptions. These hints consist largely in saying: do not look for progress or meaning in history … Such purely negative maxims neither spring from a theory nor constitute a method" (Rorty, 1986, p. 47). In the perspective of Rorty, therefore, the inability of Foucault's work on power and knowledge to establish a theory of knowledge causes considerable concern. In stating this, however, Rorty acknowledges that, if Foucault's representation of power and knowledge is correct, the limitations on theoretical constructs of knowledge, added to the histories of human thought, represent an 'unpleasant possibility'.

To conclude, there is significant scholarly support for Foucault and the relevance of the power/knowledge nexus which he presents. This section has demonstrated how the work of Foucault is justified through its intentions and operations. While many critics will stand by their opposing interpretations, it is clear that contradictions of Foucault cannot be made on the basis of conceptualisations that fail to reflect the understanding of his work. Dews (1987, p. 215) demonstrates this: "if Foucault is claiming truth for his historical theories, while at

the same time insisting on an immanent connection between truth and power, he can only be claiming recognition for the particular system of power with which his own discourse is bound up". Whilst examining Foucault, it becomes clear that his assumptions are relevant to the specific systems of power under analysis. In other words, Foucault refrains from asserting truth for his work outside of the particular system which he is interested in. Regarding those who criticise Foucault's epistemological failure to construct methods by which to measure his claims, scholars have demonstrated how the genealogical re-descriptions that Foucault presents are legitimate contributions to the field of epistemology. Specifically, this is clear when considering how knowledge functions as a means of constructing recommendations for the avenue that epistemology should follow. Dews (1987) highlights how Foucault's power/knowledge concept represents an alternative interpretation of the roles that intellectuals and epistemologists must play, as well as suggesting how the structure and aims of epistemology itself can be reframed.

3.3 Power/knowledge in research

Having developed a sound understanding of the power/knowledge concept and how it reveals conceptually relevant insight on societal operations, it is important to further exemplify how it has been used in different domains of research. As the following sections will demonstrate, Foucault's complex, thorough and conceptually dense examinations of the inherently linked relations of power and knowledge have inspired a vast array of investigations. As well as revealing crucial information about the workings of specific arrangements under analysis, such research has also expanded Foucauldian thought by advancing it into new realms of study. It is important to learn from these approaches, as they provide vital insights regarding the practical operationalisation of the power/knowledge concept. To conclusively realise this in a coherent manner, the following review evaluates how power/knowledge has been used in two specific fields of study. One, political science. Two, environmental management. These domains of research have been chosen as they reflect many of the key topics of interest of this study. For instance, they demonstrate how power/knowledge has been used to understand political and governance systems, as well as processes of conservation and education programmes.

3.3.1 Political science and environmental management

The field of political science is a broad domain. It examines systems and models of government and governance. It is a field that analyses political processes and behaviour, using social theory to explain issues under investigation. Much contemporary work stems from classic philosophical pieces – such as those presented by Plato, Machiavelli, Marx and Foucault – and makes use of the theoretical work of these thinkers whilst evaluating topics, such as. government policy, voting patterns, international relations and political theory. By particularly focusing on the use of Foucault's power/knowledge concept within political science research, there are a range of studies that explore the operations of governance regimes in regards to land use development (Flyvbjerg, 1998; Duineveld and Van Assche, 2011), international peacebuilding (Merlingen and Ostrauskaite, 2005) and human rights law-making (Evans, 2005), among others issues. It is useful to review these studies, beginning with work which examines the topics of international governance indicators and the conflict of laws.

Governance indicators have become an increasingly common practice used by NGOs, private agencies, state departments and international organisations, as a means of comparatively ranking a nation's capacity in relation to a range of issue areas and governance spheres (Bandura, 2008). Such issue areas can include gender equality, corruption, societal rights, environmental preservation and economic growth. However, as these rankings predominantly involve empirical measurements, Löwenheim (2008) attempts to situate the practice of governance indicators in a much wider theoretical context. Learning from Foucault's concept of power/knowledge, this work clarifies the political meanings which underpin governance indicators. As Löwenheim (2008, p. 256) demonstrates, "these indicators and reports constitute an overall system of examinations that establishes and/or reaffirms structures of hierarchy and authority in the international system … These examinations not only reflect certain knowledge and ideas about 'good governance' but are also imbued with power, and they aim to shape and guide examined states' conduct". Ultimately, the work of Löwenheim (2008) highlights how a power/knowledge approach can be used to pick apart key elements of power that are regularly ignored and left unchallenged. Similarly, Herberg (2011) employs a power/knowledge approach when examining global governance and conflict of laws. The work draws upon Foucauldian thought to explore the

intricate struggle between 'state-based law' and the more emergent mechanisms of international (or transnational) law.

Switching attention to the field of land use governance, Flyvbjerg (1998) presents an interesting use of Foucauldian thinking whilst evaluating how arrangements of power, knowledge and rationality function within the planning processes. Flyvbjerg (1998), reflecting on the Foucauldian notion that power/knowledge arrangements operate in all social and political contexts, uses Aalborg's land-management plan as a 'laboratory' for examining power. In particular, he explores how specific relations of power can work as a means of shaping governance decisions toward particular, predetermined ends. The use of knowledge is demonstrated as a central component in the planning decision-making process, with a range of technical knowledge exemplified as a means of rationalising specific actions. Ultimately, the arrangements of power/knowledge which underpin Aalborg's plan are, more generally, understood as reflecting the workings of modern politics and administration. The city's plan was set up in an innovative and coherent manner, advanced by supposedly democratic and rational reasoning. However, as the plan progressed, it became increasingly fragmented; with decisions intentionally benefiting some actors, to the detriment of others. As Flyvbjerg (1998, p. 141) demonstrates, this feeds into wider discussions regarding the manner in which power/knowledge arrangements link to rationality:

> "The interplay between rationality and power operates to stabilize power relations … Decisions made via rationality-power relations can be justified by an appeal to reason, and thereby gain greater legitimacy than "decisions" based upon raw power-against-power confrontation … In the Aalborg Project, surveys, analysis, documentation, and technical argumentation are techniques used to try and create consensus; they are the kinds of attempts that characterize stable power relations".

Moreover, Flyvbjerg (1998) demonstrates how decision-making processes underpinned by 'stable power relations' are not necessarily based upon rational logic. Indeed, in his case study of Aalborg's management plan, a number of examples of the contrary are revealed. Largely, these are framed as incidents of raw power, where decisions are made to purposely exclude specific actors. Flyvbjerg (1998) presents an in depth analysis of land use governance in Aalborg and clarifies the key findings through theoretical thought. In particular,

power/knowledge is advanced as a means of neatly explaining how rationality functions in governance regimes.

A further example of how power/knowledge has been used in political science research is Evans' (2005) analysis of governance approaches to modern human rights discourse. Building upon scholarly thought regarding human rights as an international law discourse, Evans (2005) situates the domain within the context of critique. This is done as a means of clarifying why hegemonic law within the human rights discourse has developed. This links to wider discussions on discipline and the nature of human rights discourse, hence the employment of a Foucauldian lens. Following a power/knowledge approach, Evans (2005, p. 1046) suggests that; "human rights are better understood as three overlapping discourses, each with its own language, concepts, and normative framework. These discourses are the philosophical, the legal and the political". By analysing how knowledge is used in each discourse, and the underlying relations of power which relate to them, Evans (2005) comes to the conclusion that international human rights law offers a discourse of both 'freedom' and 'domination'.

Merlingen and Ostrauskaite (2005) present an interesting study on international peacebuilding between the European Union (EU) and Bosnia, conceptualising the keys findings via a power/knowledge framework. They take issue with the notion of framing peacebuilding as "an uplifting and civilizing mission", asserting that, in reality, the process "rests on an assumption that, since the end of the Cold War, it [peacebuilding] has become so naturalized in Western political discourse and mainline academic treatises on security governance as to be nearly invisible" (Merlingen and Ostrauskaite, 2005, p. 297). Their work explores the operations of power beyond the sovereign state, with emphasis placed upon the role that microphysical relations of power play as means of forging links between indigenous citizens and foreign peacemakers. A power/knowledge approach is utilised as a means of explaining the governance arrangements that rationalise a specific form of constraint. As Merlingen and Ostrauskaite (2005, p. 297) clarify, this involves "the constellation of social control that is effected by the EU's efforts, in the context of its security and defense policy, to promote democratic policing in Bosnia". Ultimately, this highlights how Foucault's power/knowledge nexus can decode governance decision-making and, in this case, reveal how particular decisions are made with the intention of restricting "the

inevitable political pastorate in the international construction of liberal peace in post-hostility societies" (Merlingen and Ostrauskaite, 2005, p. 297).

Studies have also uncovered how power/knowledge arrangements can make the application of indigenous knowledge to local or international marine governance challenging. Von der Porten et al. (2020) demonstrate how power/knowledge configurations can establish path dependency within governance frameworks, rationalising the knowledge of elite stakeholders and limiting the autonomy of indigenous communities. The use of a power/knowledge framework helps to reveal the political nature of indigenous knowledge in the context of contested coastal lands and resources (Von der Porten et al., 2020). Despite the potential value of indigenous knowledge for the management of environmental challenges, such as climate change, ecosystem destruction and biodiversity loss, it commonly struggles to overpower the more established ways of knowing that inform marine governance (Schlüter et al., 2020). However, by being aware of the unequal power/knowledge arrangements at play, research suggests that alternative approaches to enhancing the power attached to indigenous actors and their knowledge can be realised.

In the case of natural resource management, power/knowledge approaches have commonly been used as a means of uncovering how certain types of knowledge can be used as a means of creating specific governance approaches. Knowledge has also been shown to shape particular structural arrangements, which dictate the position and agency of actors (Rap and Wester, 2017). For instance, it has been demonstrated that power/knowledge approaches can play a key role in correcting some of the paradoxical issues with face natural resource management (NRM). Despite a well-developed understanding and broad consensus on how to realise sustainable forms of NRM, there remains a significant gap between the promises and the actual realities of management (Van Assche et al., 2017). A power/knowledge framework reveals how certain types of knowledge, certain ways of constituting and understanding natural resources, can lead to specific ways of managing or governing them. In an assessment of when local communities are present and absent in decision-making in the Danube delta, Romania, Van Assche et al. (2011) demonstrate how NRM policies can co-create a 'local' that is scrutinised, subjugated and marginalised. Thus, the resources and power available to local residents can be directly influenced by how they are conceptualised at higher levels of policy-making, with management decisions veiled in specific rhetoric and supported by different forms of knowledge. Despite the difficulty of attempting to shift

dominant agendas, the unravelling of power/knowledge configurations can help to illuminate how new connections between the thinking and organising of NRM can be produced to support more sustainable and just futures (Van Assche et al., 2017). Similarly, Jentoft (2017), in his assessment of how Marine Spatial Planning (MSP) may impact small-scale fisheries, illustrates how, once actors adopt positions of power and embed their agendas within institutions, incorporating different knowledge or facilitating challenges to the direction of management can become extremely challenging. As Jentoft (2017, p. 270) explains: "given that power/knowledge interactions work both ways, power relations and their institutional materialization regulate, and are regulated by, how knowledge integration occurs". Thus, MSP institutions, and the participation processes that they establish, determine what and whose knowledge is integrated and how.

Furthermore, Foucauldian thinking is employed as a means of both working out how specific power/knowledge arrangements advance hegemonic ways of governing, as well as conceptualising how such relations can be opposed and challenged. This is no easy feat, however. "Unravelling the inextricable link between power and knowledge in the context of NRM demands for more extensive and in-depth studies toward the ongoing investments in the knowledge infrastructures that foster and enable the quest for control" (Van Assche et al., 2017b, p. 246). A common conclusion of scholarly thought in the field of NRM is a call for a shift toward processes of natural resource governance. Largely, this is conceptualised as a movement away from the notion of using solely technical knowledge to base management decisions upon. For instance, Arellano-Yanguas and Bernal-Gómez (2017) suggest more participatory approaches to governance, while Rap and Wester (2017) endorse collaborative arrangements which recognise a range of local and expert knowledge in tandem. These arguments are advanced as a means of realising more just and sustainable NRM governance procedures. However, learning from other research on power/knowledge, there is no easy transition from one management framework to an alternative governance regime. There will inherently be winners and losers created in both realms. To realise just and sustainable frameworks, there is more that must be done than correcting institutional dynamics. "Power/knowledge dynamics constantly influence the processes of governing and the performance of institutions, including mediating the relation between actors' influences on how discourses can be created, institutionalized, and mobilized to advance particular interests" (Van Assche et al., 2017b, p. 246). Thus, by employing a power/knowledge approach to research, scholars have examined the full scope of proposed natural resource

governance procedures. This reveals both the potential benefits and challenges which they may present, providing insight on how best to realise just and sustainable outcomes.

Building on this, Van Assche et al. (2017a) expand upon Foucault's power/knowledge concept whilst reviewing research on NRM and, more generally, environmental management. By categorising the dominant discourses within processes of NRM in accordance with understandings of social–ecological structures, they assert that theoretical teachings and insights can instigate change in processes of NRM. This is advanced as a means of creating a more collaboratively informed systems of decision-making. Van Assche et al. (2017a) use Foucauldian teachings to explore this domain, reconfiguring the significance of both the material and physical world in relation to the operations of NRM within social–ecological realms. Added to this, Van Assche et al. (2017a) dissect the topic of 'livelihoods' and include it in their Foucauldian framework. Livelihood is framed as an arrangement of both discursive and material aspects, and Van Assche et al. (2017) demonstrate the role it plays in shaping stakeholder response to NRM issues. Ultimately, this Foucauldian analysis is carried out as a means of exploring what theoretical insights of the power/knowledge arrangements inherent within NRM can tell us about the potential of creating systems of adaptive governance.

Furthermore, it is also important to recognise the work of Shava (2011) when examining the power/knowledge arrangements that underpin NRM within the case of a small town in the Eastern Cape, South Africa. The study examines the knowledge production interface between traditional health practitioners and community development organisations. Through the lens of the Foucauldian thinking, the research explores the power/knowledge arrangements embedded within the 'representation' and 'application' of local knowledges in particular community development and environmental learning settings (Shava, 2011). Specifically, by tracing the power/knowledge relations inherent within a preservation project covering medicinal florae, within which health practitioners and community groups were important voices, the research evaluates the constraining and potentially liberating impacts of power. The study of the relationship between the competing actors presents a useful 'micro-setting' for the interrogation of the governance regimes that dictate the management of natural resources. As Shava (2011, p. 72) discusses, "this reveals how power located in modern institutions is reinforced by the generation and accumulation of disciplinary (scientific) knowledge as a hegemonic regime of truth that is applied in the governance of

medicinal resources. It also reveals the location of power within the traditional healer community on the other hand and how this is maintained by the resilient cultural retention of medicinal knowledge and related practices within the community against a background of dominant Western medical practice". Learning from these culturally relevant understandings, the study generalises its findings and adds valuable insight to power/knowledge research. Additionally, Shava (2011) demonstrates how Foucauldian thinking can be used to conceptually work out how local voices can be included and legitimately represented in decision-making processes through the application of community development processes.

3.3.2 Bringing power/knowledge to citizen science

This study's literature review, *Chapter 2*, highlighted how a more explicit comprehension of power, and in particular how it relates to knowledge, is required to fully understand the transformative capacity of citizen science in marine governance processes. Responding to this problematisation, this chapter has constructed a theoretical framework, based around the Foucauldian concept of power/knowledge, to conceptualise the field of citizen science. Its philosophical foundations have been critically assessed, with learning lessons extracted from studies discussing the operations, limitations and manner in which power/knowledge has been utilised in other fields of study. Bringing these insights to citizen science offers the ability to consider how, to achieve transformative outcomes, projects must become conscious of what knowledge is, how it relates to arrangements of power and how it can be used to instigate change to processes of marine governance. In other words, power/knowledge highlights how citizen science must produce knowledge that is explicit in its composition, but which also invokes critical reflection on the topic of interest. This must involve acute analysis of knowledge systems and practices, so as to ensure that knowledge is truly reflective of current conditions and comprehends how they can be altered. Power and knowledge are the central means through which decision-making regimes are shaped (Flyvbjerg, 1998), meaning that any assessment of how citizen science can instigate transformative change to governance decision-making requires a sound conceptual basis to both develop from and relate back to. The concept of power/knowledge provides such a basis.

This study positions power/knowledge arrangements as representing key factors in the shaping of citizen science processes and outcomes, arguing that the transformation of knowledge must be understood in terms of how it is shaped by and produces power. This argument is built upon the premise that power and knowledge are co-constitutive, as Foucauldian thought asserts, meaning that citizen science must learn to acknowledge the array of power relations that define which knowledge is important and how it is used in the realm of marine governance. It is important to note that, central to the concept of power/knowledge, is the appreciation that power is not a zero-sum game. Power can be challenged, resisted and changed by developing other power/knowledge relations (Foucault 1980). Power/knowledge arrangements can, therefore, both limit and enable action. By being conscious of the duality of power/knowledge, citizen science research can develop a greater capacity to understand how and why attempts to instigate transformation fail, and how such barriers can be overcome. When operating in a power-aware manner, citizen science can become increasingly capable of realising its potential to transform regimes of marine governance into more democratic and transparent processes, that facilitate knowledge contestation and alternative pathways of knowing. However, when blind to the avenues through which power operates, as current citizen science research appears to be, there is a heightened risk that projects will simply reinforce existing relations that have been seen to limit the ability of citizen science to actively contribute to societal transformation and to enhance the influence that citizens have over governance processes.

The arguments considered in this chapter suggest that citizen science, particularly initiatives that have genuine aspirations of transforming conservation practice into more democratic and open processes, should be organised in a way that encourages reflections on the workings of power. Such projects should be designed with a recognition that unequal power relations cannot simply be 'managed away' but can be challenged through the production of what we have termed knowledge for action (Gaventa and Cornwall, 2001). The example of a co-production initiative in Caracas, Venezuela, that empowered poorer members of the public in technical water committees by way of engaging them with a broader political project set up to challenge unequal arrangements of power between the state and the population, is a useful case to reflect upon (McMillan et al., 2014). By way of engaging volunteers in a wider process of social change, the project was capable of promoting a 'rethink' of the concept of citizenship. This helped the initiative to avoid being captured or overwhelmed by the agendas of elite actors (McMillan et al., 2014). Instigating action-

orientated participation that resists being shoehorned into predefined pathways of producing knowledge and attempts to foster critical reflection and learning amongst volunteers, practitioners and governance actors is central to realising this potential. Additionally, Rosen and Painter's (2019) assessment of the Lift To Rise initiative in the Coachella Valley, which conducts research on poverty-related issues, represents an example of how co-production can effectively tackle imbalances of power through adaptive, flexible and long-term participatory processes. By engaging with community change experts, the initiative created a dynamic participation process, rooted in continual and reflexive learning between both volunteers and land-use planners. Through this process, planners were challenged to rethink participation and to support community capacity building and resource sharing, so as to build and sustain community power (Rosen and Painter, 2019). This suggests that similarly power-aware and self-reflective citizen science projects can develop the potential to expose contradictions and inconsistencies within marine governance regimes. This could involve revealing evidence of environmental injustice (Rosario-Ramos and Sawada, 2019), challenging inequality, exclusion or lack of democratic accountability (Shaw et al., 2020), and proposing alternative approaches or definitions based on collected knowledge (Thiollent, 2011).

The power/knowledge concept informs the research design of this study, presented in *Chapter 4*. This enables the foundational principles of the concept to be embedded within the methodology and research approach of this study. Research objectives and questions have been shaped around Foucauldian thinking. This ensures that the study's analysis of the politics of citizen science, exploration of how knowledge is produced, used and has impact, and investigation of how volunteer participation can be maximised, is capable of being linked back to the conceptual framing of this study and can be assessed in line with the assertions of the power/knowledge concept. This gives conceptual robustness and theoretical relevance to the findings, and provides the opportunity to use the teachings of power/knowledge to decode the full meaning of analysed results. Ultimately, by bringing power/knowledge to citizen science research, it becomes possible to more effectively analyse the opportunities and barriers to the transformation potential of projects, and learn how both theory and practice can enhance its understanding of how citizen science can fulfil its capacity to instigate change to processes of marine governance.

3.4 Conclusions

This chapter has presented the conceptual framework that informs this study's research design. The concepts of power and knowledge, and the Foucauldian concept of power/knowledge, have been introduced and critically assessed. Throughout this chapter, justifications have been made to clarify the reasons why this framework represents a strong fit for the purposes of this study. An acknowledgement of the limitations of the power/knowledge concept are also presented, with the major challenges levelled against the concept defended and responded to. This chapter has also presented an overview of how power/knowledge has been operationalised in other domains of research, specifically political science and land use management studies. This assessment presents crucial insight on the practical use of the power/knowledge concept, illustrating how it has helped to reveal instances of injustice and guided the creation of practical solutions to overcome such issues. In total, this chapter has given a conceptual basis for this study to develop from and has clarified the reasons as to power/knowledge neatly aligns with the context and aim of this research.

4

METHODOLOGY AND RESEARCH DESIGN

4.1 Introduction

This chapter discusses and justifies the methodology and research design that this study has employed. This design has been conceptually shaped by the preceding literature review, *Chapter 2*, and conceptual framework, *Chapter 3*, and creates a methodological approach that is capable of critically assessing the operations of power in the realm of citizen science and of exploring the transformative potential of the practice. This facilitates a dialogue between the conceptual framework and the collected data of this study, with the conceptual framings outlined in *Chapter 3* being used to explain the meaning and relevance of the research findings. For this research strategy to successfully uncover the workings of power/knowledge arrangements, a sequential form of a mixed-methods design is followed. This involved the use of semi-structured interviews with citizen science actors to develop insight on the organisational dynamics of the field, before learning from these findings and critically assessing volunteer participation through an online survey. This sequential approach to research facilitates the opportunity to be guided by the field and not to impose a rigid framework or to presuppose potential findings.

This chapter will begin by explaining the research design in greater detail *(4.2)*, justifying why a sequential mixed-methods approach was followed and clarifying the context of the study (4.2.1). An overview is then provided of the 8 marine citizen science projects that were selected to be analysed as part of this study *(4.2.2)*. Background information on the projects is provided, as well as an explanation on why they were chosen. The two research methods that were employed by the research design are then discussed – semi-structured interviews *(4.3)* and an online survey *(4.4)* – with space given to assess the data collection and analysis procedures for each method. The chapter concludes by mentioning a small number of methodological issues *(4.5)* and ethical considerations *(4.6)* that were encountered.

4.2 Research design

Flyvbjerg (2006) outlines how good social science is problem driven and suggests that, in most scenarios, a combination of qualitative and quantitative methods present the most effective means of assessing a specific context under review. Indeed, by definition, "mixed

methods is a procedure for collecting, analysing, and "mixing" or integrating both quantitative and qualitative data at some stage of the research process within a single study for the purpose of gaining a better understanding of the research problem" (Ivankova et al., 2006, p. 3). This research adopts the use of a mixed-methods approach in order to assess the context of marine citizen science and sets the research problem of exploring how the barriers to transformative citizen science can be understood and overcome. This approach maximises understanding of the research objectives of this study and adds to the overall aim. When employed in combination, qualitative and quantitative approaches can complement one another, enabling for a more robust examination of the research context and taking advantage of the strengths of each method (Ivankova et al., 2006). Perhaps most importantly, following a mixed-methods approach allows for the cross referencing of evidence to determine the best possible and fullest answer (Kresby et al, 2013). This study's incorporation of a mixed-methods approach is reflective of a methodological shift that has occurred in the realm of social science, whereby there has been a move away from statistical scholarship towards more ethnographical interpretative studies and participatory action methods (Ivankova et al., 2006; Valentine, 2005). This shift is reflected in this study, where emphasis is placed on defining a subjectivist epistemology that can facilitate for a myriad of perspectives (Valentine, 2005).

This study can be best described as following a mixed-methods sequential design, whereby one method is conducted first to inform a complementary analysis of the other (Ivankova et al., 2006; Creswell and Piano Clark, 2007). Sequential analyses can follow a quantitative-qualitative structure, where quantitative analysis is expanded by qualitative strategies, or a qualitive-quantitative structure, where qualitative data informs a quantitative effort (Griffin et al., 2011). In many ways, however, this study was conducted as a qualitative-quantitative-qualitative analysis, whereby interviews with citizen science actors informed an analysis of citizen science volunteers through a survey that contained both quantitative (set questions) and qualitative (open questions) aspects. The rationale for employing this approach stemmed from the notion that developing a general understanding of the research problem, by assessing the politics of citizen science through qualitative analysis, could reveal specific issues of importance, such as the participation process and management of volunteers, that require subsequent analysis to be able to provide conclusions and potential recommendations. In regards to the qualitative aspects of the survey, its analysis refines and explains the statistical results by exploring participants' views in more depth. The advantages

of employing a sequential mixed-methods approach include the opportunities for the exploration of the collected results in more detail and to expand upon initial findings (Ivankova et al., 2006). This is especially useful when unexpected results arise from a data collection. Although there can be limitations of this approach, such as high levels of time and resources that may be required to collect and analyse both types of data (Creswell and Piano Clark, 2017), a mixed-methods sequential approach was a strong fit for the purposes of this study.

4.2.1 Selection of research area

As well as being the geographical location of the institution from where this research is based, Northern Ireland offers a compelling context to investigate the current standing and potential future of marine citizen science. Citizen science in Northern Ireland is well established, with a multitude of projects operating across both terrestrial and marine environments. Indeed, the island of Ireland has a strong history of engaging members of the public with scientific programmes and the expanding number of citizen science initiatives in Northern Ireland is in keeping with developments seen in other European countries (Roche et al., 2021). In Northern Ireland, despite the existence of several independent and governmental data-gathering initiatives, the information required to inform good decision-making is currently lacking and is not readily accessible (Cooper and Jackson, 2018). This has encouraged the notion that citizen science, which is capable of acting as a cost-effective means of surveying vast stretches of coastal and offshore areas, can play an important role in the future governance of Northern Ireland's marine environment. Whilst the majority of current projects are locally coordinated by NGOs, there are several emerging examples of national initiatives that are funded and co-produced by government departments. This shift from local to national citizen science, and the sudden commitment of government to become engaged with projects, is an interesting and potentially significant development. Whilst it may signal a strengthened link between initiatives and policy circles, it may also reveal other issues of importance and highlight differences of opinion in relation to the role and value of citizen science. Thus, Northern Ireland has been identified as a significantly relevant and appealing context to analyse.

In the general picture of marine governance in Northern Ireland, the Marine Policy Statement (2011) acts as an overarching legislative structure, which guides the development of marine planning throughout all UK administrations. The statement presents a range of high level marine objectives – including the promotion of sustainable economic development and the outlining of the UK's move towards a low-carbon economy – which regional Marine Plans must refer to and be in conformity with. While MSP in Northern Ireland has advanced to the stage of a draft plan, the lack of certainty regarding its legislative adoption is a key stumbling block. Likewise, concerns regarding the contents of the draft plan hint that any published plan may not fully facilitate a movement towards integrated management of Northern Ireland's marine resources. Ultimately, the current condition of marine planning in Northern Ireland is failing to facilitating the development of a socially and economically sustainable approach to marine governance. As Ritchie and Flannery (2017, p. 188) note, "while the new approach is a step in the right direction, Northern Ireland should explore the development of a single marine body with overall responsibility for all marine issues". Such a creation could facilitate a new model for marine planning in the country, one that fosters legitimate integration amongst sectors and empowers the knowledge of policy-relevant citizen science projects. In the meantime, relatively sectoral approaches to governance are conducted in Northern Ireland and the utilisation of marine citizen science are restricted to specific policy issues or emerging ecological threats.

4.2.2 Citizen science projects

Although not analysed in a case study approach, a total of 8 marine citizen science projects that operate in Northern Ireland were selected as part of this research. The projects were selected for a number of reasons. These include the diverse manner in which they engage volunteers with marine conservation, how some of the groups directly link with local marine communities, the manner in which they are supported by a diverse range of funding streams and their differing relationships with policy problems. For comparative analysis purpose, the Bonney et al. (2009b) framework for classifying the participatory structure of projects – contributory, collaborative and co-produced – is used when assessing the selected initiatives. The projects are seen to represent a strong spread of different participation structures, as shown in *Table 4.1*. Some projects, it is important to note, are devolved efforts of citizen science initiatives that are based in the UK and Republic of Ireland. While this inevitably

introduces other contexts to the study, even on a small-scale, the focus remains on the use of citizen science in Northern Ireland. Semi-structured interviews were held with the practitioners of projects, as a means of assessing the organisational properties of projects, and surveys were conducted with the volunteers of initiatives, with findings revealing insight on the participation process of projects. To provide a brief description of the projects, the context and objectives of each of 8 initiatives are discussed below. *Table 4.1* then presents an overview of the organisational aspects of the projects.

Seasearch (Diving group)

Seasearch is a project run by the Marine Conservation Society and has operated since the mid-1980s. It utilises volunteer divers to record marine species and to support the conservation of seabed habitats. As well as collecting habitat and species data, Seasearch divers also provide a general description of the dive site, conditions, and anything else of interest, including records of marine litter. The general aims of Seasearch are: (i) to map out the various types of sea bed found in the near-shore zone around the whole of the Britain and Ireland, (ii) to record what lives in each area, and (iii) to establish the richest sites for marine life, the sites where there are problems and the sites which need protection. Knowledge is held on virtual data bases, where volunteers can upload and verify recordings.

Irish Whale and Dolphin Group (Ferry survey)

The Irish Whale and Dolphin Group (IWDG) was founded in December 1990, and put forward two key objectives: (i) to establish a cetacean stranding and sighting scheme, and (ii) to campaign for the establishment of a cetacean sanctuary. The IWDG collects data on the distribution and relative abundance of cetaceans in Irish waters, and uses a volunteer surveying method, whereby participants board commercial ferry's across the Irish sea, to inform monitoring reports. Observer efforts focus on a 90° arc ahead of the ship, however, sightings located up to 90° to port and starboard are also included. Bearings to sightings are measured using the ships gyrocompass and distances are estimated with the aid of a distance measuring stick. These surveys have been done in line with the ultimate aim of the IWDG of making Irish waters a sanctuary for all cetaceans that either live in, or migrate, through Irish waters. This is achieved by lobbying processes and using collected data to inform Irish marine management.

Ulster Wildlife (Sea Deep project)

Sea Deep is a Northern Irish shark conservation project, led by Ulster Wildlife (UW) and funded by the Heritage Lottery Fund (HLF). Officially launched in April 2018, the project works alongside sea anglers, schools, community groups and members of the public. Generally, the project aims to help safeguard the future of endangered sharks, skates and rays along the Northern Irish coastline, and is a reaction to the current lack of legislative protection for such species. Sea Deep is advanced as a means of filling knowledge gaps, with the overall objective of lobbying such information to ensure the implementation of management measures that will help endangered stocks to recover.

Keep Northern Ireland Beautiful (Marine Litter Survey)

Since 2012, Keep Northern Ireland Beautiful (KNIB) have run a programme collecting information about marine litter washing up on ten beaches around Northern Ireland. With four surveys carried out each year, the data collected contributes to the Northern Ireland Marine Litter Strategy. The aim of this Strategy is to help realise the vision of clean, healthy, safe, productive and biologically diverse oceans and seas. While the surveys do involve significant amounts of beach cleaning, importantly, all information is scientifically measured, recorded and mapped. Annual reports and published of the volume and type of litter collected, while education initiatives with local schools and data partnerships with government department, are other key factors of the survey.

Royal Society for the Protection of Birds (Beached Bird Survey)

The Beached Bird Survey, coordinated by the Royal Society for the Protection of Birds (RSPB), is an annual survey involving over 600 volunteers walking along more than 2,000 km of UK coastline. Despite being the smallest of UK nations, Northern Ireland constitutes the highest number of volunteers (per capita) within the project. As well as recording the number of beached birds that are found, the level of oiling on the beach is also monitored, with data channelled into RSPB datasets. Annual reports have been used to inform both species management initiatives and beach cleaning programmes in England. Volunteers conduct all data collection tasks, although only a select number of participants engage with analysis or project design tasks. Thus, the project can be understood as a contributory or entry-level citizen science initiative.

Cloughey and District Community Association (Beach Care Group)

To legitimately explore the wide ranging scope of citizen science, it is important to showcase truly bottom-up projects. The Cloughey Beach Care Group is an example of such an approach. Set up in 2008, Cloughey Beach Care Group was established by members of the Cloughey and District Community Association (CDCA), who took an interest in the welfare of the local beaches. Following some informal meetings, the care group was formed and has steadily grown with other members of the community joining. The group works in both individually and collaborative capacities, with the main objectives of keeping their local marine and warren areas clear of litter, as well as providing a channel to bring local concerns to the decision-making level. In recent years, the CDCA also established an Erosion Monitoring Group, which uses group members to record visual evidence of erosion along the coastline, with the intention of using collected knowledge to lobby for development change.

Coastwatch Ireland (Coastwatch Survey)

A final project is Coastwatch Ireland's (CI) annual Coastwatch Survey. Generally, the survey is designed to give an overview of the state of the coast, both north and south of the border. It involves volunteers checking their chosen 500m stretch of coast (one survey unit) once a day around low tide, transcribing observations and recordings on questionnaires. Coastwatch produces annual reports of the survey findings, done individually by participating nations and at a general European level. As well as the publication of these reports – which act as an important means of recognising and appreciating the work of volunteers and encouraging them to continue their participation – the baseline data collected is then used by local communities, authorities, research organisations and NGOs, for a variety of purposes. These include wider educational outcomes – such as raising awareness of the importance of coastal zones as a valuable shared resource – training outcomes for volunteers – providing them with the necessary equipment to participate actively in coastal zone management protective and remedial action – and, at the decision-making level, impact on local, national and international legislative policy.

Table 4.1. *Organisational aspects of the selected citizen science projects*

Project name	**Type of project**	**URL**	**Funding**	**Focus of project**
Seasearch (Diving group)	Collaborative	http://www.seasearch.org.uk/	National conservation bodies	Monitoring environmental health of underwater ecosystems
IWDG (Ferry survey)	Contributory	https://iwdg.ie/ferry-surveys/	Federal ministry, national conservation bodies	Cetacean surveying
UW (Sea Deep Project)	Contributory	https://www.seadeepni.org/	National conservation bodies, lottery-funded	Shark, skate and ray tagging
KNIB (Marine Litter Survey)	Collaborative	https://keepnorthernireland beautiful.etinu.net/cgi-bin/generic?instanceID=50	Federal ministry	Marine litter surveying
RSPB (Beached Bird Survey)	Contributory	https://community.rspb.org.uk/ getinvolved/b/steppingupnorthernireland/ posts/beached-seabirds	Internal funding, national conservation bodies	Monitoring of beached birds
CDCA (Beach Care Group)	Co-produced	https://www.cloughey.org.uk/environment-awards	National conservation bodies	Marine litter surveying / Monitoring of erosion
CI (Coastal Survey)	Collaborative	http://coastwatch.org/europe/	Federal ministry, national conservation bodies	Monitoring the environmental health of shorelines

BTO (Wetland Bird Survey)	Contributory	https://www.bto.org/our-science/projects/webs	Internal funding, national conservation bodies	Monitoring of beached birds

4.3 Semi-structured interviews

Twenty-nine semi-structured interviews were conducted with citizen science actors between June 2018 and February 2019. A snowball sampling approach was used for the selection of actors to be interviewed within Northern Ireland (Noy, 2008). Beginning with a small population of citizen science actors, this study developed a larger sample by learning from initial participants and identify others who were relevant to the study. Interviewees were drawn up through a process of mapping, ensuring that a variety of actors holding different roles in the realm of marine citizen science, including those within statutory bodies, NGOs, civil servants, planning officers, and community action groups, engaged with the study and provided insight. Participants were then selected based upon the likelihood of having a detailed understanding of the issues facing marine citizen science and the emerging problems confronting marine governance processes. Having met and identified actors from snowballing efforts, a subtle rapport was established between researcher and interviewee, facilitating open discussions. *Table 4.2* (below) highlights the profiles of the selected interviewees. Following the interviews, it was decided to categorise actors within two distinct profiles; (i) practitioners and (ii) governance actors. Although there were decidedly more practitioners (19) interviewed than governance actors (10), mainly due to a smaller pool of governance actors in comparison to citizen science practitioners, all data was analysed in a partial manner and equal weighting was attached to all interviewees.

Table 4.2 *– Profile of interviewees*

PROFILE OF INTERVIEWEE	No.
Practitioner (Project coordinator or manager, NGO officer, professional scientist)	19
Governance actor (Government manager, government scientist, funding commissioner, planning officer)	10

The interviews were designed from the outset to allow the analysis of the organisational dynamics of citizen science. Interviewees were prompted to discuss issues relating to their perceptions of citizen science, their relationship with practitioners/governance actors, their experience of how projects evolve, and how knowledge is used, produced and has impact. Due to the difficulty of judging how many interviews are enough to produce meaningful qualitative research, the principle of 'theoretical saturation' was followed (Guest et al, 2006). It was deemed satisfactory that 29 semi-structured interviews accounted for saturation, as interviewee responses began to add little new to already collected data. A sample of a transcribed interview is included in the appendix of this thesis.

An inductive form of thematic analysis was used to analyse the collected interviews. This involved identifying common themes, topics and patterns of meaning that came up repeatedly (Javadi and Zarea, 2016). The most common themes regarding the organisational dynamics of citizen science were analysed to reveal commonalities amongst interviewees, with *Chapter 5* expanding upon these findings. As an inductive approach was taken to the analysis of the interviews, the data determined the themes that emerged. This enabled theoretical aspects to develop from the data and to remain grounded in empirical observation. A key advantage of this approach to qualitative analysis is its flexibility and capacity to provide a complex account of a detailed set of data. Nvivo software was used to conduct thematic analysis of interview transcript. This enabled the examination of relatively large bodies of text and multiple, iterative queries within the data. It also made cross-referencing and comparisons possible.

4.4 Online survey

Learning from the reviewed literature, it is evident that participant engagement and social transformation are central to citizen science's ability to create legitimate and sustained change to governance regimes. As such, the need to critically analyse the perceptions of citizen science volunteers and to understand how, why and on what grounds participants differ between each other, became an important objective of this study. To realise this goal, an online survey, run through the cloud-based software Survey Monkey, was constructed to examine how the roles carried out by citizen science volunteers influenced their motivations

for and outcomes of participation. An online survey was viewed as the most effective means of examining a large group of individuals and was circulated amongst the 8 citizen science projects selected by this study. Using an online survey provided two key 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. 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 four months, between February and May 2019.

The survey is comprised of four sections. The first section contains a set of closed statements regarding frequency, location, and degree of participation in citizen 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. (2002) and the wider citizen science literature were used to inform these statements. A further list of statements is posed to assess the outcomes volunteers obtained through participation. The next section contains open-ended questions to capture any additional perceptions of citizen 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. Novel statements regarding the transformative scope of citizen 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. A full copy of the survey is included in the appendix of this thesis.

Once the target of 300 responses was collected, a further reminder email was sent to project coordinators to call for any final submissions. One week after these emails were sent, the survey was closed and a total of 308 responses were collected. The survey was sent to a total of 737 potential respondents, creating a response rate of 41.7%. This figure, as well as the response rates for individual projects, is documented in *table 4.3* (below).

Table 4.3 *– Citizen science projects surveyed and volunteer response rate*

Project name	**Type of project**	**Total project participants**	**Survey respondents**	**Response rate**	**Percentage of all survey respondents**
Seasearch (Seasearch diving)	Collaborative	289	106	36.7%	34.4%
IWDG (Ferry survey)	Contributory	47	29	61.7%	9.4%
UW (Sea Deep Project)	Contributory	39	26	66.6%	8.4%
KNIB (Marine Litter Survey)	Collaborative	10	10	100%	3.3%
RSPB (Beached Bird Survey)	Contributory	115	43	37.3%	13.9%
CDCA (Beach Care Group)	Co-produced	32	21	65.6%	6.9%
CI (Coastal Survey)	Collaborative	84	46	54.7%	14.9%
BTO (Wetland Bird Survey)	Contributory	121	27	22.3%	8.8%
TOTAL		737	308	**41.7%**	100%

To analyse factors relating to the motivations, outcomes and perceptions of volunteers descriptive analysis of statistical data stemming from Likert-scale questions and (inductive) thematic analysis of responses to open questions were used. This analysis, which is presented and interpreted in *Chapter 6,* reveals insight on a much wider scale of participation related issues and demonstrates the diverse impact that engagement in citizen science can have upon volunteers. In addition to this, an exploratory factor analysis approach, the findings of which are presented in *Chapter 7*, was used to consider participation pathways in citizen science and to create profiles of volunteers. Factor analysis is a method of

multivariate analysis that examines variable relationships within a specific context (Fabrigar and Wegener, 2011). Factor analysis was used to simplify the survey data and to both uncover and examine patterns of engagement amongst respondents. Factor analysis provides the opportunity 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, factor analysis accounts for the manner in which 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. It also provides the capacity 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 citizen 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 the number of variables were narrowed down 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. The volunteers who were conceptually similar in their responses to the chosen statements were then grouped together, creating 4 factors (or profiles as this study terms them).

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 (see *Table 4.4*). The factor scores and eigenvalues illustrate high internal consistency across items within each factor (Hair, 2009). Pearson Chi-square tests were run to identify differences of significance between volunteer factors. Non-segmentation variables of the survey, such as demographics, to ensure that observed differences between the factors did not occur by chance. To interpret the meaning of the

factors, the structure matrix that shows the correlation between each statement and its factor was assessed. Positive or negative correlation values indicated whether the factor is more or less associated with the statement. The four extracted profiles were termed as *Activists*, *Conservationists*, *Hobbyists* and *Professionals*. These profiles are presented and explained in detail in *Chapter 7* of this study. The profiles reflect how different pathways to participation exist and, by critically assessing the what these pathways are, it becomes possible to develop an understanding of how participants can be supported to maximise their potential contribution to citizen science.

Table 4.4 *Total variant explained*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.282	27.351	27.351	**3.282**	27.351	27.351
2	1.641	13.675	41.026	**1.641**	13.675	41.026
3	1.206	10.051	51.077	**1.206**	10.051	51.077
4	1.015	8.462	59.539	**1.015**	8.462	**59.539**
5	.872	7.263	66.802			
6	.798	6.650	73.452			
7	.724	6.033	79.485			
8	.614	5.119	84.604			
9	.557	4.639	89.243			
10	.513	4.276	93.518			
11	.432	3.603	97.121			
12	.345	2.879	100.000			

Extraction Method: Principal Component Analysis.

4.5 Methodological issues

Although great levels of consideration and care were taken into account in the construction of this research design, inevitably, a few issues arose. Due to COVID-19, a proposed focus group with citizen science actors, where the research findings of this study were to be

presented, was unable to occur. This intended focus group was envisioned as an opportunity to engage practitioners and governance actors in a collective space and to instigate discussions on the future of citizen science by showcasing the findings of this study. Although this would have added a further methodological tool to this research and produced potentially interesting feedback, it absence was not seen as detrimental to this project's development and had no significant impact in regards to the quality of the research. To compensate, finding reports were sent to both practitioners and governance actors, and it is hoped that, post-COVID, some form of integrative meeting between actors can be arranged.

In regards to the interview process, it is evident that more practitioners took part in interviews than governance actors. This disparity between the two groups stems from the fact that there is a relatively small quantity of governance actors engaged with the realm of citizen science in Northern Ireland. Importantly, this imbalance between the two groups had no bearing on the analysis of interview data, with all interviews being evaluated with equal weighting.

It is noted that the online survey did not pose questions regarding dissatisfactions or frustrations to volunteers. In hindsight, it is appreciated that this could have revealed useful insight on the challenges to participation that volunteers encounter and, in turn, may have spawned recommendations on how these be overcome. Furthermore, measuring the development of motivations as participation in citizen science deepens is a factor that was not examine. Only after the running of the survey was it recognised that this is an increasingly important aspect of volunteer engagement (Larson et al., 2020; Phillips et al., 2019). It is a limitation of this study's survey to not examine this issue, although it will be incorporated into future evaluations of citizen science participation. Despite these methodological concerns, the survey is interpreted as yielding critical information on the participation process.

4.6 Ethical considerations

As required by all universities and research institutions, it was imperative that ethical approval was sought for this study. This ensured that the research was designed and conducted in such a way that it met ethical principles and was subject to proper and

institutional oversight in terms of research governance. While this study was not deemed as examining an ethically sensitive topic, it remains important to take the necessary steps to ensure that all participants are aware of the study they are engaging with, how their views will be analysed and who will have access the study material. Confidentiality, a hugely important consideration in research, was ensured at all times during the course of the research. Additionally, the data from the interviews and surveys were safeguarded throughout, with only the research team having access. A copy of this study's information sheets and consent forms, for both interview and survey processes, is included in the appendix of this thesis. Ethical approval documentation for this study, which was granted by Queen's University Belfast, Faculty of Engineering and Physical Science's Ethics Committee (approval number EPS 18_79), is also attached in the appendix.

5

ORGANISATIONAL DYNAMICS OF CITIZEN SCIENCE

5.1 Introduction

This chapter presents and interprets the analysis of interviews (*N* = 29) conducted with key citizen science actors. These actors involve practitioners (project coordinators and managers, NGO officers, professional scientists) and governance actors (government scientist, funding commissioner, planning officer). Collectively, these actors have insight into the internal functions of citizen science projects. This can be through direct experience of managing and running initiatives, by financially commissioning them or by being an end-user of citizen science knowledge. Interview findings reveal information on the organisational dynamics of citizen science, an area of study where relatively little is known. In particular, the results present the perceptions of key actors in relation to the frameworks of power and politics that function throughout the realm of citizen science, demonstrating how these relations practically shape the operationalisation and potential capacity of projects. Analysis of interview transcripts reveal how specific arrangements shape the development of citizen science projects, both in constraining and constructive manners. This is crucial insight for investigations of the transformative potential of participatory research and responds to the theoretical gaps of knowledge in the field of citizen science.

This chapter is broken down into 4 sections, each covering a theme that was extracted inductively during the analysis process. To begin, key perceptions on the role and purpose of citizen science are presented (*5.2*). This includes an overview of how practitioners and governance actors differ in regard to their interpretation of citizen science *(5.2.1)* and, in particular, the potential space that it should fill within the wider realm of marine governance *(5.2.2)*. Insight is provided on the varying definitions and principles of citizen science, as well as debate on the manner in which citizen science should integrate with other processes of data collection. Following this, critical discussions on the organisational dynamics of citizen science are presented (*5.3*). This section illuminates the flows and arrangements of power that underpin projects and demonstrates how the relationship between practitioners and funders can become unbalanced. This section reveals important insight on how governance actors have been seen to sway the design and scope of projects toward their own ends, by way of objective setting *(5.3.2)*, the implementation of standardised practices *(5.3.3)* and short-term timeframes *(5.3.4)*.

Section 5.4 discusses the theme of knowledge and critically evaluates how citizen science actors understand the role of knowledge within projects. This involves an assessment of how citizen science knowledge is produced, what this knowledge is, how it is communicated (and to whom), and what the impact of citizen science knowledge is. The interview findings reveal crucial disparities between the perceptions of practitioners and governance actors in relation to knowledge, with some valuing its capacity to improve 'knowing' *(5.4.1)* and others championing its ability to instigate 'action' *(5.4.2)*. The assertions of citizen science actors regarding the use and production of knowledge, and in particular how it relates to dominant relations of power, reveal important insights on the transformative capacity of the practice. To conclude, *section 5.5* interprets the analysed findings discusses them in relation to the wider context of this study.

5.2 Perceptions on the role and purpose of citizen science

It is crucial to develop an understanding of how key actors interpret the role and purpose of citizen science to fully understand how projects can realise their transformative potential. This calls for a critical assessment of the organisational elements of projects, whereby the manner in which projects are supported or impeded by internal and external forces is examined. In particular, this involves a review of how citizen science projects are conceived, operationalised and managed in pursuit of specific outputs. Core to developing this understanding is; (i) assessing how key actors understand the definition and principles of citizen science, and (ii) how space is made for citizen science.

5.2.1 Definition and principles

As illustrated in *Chapter 2*'s review of academic literature, there are many different interpretations of how citizen science can be defined. Due to the fact that projects can cover a multitude of fields – each with their own objectives, worldview, epistemology, methodology and output – creating a singular definition risks excluding a variety of activities from citizen science. This means that the principles by which projects are said to be guided by can significantly vary and, in turn, this can create varying interpretations on the purpose

and value of citizen science. This multiplicity of views is reflected amongst the responses of interviewees, who offer a range of alternative interpretations of what citizen science is and what it is capable of achieving. The findings suggest that the position of actors, in terms of their relation to citizen science projects, has a significant influence upon their understanding of the practice of citizen science. Practitioners, who are directly involved with the management of projects, are seen to define citizen science as a means of *"volunteering or amateur naturalism"* (NGO officer, #2). For these actors, the focus is on the participation process and citizen science is defined as a *"participatory effort that can benefit both science and the volunteers"* (NGO officer, #6). Conversely, governance actors are, primarily, seen to value citizen science as a tool for generating specific sets of data. As one government manager asserted, *"we are really using them [citizen science projects] for eyes on the ground, boots on the ground, where they can pick out the really easy things"* (Government manager, #3).

These contrasting interpretations are important to assess. They reveal how citizen science projects can be valued differently by actors depending on their positioning; with some viewing it as a *process* that has both social and scientific merit, and others perceiving it as a useful *tool* for knowledge production. This contrast also suggests that arrangements of power amongst the different actors involved with projects may not be equal, a potentially significant finding that can be revealed through further analysis. *Chapter 2* and *Chapter 3* have highlighted how there remains a lack of research on the power dynamics that function within the realm of citizen science, and these findings represent the first step in correcting for this. The following paragraphs examine these predominant modes of thinking amongst citizen science actors in greater detail, before considering how different actors can influence the manner in which projects are practically implemented.

Citizen science as a participatory process

From the perspective of practitioners, there is a dual-purpose to citizen science. *"It has the data collection role and the community engagement role"* (Project coordinator, #4). This mindset interprets citizen science as a multi-purpose process, whereby projects aim to simultaneously create both scientific and volunteer outcomes. Scientific outcomes can involve *"the collection of data that has the capacity to inform or in some way contribute toward scientific reports, policy decisions or management approaches"* (NGO officer, #6). Volunteer outcomes, which are also referred to as 'social' and 'learning' outcomes, can

involve *"social engagement, collaborative learning, enhanced literacy and the general benefits associated with spending time volunteering with others"* (NGO officer, #6). In other words, citizen science can *"help to build the skills, knowledge and capability of those participating so that they receive tangible benefits from being involved in projects"* (NGO officer, #7). This interpretation of citizen science suggests that projects are both a method of producing knowledge of scientific relevance, as well as functioning as a process of positively impacting volunteers. As literature has illustrated, it is the development of volunteers outcomes and active social engagement that marks a difference between citizen science and other participatory research practices. *"Citizen science is a collective endeavour that can improve formal and informal learning. By that I mean it has the ability to harness and better connect scientific evidence to policymaking, social innovation and even social learning and activism"* (Project coordinator, #4). To effectively balance knowledge and social objectives, citizen science practitioners note how *"projects require a flexible and adaptive set of methodologies that need to be constantly reviewed, meaning that you really need to think about what you want to achieve with the project"* (Project coordinator, #4).

Practitioners appear to be guided by principles associated with open collaboration, education and empowerment. *"I would describe citizen science as a process in which members of the public are empowered to contribute towards the accurate recording of the environment, be that for a particular species or a wider range of habitats"* (NGO officer, #7). Practitioners discuss how projects seek to empower local knowledge, insights and skills that otherwise may not be capable of influencing policy or management decisions. In turn, this process of supporting volunteers can be seen to *"create unity and collective capacity to deal with the issues affecting coastal communities"* (Project coordinator, #6). Therefore, citizen science can create transformative impact that *"has the potential to instigate change beyond the actual boundaries of what projects are primarily set up to achieve. Not only by producing valuable scientific knowledge or by impacting volunteers directly … [also] by developing community cohesion and developing collective support for tackling local environmental problems like marine litter and coastal erosion"* (Project coordinator, #6).

Practitioners expand upon this potential, with some discussing how active participation structures can *"reinforce an environmentally-connected sense of identity amongst participants"* (NGO officer, #7). In total, citizen science is interpreted as having principles of collaboration and learning at its core, whereby projects can *"educate and empower 'the*

general public' to know more and care about the marine environment" (NGO officer, #2). The responses of practitioners highlight how citizen science is a multi-dimensional process that can have impact well beyond the boundaries of projects. These responses also suggest that citizen science can instigate social transformation within volunteers than can outwardly support positive civic action, particularly in relation to the marine environment, an important aspect of the transformative capacity of projects. The importance of social learning, although evidently key in the mind of practitioners, is not clearly reflected in the makeup of projects. This is an important aspect to consider and an issue that will be expanded upon in the discussion chapter of this thesis, *Chapter 8*.

Citizen science as a data collection tool

Governance actors tend to define the practice as a data collection tool. Whilst the potential of projects to outwardly impact volunteers is acknowledged, these actors prioritise the value of citizen science as a means of producing knowledge that can fill data gaps and inform management choices. This is particularly the case in an era where government resources for environmental research and monitoring have significantly decreased, meaning that citizen science offers a cost-efficient alternative. As one actor notes, citizen science has risen in stock *"amongst a background of austerity and falling investment, whereby volunteers are called upon to plug the gaps"* (Government manager, #2). Citizen science, in this light, is advanced as an opportunity to *"channel the energy of members of the community into giving us information that can help a decision"* (Government manager, #1). This suggests that citizen science is valued by governance actors when it can answer specific, often pre-selected, questions. For instance, these actors state how setting up citizen science initiatives can be an effective means of *"taking advantage of the growing numbers of recreational scuba divers … and a valuable option to make use of a plethora of recordings that can't be gathered through traditional scientific practices"* (Government manager, #2). Collected recordings, once validated, have been proven *"to be used to great effect to underpin designations of marine protected areas and management of the marine environment"* (Government scientist, #1). Although practitioners interpret citizen science as having both data collection and participant engagement dynamics, the latter is much less valued by governance actors. *"In an ideal world, of course, we would have funding to support the continual education of the volunteers of these [citizen science] projects so that they become established conservationists that can keep helping us. But it's not like that I'm afraid, we need to work within our own means"* (Government scientist, #2). Citizen science serves a specific purpose

for end-users, such as providing data that can underpin designation decisions, and financial support for projects is granted based upon the anticipated realisation of such outcomes.

From the perspective of governance actors, principles such as *"accuracy, robustness and compatibility"* (Government manager, #3) are at the core of citizen science. These principles are directly related to the collection, analysis and dissemination of citizen science data. This informs how citizen science is defined by governance actors: an alternative research tool for informing decisions, environmental statements and management choices. There is a clear recognition amongst these actors of the need for citizen science to operate in a scientifically professional manner, suggesting that the primary principal of projects should be to produce robust, high quality knowledge. Governance actors discuss how *"citizen science has to be more than just "we've collected loads of litter, here's the photo call, here's the written report", which is really, really good. But it's about bringing it to the next level. That's where it will have true impact"* (Government manager, #1). This suggests that the full potential of citizen science, from the perspective of governance actors, can only be realised when projects are exclusively focused on generating policy relevant data. This is the 'next level' that such actors allude to, whereby projects are capable of consistently *"moving beyond just raising local awareness … [and] become embedded within the decision-making process"* (Government manager, #1). In total, it appears that governance actors interpret citizen science as a tool to assist structures and processes of environmental governance. This offers a refined definition of citizen science and passes limited attention to the value that coordinators assign to the social and learning outcomes that volunteers can obtain.

5.2.2 Finding space for citizen science

There is an inherent challenge to providing a definitive characterisation of the citizen science. There is no singular purpose or list of principles supported by actors, with the position of actors within the field of citizen science appearing to significantly influence their interpretation of the practice. Accounting for both practitioner and governance perspectives, it appears that citizen science includes both participatory and instrumental dynamics. The participatory dynamic relates to the engagement of volunteers, while the instrumental dynamic involves the collection, analysis and dissemination of data. Whilst practitioners stress that *"it is important for policy-makers to understand the full range of competing*

dynamics [of citizen science] so that they can navigate and support the full breadth of opportunities available" (NGO officer, #7), governance actors prefer to exclusively focus on the instrumental workings of projects and their capacity to create scientific knowledge. This multiplicity of definitions is important to assess, as it reveals vital information regarding the organisational dynamics of citizen science and hints at alternative interpretations of how projects can realise their full potential. It also suggests that the space for citizen science in the realm of marine governance is contested.

Practitioners discuss how citizen science has the capacity to fill multiple roles within the realm of marine governance. As their interpretation and suggested definition of citizen science indicates, they perceive projects to have both data collection and participant engagement dimensions. Thus, these actors argue that citizen science projects can contribute toward solving two of the major challenges facing marine governance regimes; the rationalisation of specific knowledge inputs and inadequate public participation. By offering alternative sources of knowledge that can be aligned with current thinking or in opposition to it, citizen science can *"help to broaden the datasets that policy-makers base their decisions upon … [and] lessen the probability of existent knowledge, which is often very out-of-date, being extrapolated to cover important policy calls"* (NGO officer, #7). Additionally, citizen science practitioners assert that projects can enhance the involvement of local citizens in *"planning circles and give their communities a stronger voice over environmental matters"* (NGO officer, #7). In this light, citizen science has an increasingly important role to play in marine governance processes. This leads practitioners to call for citizen science to become a key component of such regimes, evidencing how it can offer a unique potential:

> *"The active engagement that our initiatives support normally means that they are well placed to quickly respond to the most pressing needs facing marine planning or management processes. For example, we can work with government officers to create a methodology that suits the type of research they want to be conducted, I'm thinking of the Waterfoot Marine Conservation Zone and how our diving recordings contributed to that, as one example. Then, at the same time, we can shift the methodology and structure of the initiative to focus on community engagement … I've also noticed how letting the participants to engage with policy relevant issues, like marine litter or erosion or species decline, has proven to be a really useful means*

of getting people to respond to government consultation and talk with their local councillors about these important local concerns" (NGO officer, #4).

To the contrary of practitioners' arguments, actors in governance actors suggest that citizen science should operate within a more specified space in marine governance regimes. Such actors assert that citizen science is most effective when functioning as a contributory means of supplying knowledge for governance processes. Projects are by no means a guaranteed fixture within such processes, however, with reservations remaining regarding the validity of their output. Citizen science, due to the manner in which it uses non-expert participants, presents a vastly different model of knowledge production to those traditionally used in governance circles. *"Historically, marine decisions, and any environmental decisions for that matter, have been using data and information that is very government centric. By that I mean it had to be conducted by government laboratories. They were the only ones with the money and expertise"* (Government manager, #3). Therefore, knowledge and information that can inform governance decisions has, traditionally, been very specialised, pushing participatory processes and collections of local knowledge to the periphery of decision-making circles. As a governance actor explains:

> *"whenever planning decisions are made, the science had to be top notch, quality assured. So the question always is, "how can you quality assure a citizen or an amateur?" … So, really there is always this reticence against using civics" (Government manager, #3).*

The recent emergence of government supported citizen science projects, added to their heightened use within marine governance regimes, illustrates how traditional policy approaches regarding participatory input are beginning to shift. With improved validation processes and the assistance of professional scientists, governance actors have begun to interpret citizen science as a useful alternative to support marine management. This is particularly the case in the wake of diminishing funding and limited resources being granted to government departments for the running of professional research surveys. *"In reality, we are a very small team. We cannot be everywhere around the coast. So, if you want to get data on where species are occurring, like whales and dolphins for instance, then there are hundreds of eyes around the coast to learn from"* (Government manager, #3). This shift in thinking is, however, a *"slow process and it will be a while before we see citizen science as*

the go to source of data for maritime decision-making" (Government manager, #1). This suggests that there is a space for citizen science to operate within marine governance regimes, despite continued uncertainty and criticism levelled against it.

Interviews with governance actors also reveal how the potential space for projects in policy-making processes is almost exclusively related to the knowledge production capacities of citizen science. There remains a lack of value attributed to the engagement capabilities of citizen science and governance actors appear uncertain as to the specific means through which these can benefit governance processes. Nevertheless, there is evidence to suggest that a sea change in the recognition attached to citizen science by policy actors is beginning to develop:

> *"We are waking up to the breadth of local marine knowledge which is out there and we have to thank both individuals and technology for helping to channel it to the policy arena. Some old school policy-makers will tell you that they will never fully back it, but it's getting to the point where it's ignorant to bypass these meticulously collected surveys on a range of ecosystems and habitats which we have relatively little on record" (Government scientist, #1).*

This changing perception of citizen science is further reflected by a governance actors, who discusses how *"it's went from keeping citizen scientists, who are amateurs, at a distance, to now bringing them in to actually informing policy decisions ... volunteers are unpaid professionals, that's the way we see them"* (Government manager, #3). There are evident concerns and reservations amongst governance actors, in regard to the use of citizen science, yet there are also signs of a growing appreciation for the potential use of projects within policy circles.

On the practitioner side, there is also a degree of removing stigmas about the potential agenda of citizen science organisations. As one practitioner discussed, *"in Northern Ireland and with some stakeholders that we work with, there is still this sort of feeling that "oh you're an environmental NGO, you just scream and shout, you are anti-fishermen, anti-government and anti-everyone." You know, we work so hard to try and change that"* (Project coordinator, #9). Citizen science is an evolving practice and it faces many challenges in its attempt to contribute toward the better management of the marine environment. There are

suggestions, however, that the recognition that citizen science is granted is beginning to grow. It is important to explore this shifting mindset further and to examine how citizen science projects, in pursuit of transformative outcomes, are being both supported and constrained by policy and funding actors. Such insight can then be assessed to understand where lessons can be learnt moving forward.

5.3 Organisational dynamics of citizen science

This chapter has demonstrated how there are two types of actors involved with the establishment, management and development of citizen science projects. These are practitioners, who include project coordinators and managers, and governance actors, such as policy-makers, financial commissioners and government scientists. These actors, collectively, organise the manner in which projects are operationalised and shape the participation process. It is evident that there are contrasting perspectives between these two groups of actors, particularly in regard to the role, purpose and space that citizen science should occupy within regimes of marine governance. These differing viewpoints have a direct impact upon citizen science projects; their scope and how outcomes are realised. This section presents information on these topics and reveals key insight on organisational matters that have, to date, received limited attention in academic literature.

5.3.1 Funder and practitioner relationships

Traditionally, citizen science projects have been financially supported by independent charity foundations or through 'in house' resources. However, there is an increasing trend of government funding supporting citizen science. This is an issue which, despite its potential importance for studies on the transformative potential of citizen science, has received little attention within literature. This study corrects for this limitation and the following section presents the responses of key citizen science actors to interview questions on the topic of funding. This includes an overview of how actors perceive the role of financial support stipulations to shape the operationalisation of projects and how these influence the potential output of initiatives. It is important to note that funding can be a sensitive topic for actors to discuss, with inter-organisation dependency, confidentiality and disclosed contract

agreements commonplace. It was necessary, therefore, to take care when asking citizen actors about these topics. The following insight provided by practitioners and governance actors contains no classified information nor does it includes the names of any specific organisations or funders. Instead, it presents a general discussion on funding related issues and reveals crucial insight that adds to current academic thinking.

Establishing a strong working relationship between coordinators and funders is a crucial element of any citizen science project. As one departmental voice asserts, *"for a project to be successful and to achieve the goals that it sets out to achieve, it's really important that they work with us and vice-versa. From experience, I know that good communication is key. That goes for when they are applying for funding, when we agree upon the ins and outs of the project and when it comes to producing the proposed data output"* (Government manager, #2). Collaborative thinking and continual engagement between actors is, therefore, vital for the sustainable development of citizen science projects and for objectives to be met. A strong relationship, from the perspective of practitioners, involves a commitment by funding actors to appreciate a project's limitations and to assist in the management of challenges. At its core, this centres around the ability to hold open conversations on project matters.

> *"Good dialogue and partnership is essential to build trust in the project's data and the overall reputation. Robust procedures for data validation and ongoing cleansing, should the inevitable errors occur, have to be agreed, maintained and potentially updated in response to the needs of the end-user" (NGO officer, #2).*

This suggests that the potential success of a project is dependent upon a practitioner-governance actor relationship that is open and responsive to change. Actors also suggest that good relationships are crucial for the development of future initiatives. Coordinators state how, *"there isn't an endless array of funding streams out there, we work within a pretty limited pool. So it's important to build good networks when possible and to then highlight to those bodies the unique value that citizen science can offer"* (NGO officer, #7). The importance of amicable, open relationships between projects and their funders is evident, with actors illustrating how the development of trust can help to influence how future opportunities are supported. Speaking directly about marine citizen science from an Northern Irish perspective, some coordinators discuss how they believe there to be *"a good*

relationship between the environmental government agencies that fund us. As Northern Ireland is so small, we are all working for a common purpose. We share resources and data" (Project coordinator, #3). The common purpose, of helping to support marine conservation, is seen to help build this relationship and to support the manner in which citizen science projects can become embedded within governance processes.

Interviewees clarify how building strong, long-term relationships between citizen science actors is a two-way process. This means that both practitioners and governance actors must find acceptable balances between competing perceptions on what the objectives of projects should be, how data is to be produced, analysed and communicated, and what the role of volunteers should be. There is an evident need for flexibility from both actors, with coordinators mentioning how they *"should not be forced into simply resigning to the requirements of funders to establish strong working relationships … our most successful and impactful projects have always benefited from a good amount of organisational agency"* (NGO officer, #7). The potential for governance actors to overpower project coordinators when moulding the scope of citizen science initiatives is noted by some practitioners. As one practitioner discussed, *"funding can bring certain stipulations, which I totally understand, but they don't always provide the kind of freedom necessary to construct an engaging project for the volunteers"* (NGO officer, #6). Such imbalances of power are commonplace in funding relationships and, therefore, are not to exclusive to the realm of citizen science. Nevertheless, those involved with the management of citizen science projects reveal how funders often under-resource volunteer engagement processes and *"fail to realise the importance of creating active participation structures that ensure volunteers feel significantly rewarded for their contribution"* (Project coordinator, #11). This concern is further highlighted by one practitioner, who suggests that:

> *"The focus on specific outputs can impede the development of novel, more innovative means of engaging volunteers and collecting data. Often the outputs are created without volunteer engagement, meaning they have had little role in shaping what it is initially aiming to achieve" (NGO officer, #7).*

This suggests that the practitioner-governance actor relationship can, at times, become distorted in favour of the funders. In such scenarios, practitioners reveal how they and their volunteers can have limited influence upon the shaping of participation structures and the

overall scope of projects. Some practitioners mention how attempting to *"find the balance between running enjoyable and proactive citizen science group, against feeding into these bigger decision making bodies, even though we have very good relationship, is sometimes tricky … we need and we want their backing as much as possible, but we don't want to be overruled by them"* (Project coordinator, #11). The capacity of governance actors to sway the development of projects is, therefore, an evident concern for those involved with the management of citizen science initiatives. Coordinators allude to the need to make trade-offs when communicating with funders, suggesting that it can be difficult to facilitate scientific rigour, policy influence and deep citizen engagement in initiatives. These concerns are clarified by a practitioner, who argues that *"it is important for policy-makers to understand the full range of competing dynamics that we manage, so that they can better navigate and support the full breadth of opportunities available to projects. I don't think we're quite there yet"* (NGO officer, #7).

To fully understand the challenges regarding the practitioner-governance actor relationship, and how it may impact upon the transformative potential of projects, it is important to critically examine the practical ways through which governance actors are seen to be manipulating the development of citizen science initiatives. Learning from these measures, it can then become possible to consider how such scenarios can be overcome. In interviews, practitioners highlight how funders can sway projects by shaping three core aspects: (i) the objectives, (ii) standards and standardised practices, and (iii) the longevity of projects. The following section presents insight on these three themes, reflecting the perspectives of actors on both the policy and practitioner side.

5.3.2 Objective setting

The setting of objectives decides both the goals that projects seek to achieve and the research design that is to be followed. Objectives define the research purpose of a citizen science initiative and shape its potential impact upon policy, practice and participating volunteers. Practitioners discuss how the broader objective and remit of a project – e.g. to monitor specific marine species, to measure ecosystem decline or to assess the impact of plastic pollution upon marine ecology – is decided upon prior to establishment of funding networks. However, it appears that the methodology and step-by-step research objectives

of a project – e.g. how knowledge is to be produced, what dataset or gaps such knowledge will contribute to, and what the practical tasks of volunteers will involve – are predominantly decided in collaboration with funding actors. In interviews, practitioners discuss how it is at this stage that governance actors can begin to sway the development and operationalisation of initiatives. This is achieved by pushing for the creation of objectives and goals that align with the underlying interests of governance actors. These are seen to include *"filling specific gaps of knowledge that can support a policy decision … or to add scientific evidence to either support or prevent a potential coastal development. To be honest, there is usually an overriding intention, one that might not be made clear during the funding application process, that we [practitioners] will be pushed toward"* (Project coordinator, #11). Due to the legal stipulations embedded within funding agreements, practitioners accept that *"there is relatively little that can be done to prevent such eventualities from occurring. Attempting to refuse the suggested objectives of funders or to propose alternatives can risk funding falling through, as well as placing long-term support in a delicate position"* (NGO officer, #7). Therefore, some practitioners interpret the objective setting stage as a key point in the development of projects. It is at this point in which initiatives can be taken out of the control of coordinating organisations and become overwhelmingly guided by funders. Most significantly, this can restrict the scope of what a citizen science project can achieve and limit the transformative capacity of initiatives going forward.

Assessing the manner in which project objectives are set is an important illustration of how power dynamics within the organisational set-up of citizen science projects can operate. It demonstrates how the relationship between practitioners and governance actors can become unbalanced, and how this can lead to initiatives evolving toward the specific, pre-selected intentions of funding actors. As one practitioner argues, catering to the desires of governance actors can constrain the capacity of citizen science projects from actively promoting the change that their coordinators, and volunteers, can be keen to realise: *"we are really constrained at times, locked into methodologies and intended outputs that don't consider the volunteer's desires or even think about how engaging or fun it will be for volunteers"* (NGO officer, #6). This statement illustrates how governance actors can dominate the direction that citizen science projects take; creating objectives that fail to respond to the requirements and ideals of those involved with the active running of initiatives, as well as restricting the agency that project managers have in relation to decision-making processes. Other practitioners reflect these concerns, highlighting how

governance actors can set objectives that may be only loosely aligned with the principles of participation that practitioners seek to install. This can be linked to the interpretation of citizen science that governance actors are commonly seen to follow, i.e. citizen science as a data collection tool. This understanding of citizen science strips the notion of active participation from projects and is seen to frustrate some practitioners. As one practitioner asserts:

> *"they [funders] want to see the data fulfilling their priority areas, which is something which sometimes doesn't overlap very well with the citizen science projects. For instance, they may prefer to see us diving on some muddy habitat or some slightly more dangerous sites, deeper water, things like that. And we just have to be really careful that we don't get overpowered by those decisions and go "OK, well they want us to dive there and that will feed into this and then we have to do that". Because we have to protect our participants. We must make sure that they are safe and comfortable doing the tasks asked of them and, just as importantly, we must ensure that are enjoying an active role in the project where they feel engaged as scientific contributors and satisfied with their participation" (Project coordinator, #11).*

This general theme of governance actors coercing citizen science projects into setting policy-defined objectives, which reflect little emphasis upon the unique potential of projects as participatory initiatives, is noted by several practitioners. As one discusses, *"this [the focus of objectives being on scientific aspects] is expected, of course, but it is a frustrating issue that often limits the scope of citizen science to really get engaged with volunteers, provide them with the time and resources necessary to train them up and instil confidence in them that they can conduct their often complex and technical tasks"* (NGO officer, #8). Indeed, the setting of objectives in this manner has been seen to harm the both the recruitment and retainment of volunteers. Practitioners speak of how, "*we have lost a number of really good volunteers because of the creation of purely scientific objectives and it is frustrating to see that. It can put off other participants as well, because they won't join an initiative that others feel let down by"* (Project coordinator, #11). Ultimately, the concerns noted by practitioners relate to an underlying feeling that citizen science is misinterpreted by many governance actors. Their understanding of a citizen science, as a cost-effective data collection tool, is in direct contrast to interpretations of practitioners, who champion the capacity of

participatory research to function as both a scientific practice and a means of engaging citizens with environmental conservation.

Attempting to strike a balance between an effective project that can engage a large volume of volunteers, whilst simultaneously producing valuable, robust data to influence and inform decision making, is by no means an easy task. Governance actors have requirements to respond to and, with limited budgets and diminishing resources, often look to citizen science as a useful alternative. For this relationship between governance actors and citizen science to grow in a sustainable manner, however, it appears crucial that objectives are set with the intentions of both funders and practitioners in collaboration. Currently, as one practitioner asserts, "*funders undervalue two things. One, that social engagement and education and the general commitment needed to work with volunteers on a professional level is important to effective citizen science monitoring and recording. And two, that giving us strict output objectives is much more damaging for our long term ambitions than they think*" (NGO officer, #6). Practitioners, at times, reflect evident feelings of frustration toward funders, particularly in relation to the manner in which the objectives that they encourage have refined the scope of investigation that citizen science initiatives can follow. Yet it can be difficult for practitioners to speak out against this or to challenge it. Funding stipulations can place projects in a delicate balance and force practitioners to prioritise the needs of funders and end-users over their own volunteers.

5.3.3 Standards and standardised practices

Interviews with citizen science actors reveal how the effectiveness and transformative scope of projects can be significantly influenced, and at times restricted, by the standards and standardised practices that funders implement. The creation of standards is a central part of citizen science, shaping several elements of how projects are operationalised. These include data standards that ensure scientific quality and help to increase the trust placed in citizen science datasets, as well as participation practices that regulate the manner in which volunteers carry out tasks. Standards, as one governance actor suggests, *"help to even the terrain on which citizen scientists meet policy ... Standardised practices help us to coordinate the work of citizen science projects and provide the means for distinguishing relevant and reliable data from the irrelevant and unreliable"* (Government manager, #1). Standards,

therefore, determine to what extent and in what ways citizen science data is incorporated into policy circles. This leads many practitioners to interpret standards as having a dual-role in shaping the scope of projects. A project coordinator discussed how, on one hand, standards serve a *"bridging function that can enable our data to have a higher measure of legitimacy among policy and decision-makers"* (Project coordinator, #11). At the same time, standards can serve a *"policing function that allows those same policy-makers to dismiss some of our knowledge as irrelevant, without taking into consideration the intricacies of what local knowledge represents and how it can vary in composition and structure"* (Project coordinator, #11). Such assertions highlight how standards can contribute to the establishment of expert authority, thus 'policing' the boundaries of projects and pushing them toward the production of knowledge that can seamlessly and efficiently link up policy thinking. This, evidently, has the potential to restrict the capability of projects from producing different types and forms of knowledge. Ultimately, standards and implementation of standardised practices represent a challenging issue within the organisational realm of citizen science and are shown to both support and constrain the output of projects.

In interviews with governance actors, the implementation of standards and standardised practices are revealed as being be crucial for the successful alignment of citizen science initiatives with marine governance decision-making. For instance, actors discuss how: *"detailed regulations on how citizen science projects should use their volunteers, validate the data they collect and feed those recordings into our scientific datasets are paramount"* (Government manager, #2). In a similar vein, the absence of standards can be seen to render citizen science data unusable, regardless of its value or insight. Interviewees state how it can be *"frustrating when we get an array of data that isn't curated in line with the standardised criteria that we use. We've had to turn away a lot of really useful knowledge simply because we can't make use of it"* (Government scientist, #1). To combat such issues, governance actors demonstrate the significance of implementing standards by discussing how they can function as a assurance mechanism for projects, ensuring that citizen science knowledge has a pathway to policy. As one governance actor discussed:

> *"The setting of standards is a great way, and indeed a necessary way, of guaranteeing that results generated by an initiative in one site will be just as reliable*

and relevant as the recordings that we [government scientists] carry out in others" (Government manager, #1).

In the absence of standards for data collection and analysis, governance actors discuss how the trust that they place in citizen science projects can diminish. Standards embed a degree of uniformity within initiatives and help to support consistency in the manner in which they operate. *"We have to make sure that we are using the best information to inform marine policy. It has to be scientifically repeatable and assured. If we base a decision on a dataset that turns out to be disproven by a professional study, then everything goes up in the air and we lose significant ground"* (Government manager, #1). Should citizen science projects successfully influence the management of marine environments and contribute to policy discussions, the implementation of standards, in the perception of governance actors, are imperative. Policy actors show a distinct reluctance to engage with projects that fail to follow standardised research protocols, whilst simultaneously highlighting how standards can help to streamline the transfer of citizen science knowledge to policy circles.

Interviews with citizen science practitioners reveal a contrasting argument regarding the role of standards and the manner in which they shape the organisation of projects. Several practitioners, whilst acknowledging how standards can enhance the legitimacy of citizen science knowledge, argue that the implementation of standards can limit both the scope of what initiatives are capable of achieving and the agency that is afforded to volunteers. The term 'policing' is mentioned by one practitioner when discussing the role of standards, demonstrating how there is a perception that standards can drive projects to operate within specific, predefined manners. By implementing standards on how data is to be collected, analysed and disseminated, citizen science practitioners argue that funding actors can sway the methodology of projects and embed strict guidelines on what can, and cannot, be done. This, as one practitioner asserts, has the potential to *"turn projects that are meant to be about getting non-professional members of the public engaged with environmental monitoring, into professionally moulded research studies that are often difficult for some volunteers to get excited by"* (Project coordinator, #11). In such instances, there is a higher potential for volunteers to become disinterested or to feel out of their depths, due to the increasingly technical and professional participation process that must be followed. This can negatively impact the potential output of projects, with one practitioner illustrating how *"every time we lose volunteers we lose their potentially valuable local knowledge and,*

regrettable so, hinder our broader objectives" (Project coordinator, #2). Other practitioners reflect on this point, discussing how standards, and the administrative burden that they can present, means that:

> *"too much of our time and energy is being spent on extensive paperwork and training with our volunteers, especially when we have limited resources to conduct the actual research anyway. This seems to be a typical issue for lots of citizen science groups, where the funding regulations push us to operate at the level of much vaster well-resourced institutions" (Project coordinator, #9).*

Ultimately, standards are a double-edged sword in the realm of citizen science, operating as both an obstacle and potential resource. Although standards are often presented as a means of bridging the boundaries between citizen science and policy, offering projects the chance to gain access to expert-dominated arenas, they are also seen to be an effective means of policing what projects can achieve. Standards make experts' judgments and practices robust, in part by linking them to other powerful political and legal infrastructures. In turn, standards can curtail the agency of projects and force the creation of strict methodologies that guide coordinators, and their volunteers, to act in specific manners. The challenge for citizen science, as the findings from interviews suggest, lies in making strategic use of standards and deciding when to challenge them. Developing strategies for simultaneously exploiting and challenging standards is no small task, yet it is one that may be aided by recognising the double-edged power of standards.

5.3.4 Duration of projects

A further theme revealed in interviews that has implications upon the organisational structure of citizen science projects relates to differing perspectives regarding the duration of initiatives. For practitioners, the relatively short-term nature of funding was discussed as an impactful issue upon the creative scope of citizen science projects. Often, funding for a project is granted for between 1-3 years with no guarantee of follow-up financial support. As one practitioner discussed, this can mean that *"the initial good work carried out by a project slows down or stops entirely. It can be a real waste because it takes time to get things running as we'd like and then, before you know it, we have to start looking for new funding*

streams or be forced to look at how we can transfer volunteers to other projects" (Project coordinator, #11). Expanding on this point, practitioners discuss how project objectives, such as, *"empowering volunteers and establishing research protocols that can get the most out of them [volunteers] requires time and ongoing commitment from funders"* (NGO officer, #7). However, securing long-term funding networks that evolve and respond to the dynamic needs of a citizen science project is revealed as being increasingly difficult.

Governance actors discuss the challenge of time-bound funding in similar depth, asserting that they themselves can be restricted by financial boundaries. This can force them to make decisions on what projects to support and for how long by considering the wider policy field that they are responsible for. As one government manager asserted:

> *"We cannot satisfy the funding requirements of all citizen science projects here. That is obvious and an issue that all commissioners feel, especially in government departments. So, in our case, we have to think about what type of data do we need at the moment, be it fishing stock information or endangered species recordings or recordings on marine litter, whatever the most pressing gap in policy is. Then we have a look at what citizen science projects are applying for funding or who would like to be, and start discussing with them how we can work together" (Government manager, #1).*

This suggests that governance actors often seek out citizen science initiatives that align with their most pressing challenges. Funding agreements are then shaped around these challenges, meaning that projects are supported to fill specific gaps of knowledge within given time-frames. As a governance actor explained, *"usually, given our own timeframes and resource pots, we have granted 2-3 years' worth of financial support to the projects that we work with. We aren't restricted to that, it just depends on the context, and by and large that has worked for us"* (Government manager, #1). Placing timeframes and deadlines on the contribution of projects is understood as being a necessary means of receiving guarantees on what data will be collected, analysed and submitted by citizen science initiatives. It also reflects upon the overarching perception of governance actors that citizen science is a tool that should be financially supported so as to generate valuable data and, once this purpose is served, funding is often concluded.

Practitioners discuss the multiple ramifications of funding timeframes, illustrating how it can restrict their capacity to establish long-term community action. Many projects work within the restraints of short-term funding by seeking to help their participants become 'leaders' who can continue to carry out their citizen science tasks even when funding has ceased. As one practitioner explained, *"ultimately what we've said to the funder is that we're going to try to have people who are sort of leading this by the end of the three years. We have funding at the end of the project to put on training. So we'll identify a small group of people, we'll pay their way on a two-day course where you get taught about public speaking skills, you get all of this. And then they will be the people who run the shark tagging program for Northern Ireland after we finish"* (Project coordinator, #9). Although some charity financial bodies, such as the HLF, are said to *"value community and participant engagement on a greater scale than government departments often do"* (Project coordinator, #11), there are few examples of citizen science projects that are granted extra or continual phases of funding. As a practitioner discussed, there are also limitations on receiving new funding grants from the same organisation:

> *"if you've been given three years, if you want to apply for more money you can't do that until the project has officially stopped. So even in the best case scenario, you've maybe a year's break. Which can be quite damaging for a project that needs to have a staff member there. And they don't like to refund. So even if it's a similar thing, it needs to be a bit different somehow" (Project coordinator, #9).*

Other practitioners mention the degree to which projects can slowly recede as funding becomes difficult to sustain. *"We might get top ups and smaller grants after the initial block grant is finished, but they rarely enable us to operate at the same pace and with the same impact as before. The longer running citizen science projects are always supported by internal funding or by organisation members. Smaller groups like ourselves just can't match that and that's the frustrating thing"* (Project coordinator, #2). In total, funding timeframes are revealed as being significantly influential factors in the organisation of citizen science projects. Discussions with actors illustrate the challenge of obtaining long-term funding, whilst also shedding light on the rationale of government funders for supporting short-term, specifically focused grants. It is vital to consider both perspectives when assessing how changes could be made to allow for the more sustainable management of citizen science initiatives.

5.4 Production and use of knowledge

Central to the interviews that were conducted with citizen science actors were discussions on the production and use of knowledge. At its core, citizen science is a means of getting engaged members of the public involved with scientific knowledge production processes. Of the projects that are analysed in this study, citizen science knowledge is specifically related to the conservation of marine environments. Generated knowledge stems from continual sighting efforts, monitoring schemes of maritime species and habitats, as well as surveying records on marine litter and coastal erosion. Whilst each of the projects assessed in this study are seen to produce, use, communicate and disseminate knowledge in content-dependent manners, there are many similar trends amongst the projects that important to examine. As *Chapter 2* demonstrated, the ways in which citizen science produces knowledge is a well discussed topic in academic literature, with a multitude of studies demonstrating the different types of knowledges that can be generated. However, current literature places much less emphasis on examining two other knowledge related issues, both of which are important to investigate if an understanding of how citizen science can act in transformative manners is to be achieved. First, where citizen science knowledge goes after production, in other words how it is used and by whom. Second, the impact that citizen science knowledge has and on what grounds. This study has attempted to fill these gaps by questioning these topics with key citizen science actors. Analysing both how citizen science produces knowledge and what is done with this knowledge is advanced as a valuable means of revealing insight on the transformative capacity of the practice. The following section thematically breaks down the discussions carried out with interviewees, illustrating the major trends and diverging perspectives that key actors hold.

As an alternative to discussing the wide range of knowledge types that citizen science projects can produce, a theme that is widely researched in current literature, the following paragraphs present insight on how practitioners and policy-makers discuss the manner in which the knowledge of citizen science is used. Thematically analysing the responses of these actors, two dominant interpretations were noted. The first relates to the notion that citizen science knowledge is a means of contributing toward our collective understanding of the marine environment. This study, as explained in *Chapter 2*, defines this as knowledge 'for knowing'. As the following section will discuss, some actors interpret this approach to knowledge production as a means of maintaining the *status quo* of marine governance. The

second perception is that citizen science is an opportunity to challenge current thinking through the active production of alternative knowledge, referred to in this study as knowledge 'for action'. This is a more radical interpretation of how citizen science can produce knowledge and is construed as an attempt to challenge the *status quo* of how decisions are made within marine governance processes. Governance actors, as well as the majority of citizen science practitioners that were interviewed, are seen to, largely, align with the assertion that citizen science is a means of producing knowledge for knowing. However, there are a number of practitioners, particularly those associated with co-produced projects and activist organisations, who recognise the potential of citizen science to also generate knowledge for action.

The way in which the differing perceptions of citizen science actors are argued is expanded upon below, with important links to discussions on the transformative capacity of citizen science highlighted throughout. Knowledge is seen to represent a powerful means of shaping marine governance processes and the manner in which decisions are made. How the knowledge of citizen science can influence the governance level is a crucial point of investigation for this study, and the following findings shed light on how it is used and, equally as importantly, prevented from being used in certain circumstances. Suggestions on how barriers to the use of citizen science knowledge can be overcome are also mentioned. This section will conclude with a brief discussion on the rising use of technology within citizen science and how it offers both opportunities and challenges for the production and use of citizen science knowledge.

5.4.1 Knowledge 'for knowing'

In the eyes of some citizen science actors, the knowledge that projects generate is advanced as a way of contributing toward an improved understanding of the marine environment. As one governance actor summarised, *"we receive data from citizen science to help us make our recommendations, to help us understand what's actually happening"* (Government manager, #2). Citizen science knowledge, in this sense, is a contributory source of information. It adds to current understanding and introduces findings that can broaden the datasets upon which governance decisions are made. Governance actors discuss how contributing to professional knowledge bases should be recognised as *"the key value of [citizen science] projects, the level*

at which they are having real impact upon conservation" (Government manager, #1). In other words, this process of knowledge share is interpreted by governance actors as representing the pinnacle of what citizen science can achieve. The knowledge that projects produce is transformed from amateur recordings into scientifically recognised material that can inform management decisions regarding the future management of marine environments.

Moving beyond general discussions on the value of citizen science knowledge, interviews reveal crucial insight on the manner in which it used within policy circles. Governance actors suggest that the higher the quantity of citizen science knowledge that they are presented with the better, even when the levels of data quality that such knowledge holds is unpredictable. Although the responses of governance actors to questions on the role of data reliability hinted at the importance of matching professional standards, discussions on the practical use of citizen science knowledge present a slightly altered view point. Governance actor appear to suggest that the more knowledge and insight that is available on a particular marine species or sites, the greater opportunity for knowledge on the marine environment to be broadened. In turn, marine management processes can become more accurate in their approach to conserving marine and coastal regions. One governance actor, when demonstrating how policy is informed, noted how *"each piece of information is logged and graded depending on where it came from. As long as we can account for it, it can be valuable for us"* (Planning officer, #1). The process of grading knowledge is a tactic of organising datasets and involves reviewing the consistency and origin of data. This reflects the willingness of governance actors to incorporate citizen science data in policy, particularly if it reflects knowledge that is otherwise unknown, as the need to continuously *"develop our datasets and fill spaces of uncertainty can be an endless task"* (Government manager, #2). Governance highlight the importance of data accountable, exemplifying how they can track the source of data records and enquire for further detail, if necessary. As one governance discussed further:

> *"There's no such thing as bad data. Bad data is good data if you know how bad it is. Right? So in other words, whereas we would have always wanted a full data set on everything, even just to have information to say that "this crab" or "this mollusc" was on this site on this day, even if it's just one species, that's useful data these days. We don't need to know everything else around it, because we never know when we need to know that species was present, you know? That's why I welcome civic initiatives*

and have pushed for them to receive greater recognition. There's a host of individual and collective records, and by that I mean the project outputs, that have huge significance for marine preservation and it is all of use one way or another" (Government manager, #3)

These responses, although somewhat in contrast to discussions on the importance of data verification, reflect how the manner in which citizen science knowledge can assist governance by broadening central datasets is evolving. Governance actors reveal how quantity of data can be equally as important as quality, specifically when *"there are pressing policy challenges that we need to resolve to ensure the sustainable development of Northern Ireland's maritime environment"* (Planning officer, #1). Insight is presented on the growing value placed upon citizen science knowledge and the manner in which this knowledge can be held accountable when used to support policy recommendations. The suggestion that 'there is no such thing as bad data' may also illustrate an example of knowledge rationalisation within the governance realm. If knowledge fits with the goals of governance actors, regardless of its quality, it has the potential to influence policy decisions.

When discussing the process of citizen science knowledge being used to enhance the wider scientific understanding of the marine environment, practitioners discuss how their knowledge can reach a range of end users. Most commonly, these are policy or local council decision-makers, whereby citizen science knowledge is transferred to actors that incorporate it into their management approaches or decisions. However, there are also other end users of citizen science knowledge, including *"academic researchers, environmental charities and organisations, land developers or private planning companies that want to strengthen their proposals by using our knowledge"* (Project coordinator, #12). However, when considering how citizen science knowledge can instigate transformative change to marine governance processes, practitioners, unsurprisingly, focus their attention upon the realm of policy. As policy actors illustrated in interviews, there are a multitude of ways in which they use citizen science knowledge. Practitioners discuss these processes in similar detail, as well as providing some insightful information on how they believe that more can be done to involve the knowledge that initiatives are capable of generating. Some practitioners argue that governance actors are exclusively interested in using citizen science knowledge that is quantitative information. As one practitioner discussed, the preference of governance actors to only make use of the quantitative data that projects produce can limit the ability of their

alternative, 'truly amateur' pieces of knowledge from impacting policy and management processes:

> *"It's all kind of getting people out there and writing numbers down on a data recording sheet. So we are producing spreadsheets with quantitative, but non-professional, scientific data. But then we've got the other knowledge. It's how do we bring in everything else that citizen science can be: stories, anecdotal evidence, local traditions, non-verified records, all of these extra things. There's not always a pathway for that kind of insight, despite that value it carries" (Project coordinator, #9).*

The framing of citizen science as means of producing knowledge for the purposes of adding to current thought exemplifies how projects, should they contribute to the shaping of policy, are regularly bound to professional data collection protocols. In particular, this can shape the forms of knowledge that can make the leap from citizen science to policy, with qualitative information often being deemed as incompatible with governance datasets. As another practitioner argued, initiatives are often made to produce quantitative data that *"adds to what is already known on a specific topic, a bit like an update on the current condition or stock of a specific maritime species"* (Project coordinator, #12) and are forced to place any qualitative insight to one side. Practitioners suggest that this limitation could be rectified if governance actors acknowledged the value of alternative knowledge sources. As one project coordinator responded:

> *"even in decision-making processes, modelling is used so much. And it's so accepted, but it's just invented, you know? You take a few points of truth and you then tell a story over it. Maybe that's the way you need to explain citizen science. We're taking a few points of truth, we're putting a story over by incorporating local insight and cultural heritage and then you can go out and ground truth as much as you can" (Project coordinator, #9).*

This comment, along with others, demonstrates how some practitioners are of the belief that the current use of citizen science knowledge, although increasingly evolving within governance regimes, is capable of growing further and of changing in complexion. The knowledge that citizen science generates is increasingly recognised as a source of important

scientific information that can enhance established datasets. Yet there are concerns, from practitioners, that governance actors must evolve in their interpretation of how to use citizen science knowledge.

5.4.2 Knowledge 'for action'

In addition to filling gaps of knowledge and contributing toward our general understanding of marine processes, some citizen science actors suggest that projects are capable of instigating action through the knowledge that they produce. Although contributing to current knowledge can be interpreted as a means of maintaining the *status quo*, in the sense that established governance approaches and decision-making mechanisms are strengthened, using knowledge to instigate action is understood as an attempt to challenge the *status quo*. This involves the generation of knowledge that can contradict current understandings or suggest an alternative narrative for decision-makers to follow. This perception of the use of citizen science knowledge is much less discussed by governance actors and is only referenced by practitioners who are associated with co-produced initiatives or activist organisations. As a practitioner explained, *"to challenge policy effectively we need to produce knowledge that can get the attention of government, not just because of the story that we are revealing but also because of the publicity or community concern that it can pick up … in the past we've used intimate recordings or different types of data, like videos or photos, as well numbers and records … at the end of the day, we just want the environment to be rightfully protected and we will use whatever material necessary to allow that to happen. We shouldn't need activism and the input of citizens to do that, but at times that is what's required"* (NGO officer, #6). Knowledge 'for action', therefore, necessitates action from both those involved with citizen science projects and those in governance positions. This includes action by volunteers and practitioners to collect data, analyse its meaning and share it with potential end users, and action by governance actors to respond to this knowledge and to instigate change in their approach. This is reflected in the statement of one practitioner, who illustrated how they *"present the knowledge that we have, which the council aren't aware of, and use it to highlight the issue of erosion along the beach and Burren before it's too late"* (Project coordinator, #1). It is a process of knowledge communication and pushes governance actors to actively respond to the suggestions of citizen science projects.

Interviews reveal how the notion of knowledge 'for action' is, primarily, about introducing new knowledge. This does not suggest that projects must use knowledge to incite conflict or hostility, as has been seen to work in other activist approaches. Instead, citizen science practitioners mention how knowledge 'for action' is a process of proposing alternatives to current thought. As one coordinator mentions, governance actors:

> *"won't be interested in it [knowledge] if we force it at them ... the confrontational approach doesn't do anybody any good, not in my experience, not in the area of the environment and certainly not in a local sense. The friendlier approach of working together and creating good contacts and networks with councillors or the decision-makers is definitely the much more pleasant way to getting the thing done, but I appreciate at times we need to question them. Not question their authority, but their understanding of a local problem that we all know they don't have the resources to measure themselves" (Project coordinator, #1).*

An example of how citizen science can produce knowledge 'for action' and can instigate transformative change to marine governance processes was revealed when discussing the designation of the Waterfoot Marine Conservation Zone (MCZ) with interviewees. The site was designated as a protected area following the submission of knowledge collected by Seasearch, a voluntary diving group. There was limited recordings of the quality and coverage of seagrass in the Red Bay of Waterfoot, despite concerns from local fishers and environmentalists over its conservation, prompting Seasearch to conduct extensive mapping studies before presenting this information to policy-makers and calling for protected designation of the site. This then led to one of the first MCZs being designated in Northern Ireland and has helped to ensure the protection of one of the largest seagrass beds in the country. As a governance actor discussed when explaining the case:

> *"We can't be everywhere, so Seasearch identified a seagrass bed in Waterfoot. They mapped it and then came to us and we then made it a MCZ. So there's a clear example of when citizen science approached us and said "we think this". And we didn't just take it and say "yeah, we'll make it". We then had to go back and audit check it. So we followed it up with more intensive surveys. But it was basically a third-*

party nominated site. All the other ones we would have done ourselves" (Government manager, #3).

This is a powerful example of citizen science using active approaches to calling for change. It also exemplifies how governance actors are willing, under the right circumstances to engage with alternative knowledge and to change their knowledge bases when prompted to do so. *"Those local volunteers certainly set the momentum and we were able to push on and bring it a little further. I mean, it made it to be a designated site, which is a big achievement and crucial for marine conservation"* (Government manager, #1). The example also illustrates how citizen science, often restricted in its output by more powerful governance actors, can instigate action to challenge power structures. As one practitioner discussed, *"we don't advertise the idea of generating change or changing policy as one of our objectives but it no doubt has an impact on how our projects develop and attempting to change power structures is inherent to the impacts we want to achieve"* (Project coordinator, #11).

The case of the Waterfoot MCZ designation was also mentioned by other practitioners, who reflect upon the wider issues that it relates to in terms of the shifting of power and the role of citizen science is governance regimes. As one coordinator discusses, *"we've got some really nice examples like the Seasearch surveys leading to an MCZ, but I don't think that will be a common occurrence unless the recognition given to citizen science by those in power begins to shift. I'd like to see the marine governance in Northern Ireland become: step one, what do we know from citizen science? Step two, how can we funnel the knowledge it creates into our datasets and use it to change marine governance for the better? We're not at that stage yet"* (Project coordinator, #9). Interviews reveal an interesting dynamic between the use of citizen science knowledge for purely contributory purposes, and for more activist-like functions. Examples are provided of how knowledge can both constrain and support the potential of citizen science projects from operating in transformative manners. It is important to reflect upon these examples, to consider what they tell us about the power dynamics in operation within citizen science and to learn how changes can be made to allow projects to more effectively transform the degree to which local knowledge can influence marine governance.

5.4.3 The impact of technological advancements upon citizen science knowledge

An aspect of how citizen science knowledge is produced and used in the realm of marine governance that is important to reference is the process by which data is communicated and disseminated. In particular, the impact that technology has had upon the ability of projects to more efficiently communicate knowledge to end users is found to be a crucial development of the last decade and hints at what the future of citizen science could hold. Interviewees reveal how the evolvement of marine citizen science has been enabled through technological developments, whilst also suggesting potential pitfalls of the enhanced use of technologies within projects. One practitioner mentioned how *"our data collection processes can now be carried out through a wide range of instruments and devices, including mobile apps, web services and virtual data dumps or datasets … it [technology] can really enhance the amount of data that our volunteers collect and we are really pleased with the efficiency that we can now communicate our findings"* (Project coordinator, #7). Other practitioners note the use of technology for administrative and verification purposes, mentioning how the development of *"virtual forums and virtual meetings is helping the promotion and formation of our meet ups. They are really useful for quality checking as well, as volunteers can put forward their records or sightings and others will respond with their thoughts"* (Project coordinator, #4). These assertions suggest that the continued development of new technologies could help to increase the number of both citizen science projects and of participant numbers, as well as facilitating a greater level of interaction between participants. As a governance actor also noted, *"these emerging technologies that have become commonplace in some projects give the potential to engage broader audiences, motivate volunteers to do more and, probably of most importance to us, improve the data quality of records"* (Government scientist, #1).

There are potential limitations to the increased use of technology within citizen science and a number are suggested by interviewees. Most prominently, there are concerns that technology will *"eventually push away our participants … either they will feel like their contribution is less important than that of a virtual mapping tool or by becoming disillusioned with the sheer lack of social engagement … I do fear that technology could damage the real meaning of civic science"* (Project coordinator, #4). The rate at which technology advances is a worrying factor for some practitioners, particularly when considering the impact that new devices or online applications can have upon the practical role and enjoyment that

volunteers receive. Citizen science projects will soon face a decision to development in line with new technologies or remain socially-focused endeavours. As practitioners suggest, the degree to which projects use technology in the future will be influenced by governance actors. If technologically-guided research becomes the core means of informing government decision-making, the funding available to citizen science may encourage the enhanced use of virtual methodologies. As one governance actor discussed, *"advances in AI [automated intelligence] and machine learning are going to massively help us cover more ground in the future"* (Government manager, #1). This suggests that the use of citizens in knowledge production processes may recede in the coming years and, equally as worrying, further indicates that local knowledge sources, such as stories and cultural narratives, are unsuitable for governance decision-making. These findings hint that the use of citizens will be challenged by a rising use of technology within governance processes and it appears likely that citizen science projects will be forced to adapt and evolve in line with these changes.

5.5 Conclusions

This chapter has presented the findings of interviews with a range of citizen science actors. The responses of actors were analysed, with key themes being extracted and presented throughout this chapter. These themes covered issues relating to the purpose and role of citizen science (5.2), the organisational dynamics of projects (5.3), and the manner in which knowledge is produced and used (5.4). Collectively, these sections reveal a narrative on the functioning of power within the citizen science field. The findings that are presented represent crucial insight on the relationship between citizen science practitioners and governance actors. There is a distinct indication that the balance of power between these two actors can, at times, become uneven and lead to restrictions and limitations on the output of projects. Governance actors are seen to have significant sway upon the organisation and development of projects, utilising specific measures – such as objectives, standards and timeframes – to guide projects toward specific, pre-determined ends. This can push citizen science practitioners to arrange their volunteers, methodologies and potential outputs in particular ways that serve to maintain marine governance protocols. These measures are revealed as being 'two-sided', in the sense that the measures implemented by governance actors can help to create a link between projects and policy, whilst also policing what projects can, and cannot, achieve within these arrangements. Ultimately, this suggests

that the process of state support for citizen science projects, whilst appearing as a transfer of power to non-state actors, in reality signals the creation of new arrangements that can turn projects into both objects and subjects of governance actors.

Discussions on the manner in which citizen science knowledge is produced and used also reveal critical insight relating to the power arrangements that shape the scope and capacity of citizen science initiatives. *Chapter 3* of this study discussed how certain types of knowledge and certain ways of constituting and understanding the natural environment have, traditionally, led to specific ways of governing it. In many instances, powerful governance actors can then use knowledge to exclude potential alternatives and work to maintain a *status quo* of how the natural environment is used. Without critically examining how knowledge and power interact within a particular realm, little can be done to instigate change. Until now, such insight has not been revealed in the realm of citizen science and there is little discussion on how citizen science can work to challenge instances of undemocratic or unjust governance.

By examining the types of knowledge that are produced and used in the realm of marine citizen science, this chapter has unravelled important insight on both the structures of power that exist and the manner in which projects can be constrained and forced to operate in contributory ways. Most importantly, the findings also reveal how projects can be made to do more and can overcome the barriers that restrict their potential to instigate transformative change. This links to the theory of power/knowledge, which is discussed in detail in *Chapter 3* and is used to inform the conceptual thinking of this study. The power/knowledge arrangements that function within the field of citizen science are seen to dictate and control how projects operate. However, as the theory emphasises, power is not a zero-sum game and can be challenged, especially when the mechanisms of control can be exposed. *Chapter 8* will expand upon how the findings of interviews expose power/knowledge arrangements in citizen science and how this insight can be used to formulate alternative futures for citizen science.

6

MOTIVATIONS, OUTCOMES AND PERCEPTIONS OF VOLUNTEERS

6.1 Introduction

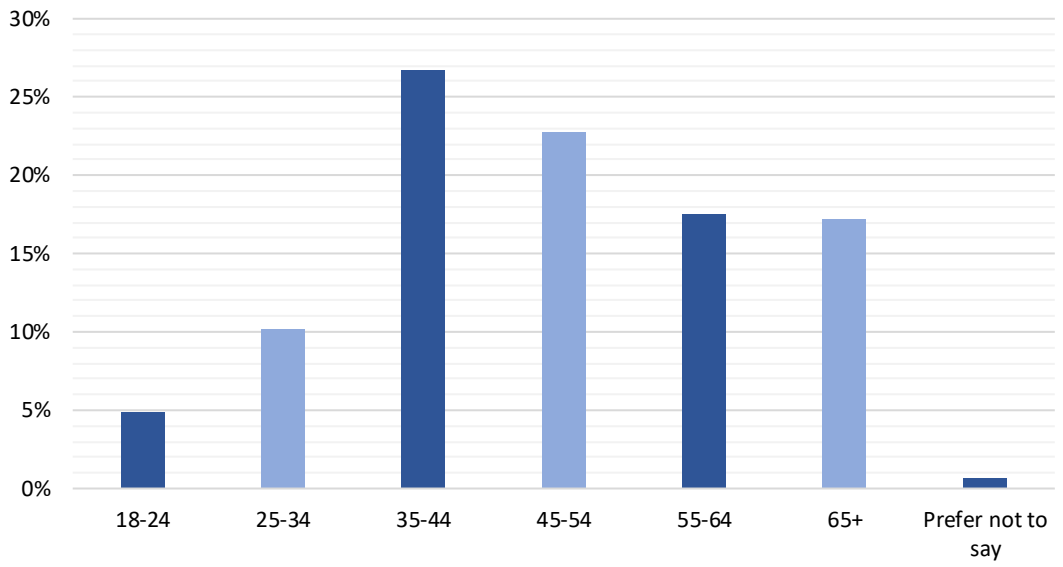
This chapter presents the results of descriptive and thematic analysis of an online survey carried out with citizen science volunteers. The findings reveal how volunteers' perceptions of the purpose and potential of citizen science are dependent upon their degree of participation, motivations for and outcomes of engagement. This chapter critically reflects upon these findings, demonstrating their relevance for the wider objectives of this study. To begin, a review is provided of the demographic characteristics of the survey respondents (*6.2*). This illustrates the variance among respondents in regards to gender, age, educational attainment and employment status. Following this, a detailed overview of the respondents' participation in citizen science is presented (*6.3*). This section descriptively evaluates the degrees of engagement (*6.3.1*), motivational drivers (*6.3.2*) and attained outcomes (*6.3.3*) of citizen science participants. Primarily, this is achieved by using descriptive analysing approach to evaluate a list of Likert-type statements used in the survey. Added to this, open-ended questions are thematically analysed to uncover further insights on citizen science participation and to add clarification to the previous answers of respondents. To conclude this chapter, the analysed findings are summarised and discussed in relation to the wider context of this study (*section 6.4*).

6.2 Demographics of respondents

A total of 308 respondents completed the survey, with slightly more males (55.4%) than females (44%) taking part. A further 0.6% chose not to disclose their gender. All respondents were above the age of 18 (*figure 6.1*), with the majority of survey respondents (26.7%) stating that they were aged between 35-44. The second most common age group amongst participants was 45-54, accounting for 22.8%. A relatively high percentage of respondents (17.2%) noted that they were 65 or older, while a further 17.5% were aged 55-64. There was a much lower number of citizen science volunteers in younger age brackets, with 4.9% aged between 18-24 and an additional 10.2% between 25-34. This overview is in line with current evaluations of citizen science. Studies have demonstrated how it is predominantly middle-aged and older individuals who participate in citizen science (Walajahi, 2019), with little deviation between the number of male and female participants (Dawson, 2018; Tindall et al.,

2003). Contrasting with most other spheres of political life, studies have shown how women are, generally, well represented in participatory environmental projects and movements (Tindall et al., 2003; Schahn and Holzer, 1990).

Figure 6.1 *- Age groups of respondents*



The makeup of survey respondents in regards to their education (*figure 6.2*) illustrates that citizen science volunteers are, predominantly, highly educated. The International Standard Classification of Education framework is used to assess the education of respondents. A total of 59% stated that they have attained a Bachelor's degree or equivalent, with 31% holding a Master's or equivalent and 11% holding a Doctorate or equivalent. This is significantly higher than the national average in Northern Ireland, where 24% of all citizens over the age of 18 hold some form of university degree (Office for National Statistics, 2013). Professional qualifications, including teaching, nursing and accountancy credentials, were held by 19.8% of the respondents. Added to this, 39.9% of participants achieved some form of vocational/work-related qualifications. Most significantly, only 1% of survey respondents stated that they held no qualification at secondary or tertiary levels of education. This demonstrates how citizen science participants, predominantly, come from highly educated and academically qualified backgrounds. This is consistent with current evaluations of citizen science participation, which have illustrated how the vast majority of projects contain a markedly educated (Evans et al., 2005; Walajahi, 2019) and scientifically trained (Chase and Levine, 2018) citizenry.

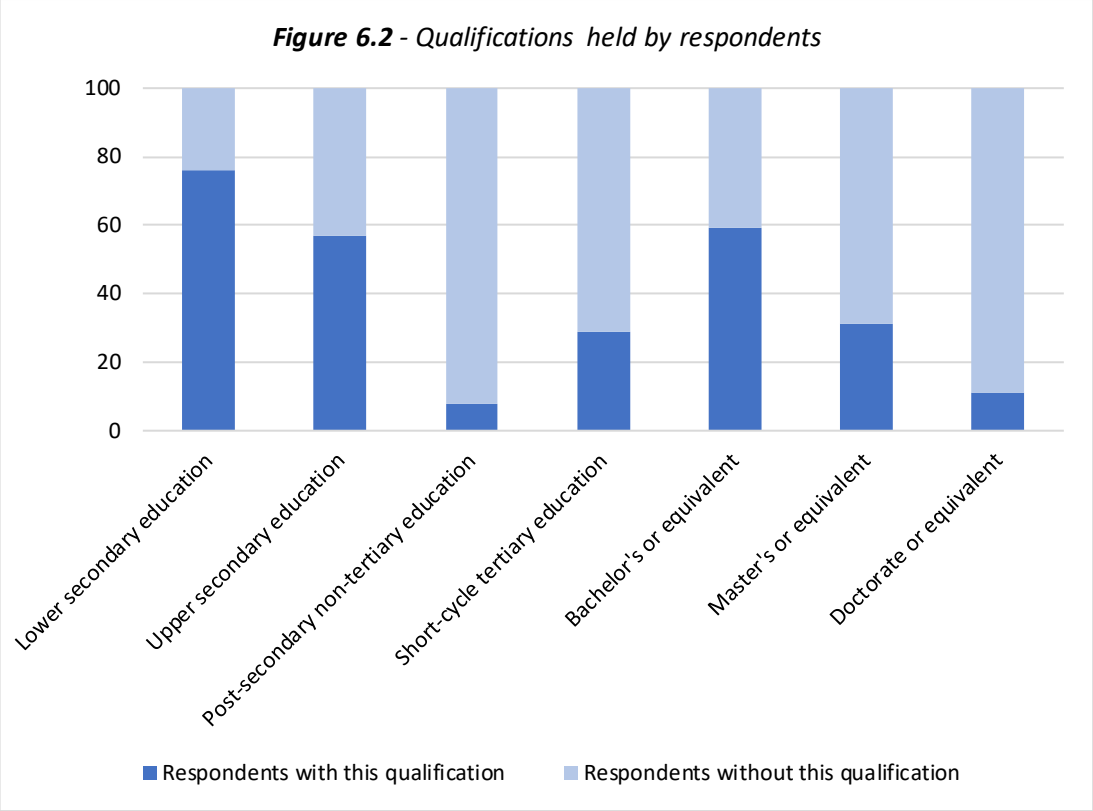
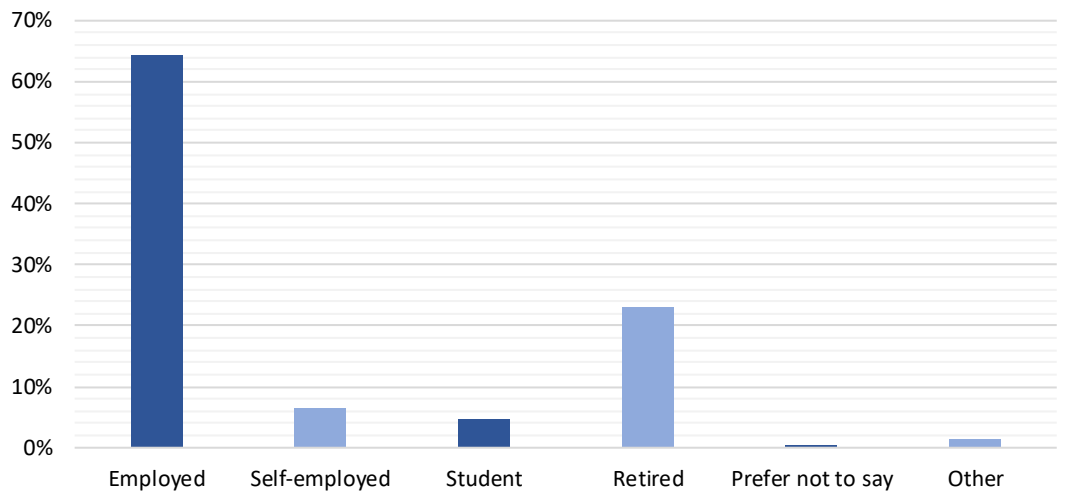


Figure 6.2 *- Qualifications held by respondents*

In regards to the employment status of respondents (*figure 6.3*), a strong majority (64.3%) stated that they were in full-time positions. Added to this, 6.4% of survey participants stated that they either worked in a freelance position, were self-employed or owned a business. A significant number of participants stated that they were retired (23%), in contrast to the relatively low number of citizen science volunteers who are currently studying on a full or part-time basis (4.6%). Other respondents (1.4%) stated that they were full-time carers, working as volunteers or unable to work due to health reasons. Interestingly, there were no survey respondents who noted that they were unemployed. Generally, this presents citizen science as a participatory practice which involves highly educated and full-time working middle-age members of the public. This supports current studies which frame citizen science as a practice which, traditionally, has been dominated by well-educated groups of individuals who are driven to further develop their environmental and scientific understandings (Chase and Levine, 2016).

Figure 6.3 *- Employment status of respondents*



Of the survey respondents who were employed, a high percentage held positions in the domains of elementary and secondary school teaching (16.1%), and university lecturing and research (13.3%). There was also a significant amount of participants who worked in the environmental sector. Many of these citizen scientists worked with a specific focus on the marine environment, either as scientifically qualified ecologists (7.8%) or in conservation management roles (8.2%). Additionally, a high proportion of volunteers held positions in volunteer organisations, local community groups and NGOs (18.4%). These findings are reflected in the word-cloud diagram below (*figure 6.4*), with the most frequently stated employment positions presented in larger font. A number of participants held managerial or senior positions in their company or organisation, while a much lower ratio worked in assistant or associate roles. Primarily, this reveals that the vast majority of volunteers who are in full-time employment hold positions in one of three sectors. One, teaching, education and research. Two, environmental management and conservation. Three, not-for-profit, volunteering and community organisations. Less frequently held positions included nursing (1.3%), engineering (2.3%), banking (2.7%) and tourism related posts (3.6%).

Interpreting the demographic status of the survey respondents, the socio-economic profile of the common citizen scientist is sketched as a middle to upper class individual. The majority of volunteers are employed, commonly in well-paid professions, educated with significant qualifications, and are over the age of 35. Whilst evaluating the findings, there is also an indication that a significant proportion of citizen science volunteers are scientifically and

environmentally literate. This stems from a high number of survey respondents who work in the field of ecology and biodiversity, as well participants who hold positions related to conservation management. While these findings are in line with other evaluations of the demographic status of citizen science volunteers (see Dawson, 2018; Chase and Levine, 2018; Pandya, 2012; Toomey and Domroese, 2013), as well as aligning with trends in environmental conservationism more broadly (Tindall et al., 2003), they contrast with seminal interpretations of citizen science's capacity to engage with marginalised communities and individuals (Bonney et al., 2009b). With an overwhelming dominance of middle to upper class, well educated, middle-aged individuals, the findings of this survey suggest that there is limited inclusion of marginalised or lower class members of the public. For example, there is little representation of citizens who do not have academic qualifications, are in low-paid employment or do not have a full-time job. There is also a relatively low quantity of participants who work in fields other than teaching and research, environmental conservation or charity. Again, this demonstrates a relatively narrow demographic scope within citizen science. This has led an increasing number of researchers to call for citizen science to implement more inclusive recruitment measures (Chase and Levine, 2018) and to engage with marginalised citizens at the beginning of projects (Walajahi, 2019).

Figure 6.4 – *Word-cloud diagram of the most frequently held employment positions*

It is also important to clarify two further points regarding the demographic makeup of the survey respondents. First, the significant proportion of citizen science volunteers who are retired. In total, 23% of survey respondents stated that they were retirees. This illustrates that citizen science projects are not exclusively tailored to attract young or middle-aged individuals, but also interest and cater for older individuals. It is important to critically examine the reasons for this high level of retiree participation, which research in the field of environmental engagement has associated with abundances of spare time, feelings of social responsibility and desires to remain socially engaged (Evely et al., 2010; Fraser et al., 2009). *Section 6.3* will shed light on these assumptions by examining the drivers and outcomes of citizen science participation amongst volunteers. While current evaluations of citizen science have provided detailed reviews of the makeup of participants, there remains a lack of critical discussion regarding the reasons behind age variation amongst volunteers. It is necessary to correct for this and reveal more about the demographic diversity of citizen science participants, which presents useful information for both practice and theory.

A second point of interest relates to the relatively equal balance between male (55.4%) and female (44%) survey respondents. This contradicts with traditional interpretations of engagement with community-based biodiversity and wildlife activities, which demonstrate significantly higher levels of male than female participation (Bandiaky, 2008). Research has noted how household-oriented engagement with pro-environmental behaviours, such as recycling, is more common amongst females, whilst males more regularly commit to society-oriented actions, such as publicly protesting for environmental justice and supporting participatory research (Hunter et al., 2004; Schahn and Holzer, 1990). Such assertions reflect broader examinations regarding the male-dominance which is inherent within public and deliberative participation processes (Coffé and Bolzendahl, 2010; Karpowitz et al., 2012). The findings of this survey, however, suggest that females are becoming increasingly important players in biodiversity monitoring processes. This builds upon studies which claim that rising levels of women are entering wildlife programs and ecological professions (Anthony et al., 2004), which is slowly eradicating the dominance of elite, privileged gentlemen in participatory research (Mahr and Dickel, 2019). Recent evaluations of citizen science present limited evidence of gender inequality within projects (Rotman et al., 2012) and the findings of this survey are in line with such assertions.

6.3 Participation in citizen science

To fully understand the motivations for and outcomes of citizen science participation, it is important to first consider the ways in which volunteers engage with projects. As *figure 6.5* shows, over half of the survey respondents (52.8%) stated that direct contact from a project coordinator played a part in initiating their current participation. A total of 40.9% of volunteers said that their present project was recommended to them by friends, family or colleagues. Added to this, some participants also stated that they became aware of their citizen science scheme by means of online information (19.8%) and advertisements on TV, radio and newspaper (1.6%). Other drivers for participation included recommendations from diving clubs, universities and NGOs. Due to the high number of respondents who stated that they were directly contacted by citizen science coordinators, it appears that the majority of volunteers have pre-established links with the organisational staff of projects. Largely, this is due to the fact that many citizen science volunteers participate in a range of projects over long periods of time.

***Figure 6.5** - Sources of information to initiate participation in current project*

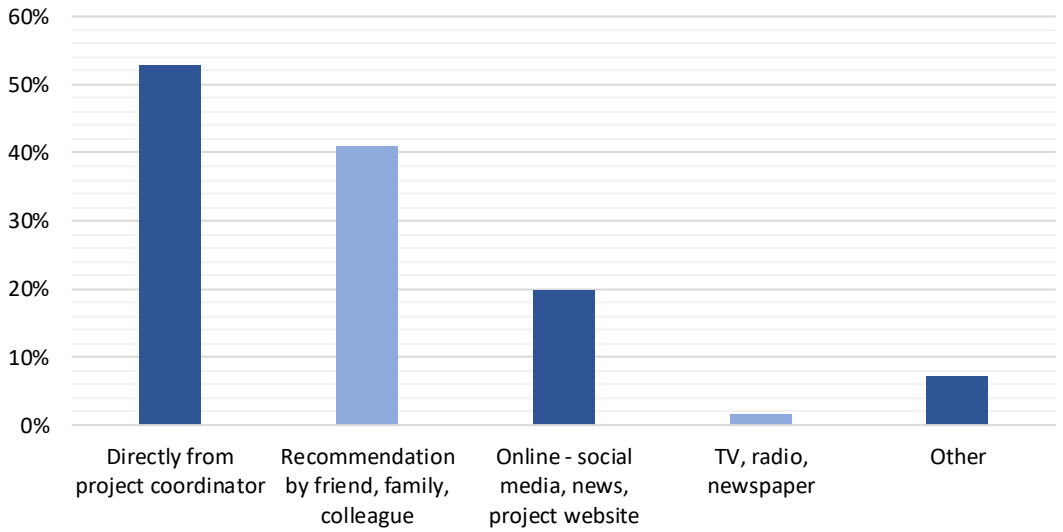
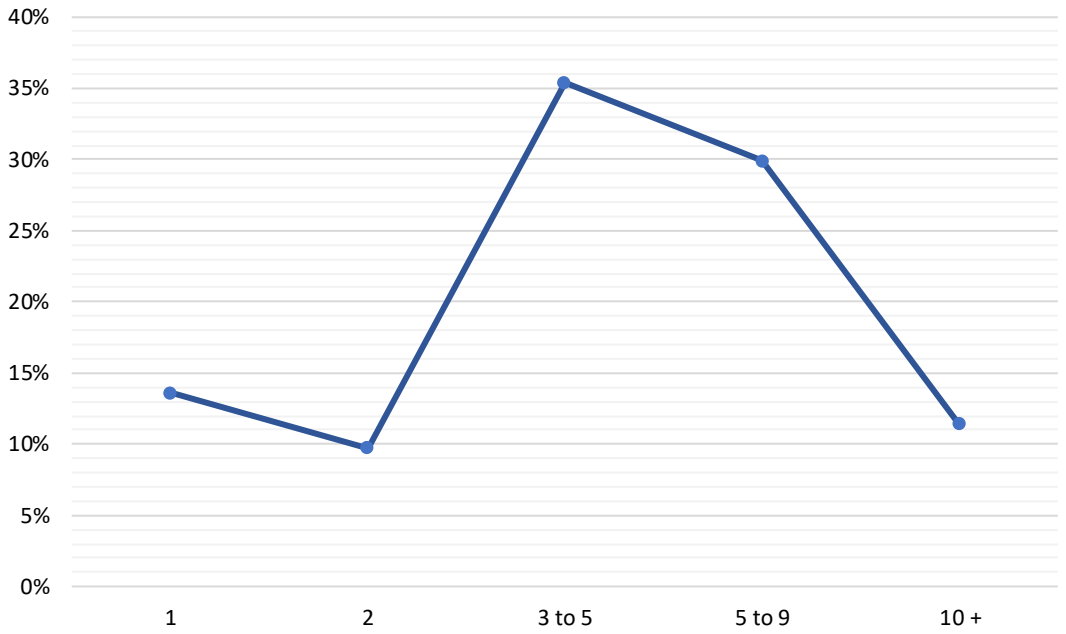


*Figure 6.*6 illustrates how almost half of the survey respondents (41.3%) stated that have participated in five or more citizen science projects, with 11.4% noting that they have engaged with 10 or more projects. In contrast, only 13.6% of the volunteers said that their current scheme was their first experience of citizen science. Through their engagement with

citizen science, participants develop links with coordinators and respond to their calls to interact with alternative schemes. This is an important insight to citizen science, as it demonstrates that volunteer participation is rarely a one-off occurrence. Survey respondents illustrate how it is common to participate in several projects, thus developing skills and social relationships in the process. Added to this, it is clear that projects are mainly advertised within the citizen science community and do not receive significant coverage beyond this level. Evidently, this plays a part in the lack of diversity and engagement with marginalised individuals which citizen science projects have become associated with.

Figure 6.6 *- Number of citizen science projects respondents have participated in*

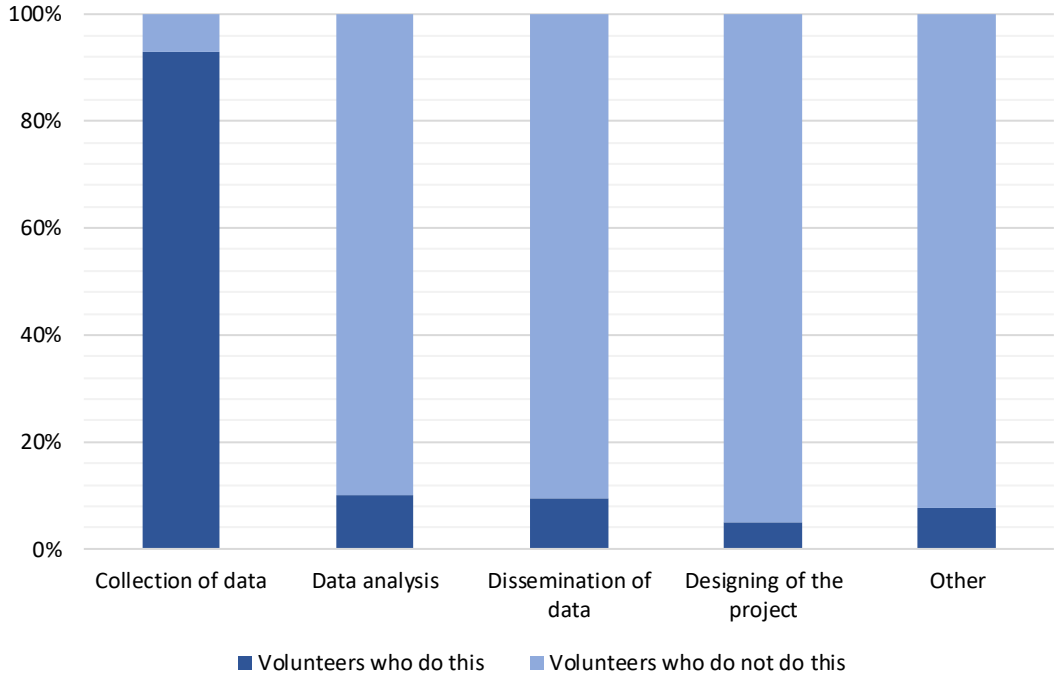


6.3.1 Levels of engagement

Engagement with citizen science can be defined on different levels. These levels are associated with volunteer tasks. *Figure 6.7* demonstrates how the roles carried out by survey respondents are relatively restricted to data collection tasks. Indeed, the vast majority of volunteers (92.9%) stated that participation with their current citizen science project involved the collection of data, with a significantly lower number engaging with roles regarding the analysis (10.1%) or dissemination (9.4%) of data. Even fewer respondents (4.5%) took part in tasks linked to designing the structure of their current project. Other roles

carried out by respondents included delivering training, organising logistical issues and liaising with local stakeholders. Added to this, 4.9% of respondents noted that their role involved taking part in project meetings arranged with local councillors and government departments. This suggests that lobbying against decision-makers reflects an important aspect of citizen science participation, albeit for a small number of volunteers. Ultimately, the responses of participants suggest that citizen science is a contributory process. Volunteers assist with the creation of data on behalf of pre-established and pre-designed programmes. Thus, citizen science participation is, predominantly, concerned with filling gaps of knowledge and answering specific, predetermined research questions. This challenges the assertions of seminal models of citizen science (see Bonney et al., 2008a; Conrad and Hilchey, 2011), which suggest that collective and co-produced projects, where participants play significant roles at all stages of project development, are common. In reality, the majority of citizen science participants play relatively tailored roles in projects, with their principal objective relating to the development of datasets (Bela et al., 2016).

Figure 6.7 *- Roles played by volunteers in projects*



The findings of the survey suggest that volunteers who carry out tasks beyond the level of data collection have specific skills and experience which separate them from other participants. While the development of such expertise is often shaped by external factors,

such as qualifications and previous experience, the training which citizen science projects provide is also important in this process. *Figure 6.8* reflects the manner in which survey respondents received training in their current projects. Predominantly, participants noted that they received some training through internally conducted, instructor-led training by coordinators and project managers (65.9%). Survey respondents also stated that other methods of training included written handouts and guides (47.9%), as well as externally conducted instruction courses (15.9%). Almost half of the participants (42.9%) also suggested that much of their training was conducted whilst carrying out projects tasks, a form of *"learning on the job"* (Male, 65+, retired). Despite the rapid growth of online citizen science (Curtis, 2014), web-based activities and training were much less common amongst participant projects (3.9%). Largely, this is due to the practical nature of the citizen science projects covered by this survey. Other forms of training included informal discussions and knowledge share between volunteers, as well as open days and workshops run by other organisations. It is evident that, following an evaluation of the training carried out by survey respondents, that the development of volunteers' skills is, predominantly, a task for project coordinators and organisational staff. Emphasis is placed upon internal instructor-led training or through the dissemination of written guides by project coordinators. Again, this suggests that citizen science is, largely, a contributory process; where volunteers are structured in their training and participation. Practitioners shape the projects and provide specific training which allows participants to carry out predetermined roles, in the advancement of set objectives.

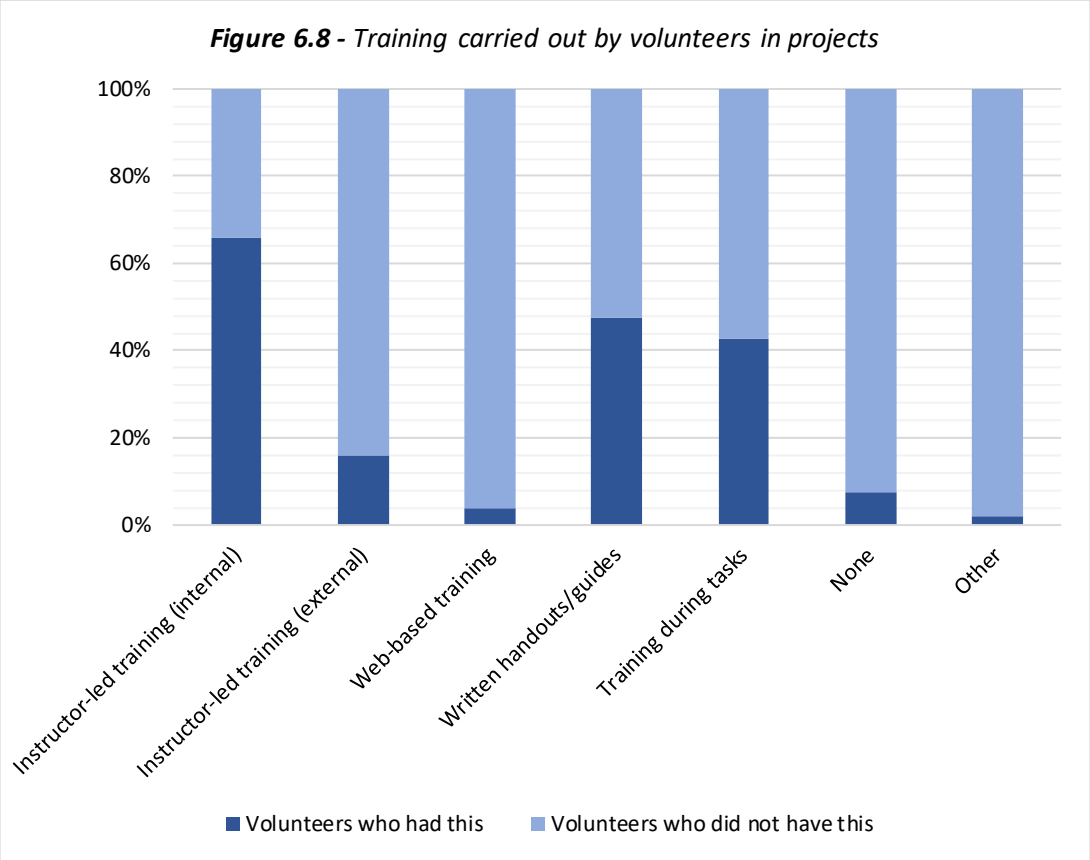


Figure 6.8 *- Training carried out by volunteers in projects*

Adding further insight to the above discussion, it is also important to recognise that over a third (34.1%) of survey respondents stated that they did not receive internal instructor-led training. Of these participants, 59% carried out data analysis and dissemination tasks, while 32.4% played a part in designing their current project. This suggests that a significant proportion of participants have pre-existent experience of carrying out technical roles beyond the collection of data and do not require instructor-led training. Likewise, 33% of those who did not receive internally conducted training have participated in over 5 citizen science projects. Once more, this suggests that participants with previously developed expertise through participation in other schemes may not require training to carry out tasks in their current project. It also highlights that citizen science participation is not entirely structured by organisational figures and forces. While contributory processes appear to be the dominant form of citizen science, the survey findings suggest that there is scope for participants to move beyond this level of engagement and carry out more technical roles that are key to the development of projects. Key to this possibility, it appears, is participant experience and expertise. Ultimately, the findings of the survey reveal that there is variation amongst citizen science participants in regards to the level of engagement. There are

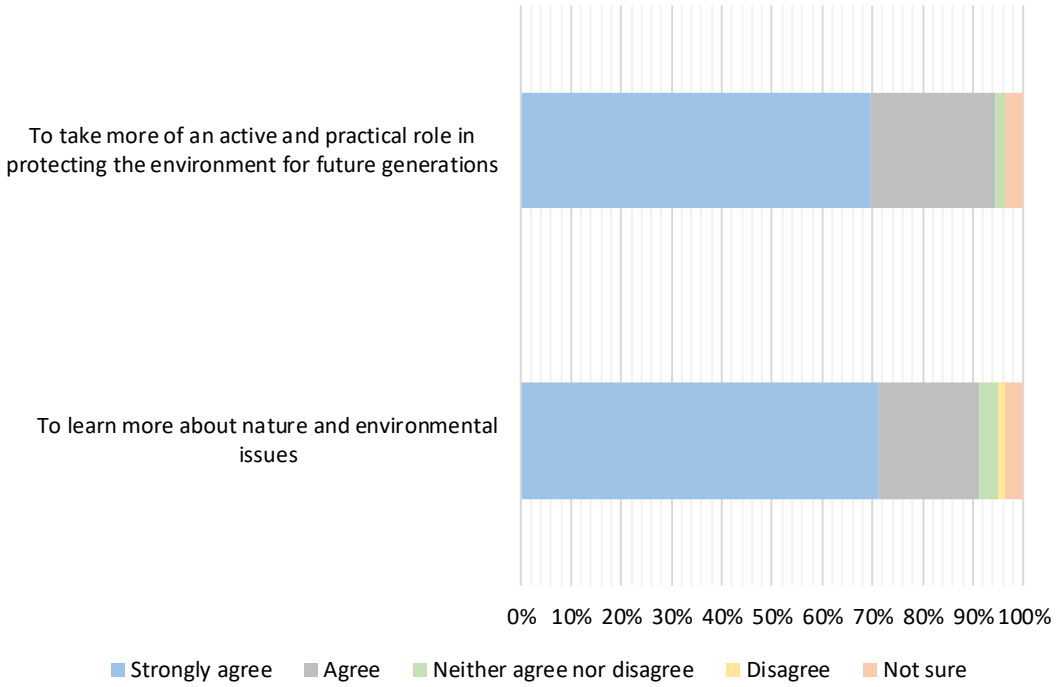
different training arrangements, task requirements and levels of responsibility which participants align with. To understand the reasons for this diversity and what it tells us about the transformative potential of citizen science, it is essential to consider why volunteers engage with citizen science; questioning what motivates them to participate and what they seek to achieve from doing so.

6.3.2 Motivations for participation

Environmental motivations

When asked about their motivations for participation in citizen science, as *figure 6.9* illustrates, the vast majority of respondents (69.5%) strongly agreed that desires to take more of an active role in conserving the environment reflected a key driver. Limited numbers of respondents noted feelings to the contrary, suggesting that environmental incentives played a key role in attracting volunteers. Desires to improve individual practice and enhance the contribution which participants make to wider conservation processes is, therefore, central to citizen science participation. As projects directly engage with environmental issues and attempt to tackle specific issues, they act as vehicles for participants to realise their own desires to become more environmentally conscious and active. Likewise, when asked how important learning more about environmental issues was to participants, 71.1% of respondents strongly agreed that it motivated their participation with their current project. For example, respondents stated how they were driven to *"spend more time in coastal areas to learn more about ecosystems"* (Female, 25-34, teacher). This suggests that survey respondents also view citizen science as a means of improving their individual knowledge and understanding of nature and ecological processes. Ultimately, this presents a useful duality to explain the environmental motivations which drive citizen science participation. Volunteers are motivated to both collectively contribute to conservation processes, through the roles which they play within their projects, and to simultaneously develop their personally knowledge of the environmental themes they engage with. As the findings show, this is true for the majority of respondents.

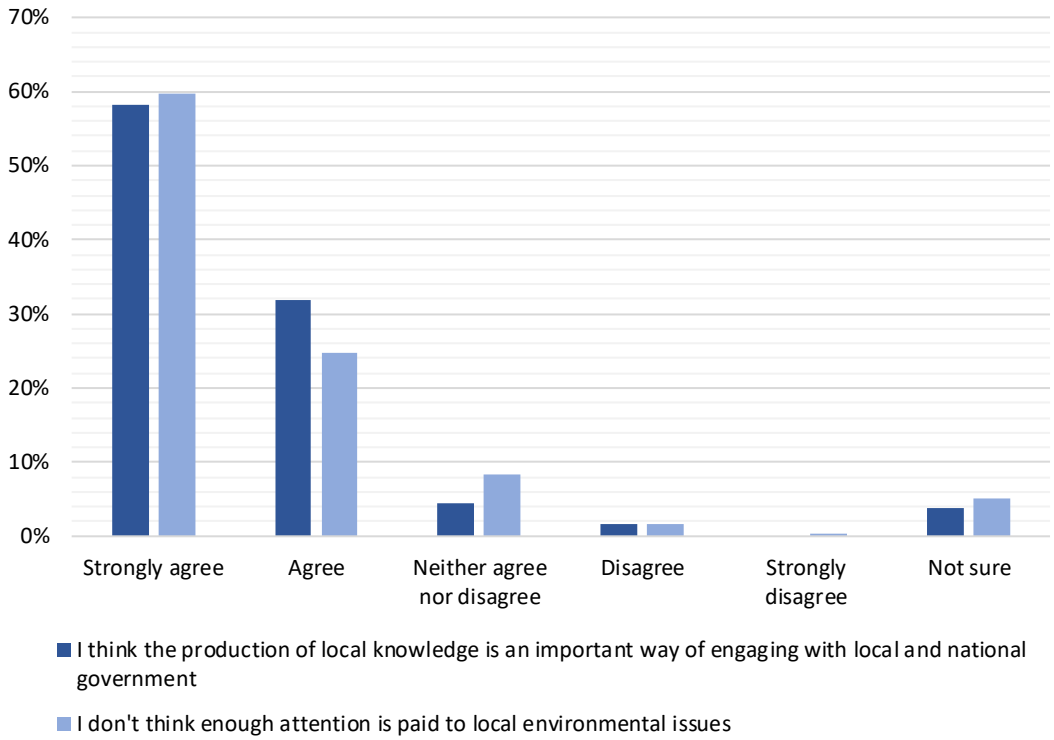
***Figure 6.9** – Environmental motivations for participating in citizen science*



Community-based motivations

Added to the environmental motivations for participation, many respondents stated that community-based drivers played a part in attracting them to engage with citizen science (*figure 6.10*). Primarily, these drivers are linked to *"putting something back into the community … to improve our own environment"* (Female, 65+, retired). In turn, these desires supported motivations to enhance the role of local knowledge in the realm of decision-making and to improve the manner in which communities can engage with political actors regarding local concerns. The findings of the survey suggest that these community concerns are of critical importance for a number of volunteers. For example, 59.7% of respondents were in strong agreement that not enough attention is currently paid to local environmental issues, with only 15.6% of respondents in disagreement or feeling indifferent to the notion. Added to this, a total of 89.9% of participants agreed that the production of local knowledge is an important way of engaging with local and national government.

Figure 6.10 *– Community-based motivations for participating in citizen science*

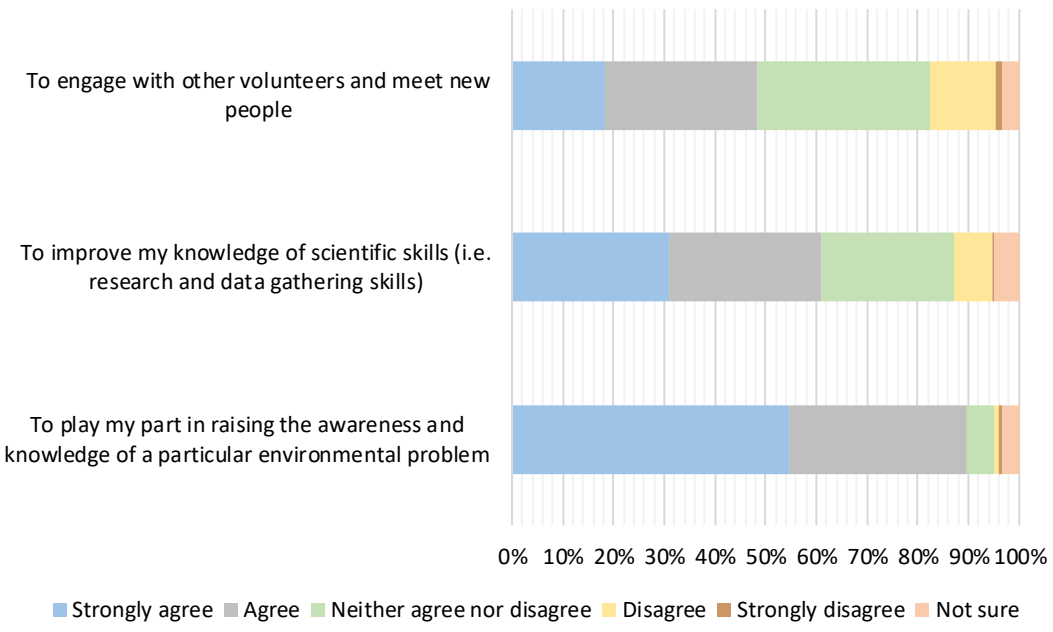


Interpreting this, there is an evident belief amongst many respondents that citizen science can collectively play an important role in bringing local environmental issues to the attention of decision-makers. For example, respondents mentioned how they were motivated *"to get together with other members of the community and raise awareness of conserving the beach"* (Male, 55-64, self-employed). Through the knowledge which citizen science produces and the awareness it raises, respondents understand projects as a way of influencing powerful actors to implement change to current environmental management arrangements. A significant degree of citizen science participation, therefore, is driven by community-based aspirations. In this light, citizen science is a platform which can reconfigure the degree of importance placed upon local environmental concerns and lead to the development of more engaged and responsive relationships between communities and government.

Personal motivations

A further theme of volunteer motivation regards personal drivers for citizen science participation (*figure 6.11*). Generally, these regard drivers for participation which link to the development of skills, social networks and social responsibility. In comparison to the environmental and community-based motivations, personal incentives received significantly lower amounts of importance. In particular, under half of the respondents (48.1%) agreed that the opportunity to engage with other volunteers and meet new people played a part in motivating their participation. A total of 37.6% felt indifferent to the idea of engaging with citizen science to develop social networks, while 14% disagreed entirely. While it may represent an outcome of participation for some respondents, relatively few interpret the development of social relationships as a key driver for engagement. Similarly, the opportunity to improve scientific skills was not advanced as a key motivation for participation. A total of 30.8% strongly agreed that desires to improve their research techniques represented an important reason for participation with their current project. While this appeared as less appealing than enhancing environmental knowledge, it shows that around a third of all participants are exceedingly keen to develop their capabilities of conducting scientific tasks. This suggests that they are keen to either transfer these skills to other scientific endeavours or to continuously evolve and enhance their engagement with citizen science.

***Figure 6.11** – Personal motivations for participating in citizen science*



There is also a notable contrast between those volunteers who were significantly motivated to participate as way of engaging with others, and those who strongly agreed that improving their scientific skills acted as a driver for their engagement. Of the participants who agreed or strongly agreed (48.1%) with the statement that meeting others encouraged their participation, only 13.5% agreed or strongly agreed that they also were driven by desires of developing their scientific expertise. This suggests that there are variations amongst participants. Those who are more driven by social opportunities and those who are driven by educational prospects. By further evaluating the outcomes of participation, it is likely that further variations amongst participants will be revealed. A further point of interest relates to the degree to which social responsibility of raising awareness of specific environmental problems motivates participation in citizen science. Over half of the respondents (54.5%) noted that they strongly agreed that playing their part in creating knowledge to support increased recognition of particular concerns drove them to participation in citizen science. This suggests that many participants respond to citizen science projects which focus on tackling or investigating specific environmental aspects that they feel a responsibility to tackle. More broadly, it highlights that the majority of volunteers seek out citizen science projects which particularly suit their desires and interests. Rather than participating for the sake of participation, volunteers engage with projects which align with their interests and concerns. For example, 86.9% of the 46 Coastwatch volunteers who responded to the survey noted that they strongly agreed that their participation was motivated by play their role in responding to a specific environmental problem. As the Coastwatch project is designed to examine and practically conserve wetlands, it is evident that volunteers participate as they have a strong desire and responsibility to protect their marine environments.

Figure 6.12 – *Word-cloud diagram of most frequently mentioned motivations for participation*

Added to the Linkert-type list of statements responded to by participants, they were also asked to note any further motivations which contributed to their participation. *Figure 6.12* (above) presents a world-cloud diagram of the most frequently mentioned terms. Of significant importance were the terms 'support', mentioned by 31.5% of respondents, and 'help', mentioned by 28.6%. This suggests that a key motivational driver for many participants was to play their part in assisting the development and success of projects which tackled a topic they found of importance:

> *"I heard about the group and felt it would be good to support them. I have noticed the increasing plastic pollution problem, so it's nice to work together to tackle it"* (Female, 35-44, teacher).

> *"The more aware I have become of the failings of current environmental management in the UK, the more driven I have become to support citizen-led projects which seek to challenge the mess we find ourselves in"* (Female, 55-64, environmental charity coordinator).

Furthermore, a regularly mentioned motivation related to the opportunity to work alongside like-minded people and become part of a collective group. These integrative thoughts suggest that a significant proportion of respondents are driven to engage with fellow volunteers who share similar interests and hold parallel feelings about the role of citizens in conserving marine environments. It also alludes to the idea that participants feel a collective responsibility to act and, as such, learn in a collaborative manner as part of a team. In total, 11.4% of respondents referenced terms including "like-minded", "team", "group", "collective" and "together".

> *"it enables me to meet and dive with like-minded people who are interested in the same thing, i.e. marine life"* (Female, 35-44).

> *"Engage with like-minded folk and learn more about conservation practice and the role volunteers can play"* (Male, 65+, retired).

> *"To spend more time with other divers, as I used to regularly dive alone"* (Male, 45-54, mechanical engineer).

Some volunteers advance citizen science as a means of developing their recreational hobby into an activity which can contribute to science and conservation, more broadly. Participants discuss how they were driven to *"give something back whilst enjoying my hobby"* (Male, 45-54, civil servant), suggesting they view citizen science as a way of giving a *"wider meaning" (Male, 34-45, warden)* and *"outward impact"* (Female, 65+, retired) to their pastime. Terms and phrases similar to "giving meaning" to recreational hobbies were mentioned by 8.4% of respondents.

> *"To take my diving from a recreational activity to something that has a knowledge output and can help conservation matters"* (Male, 35-44, financial advisor).

> *"After watching Blue Planet last year and learning about the effects of plastic pollution, I wanted to turn recreational diving into something more practical and become more environmentally active"* (Male, 35-44).

> *"I'm interested in nature and conservation issues generally and the opportunity arose to take part in a survey in which I would have been interested in in any case"* (Male, 55-64, local council staff).

Finally, respondents also noted how a growing sense of concern regarding the effects of pollution and climate change, among other environmental issues, motivated them to participate in citizen science projects. For example, one participant discussed how she was *"worried about litter and erosion along our coast, so … I thought the project would be a practical way of raising awareness of those issues"* (Female, 35-44, teacher). Other respondents shared similar thoughts, highlighting how they were *"growing worried about the declining condition of the coastline … [as such] supporting a local initiative that is having success greatly appealed"* (Female, 65+ retired). This suggests that a proportion of citizen science volunteers responded to the increasing pressures which are affecting their local environment and felt compelled to play their part in practically tackling the impacts. This transitive relationship between concern and action was mentioned by 13% of respondents. Some of these participants stated how they were particularly concerned by the lack of response from local and national government to tackle environmental concerns. In turn, they used citizen science as a platform to challenge this governmental inaction and call for the creation of more considered responses by government. In total, terms associated with the theme of challenging government were mentioned by 12.3% of survey respondents. For example, respondents discussed how they were motivated to:

> *"get involved with a progressive initiative which can help a local issue (pollution, erosion) and hopefully instigate change at the council/government level"* (Male, 55-64, retired).

> *"Take a stand against the lack of government drive to conserve our beaches and coastlines"* (Female, 35-44, NGO coordinator).

Ultimately, the survey respondents noted a wide-range of drivers which motivated their engagement with citizen science. While there was much variation in their responses, the findings illustrate how the opportunity to realise particular goals and objectives through their participation was a common motivation for many participants. As highlighted, such objectives included community-based desires to become part of a collective group, as well

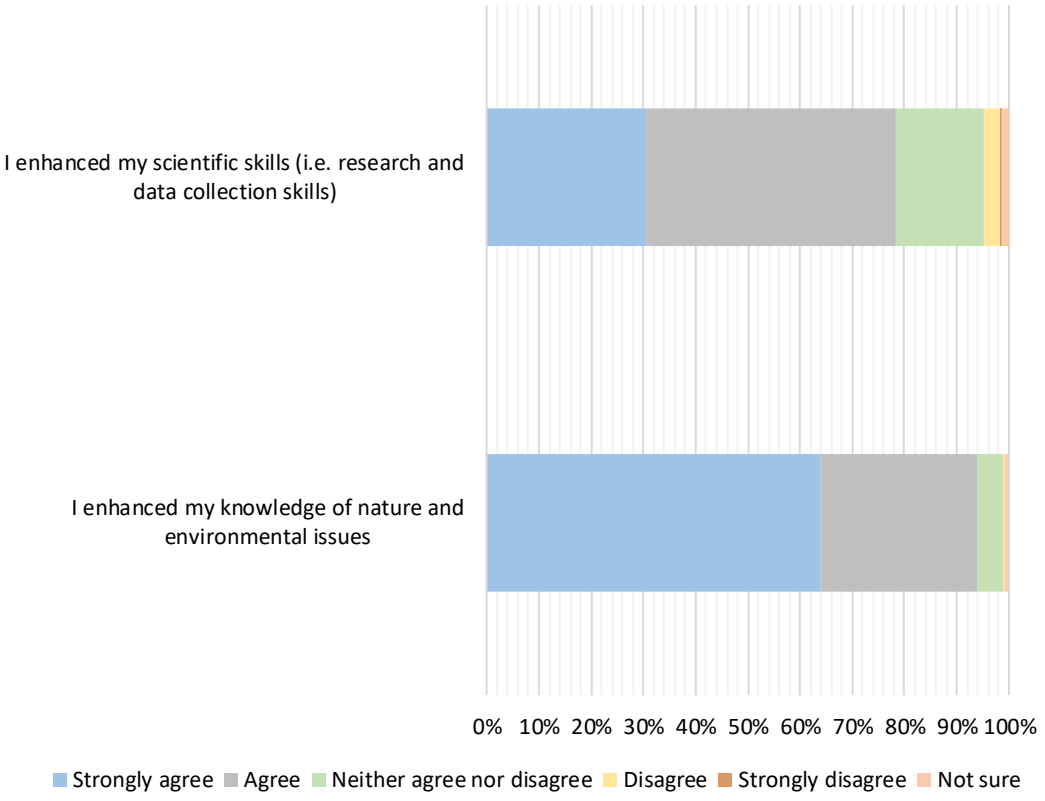
as individual goals to enhance knowledge and become more environmentally active. In and of themselves, these findings present revealing insights on citizen science participation and improve our understanding of the practice, more generally. However, to understand the full scope of citizen science, and how it can realise its transformative potential, it is critical to learn more about the outcomes which volunteers obtain following participation and what they tell us about the impact of the practice.

6.3.3 Outcomes of participation

Learning and skill development

Of the various motivations for participation discussed in *section 6.3.2*, individual learning was a central driver for many respondents. For example, volunteers discussed desires to enhance their educational understanding of scientific, environmental and social matters, and advanced citizen science as a vehicle through which such objectives could be operationalised. These learning objectives are reflected in the outcomes obtained by respondents, with a high proportion of participants discussing the educational enhancements which their participation had led to (*figure 6.13*). In total, 64% of respondents strongly agreed that they had improved their knowledge of nature and environmental issues. Relatively few participants suggested that they had failed to develop their understanding of such topics, highlighting how citizen science is a proven means of environmental and ecological education (Brossard et al., 2005; Bonney et al., 2009b). This is further reflected when analysing the degree to which participation improved the scientific skills of citizen science volunteers. Over three-quarters of participants (78.2%) either agreed or strongly agreed that their ability to conduct research improved following their engagement with their current citizen science scheme. This included advancements in the data collection, analysis and dissemination skills of volunteers, as well as their organisational and team work capabilities. In general, the findings of the survey suggest that developing environmental and scientific knowledge is a central output of citizen science participation. Whilst it is not inevitable that participants will enhance such skills when engaging with projects, nor is it certain that enhancements will occur in an equal manner amongst volunteers (Chase and Levine, 2016), it is clear that the vast majority of respondents' view citizen science as an important means of environmental and scientific education.

***Figure 6.13** - Development of skills post-participation*

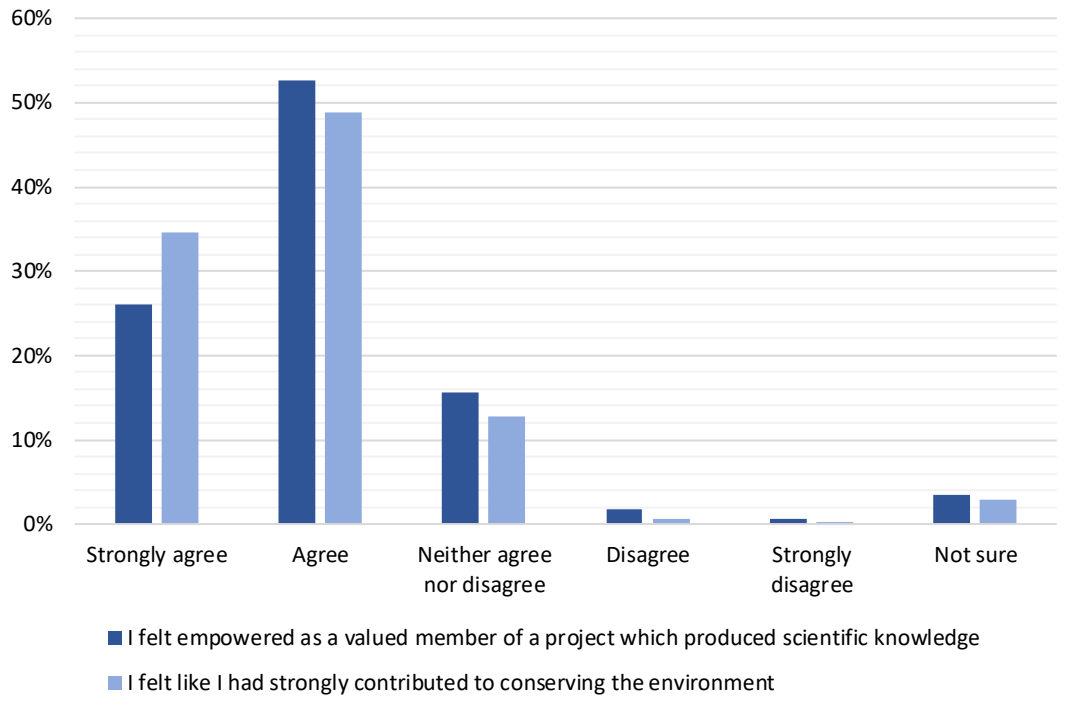


Personal development

Added to the educational advancements which citizen science is seen to instigate, survey respondents also note a significant level of personal development following participation (*figure 6.14)*. Again, this relates to the motivations of participants. The majority of volunteers illustrated a clear desire to engage with citizen science as a way of enhancing the role they play in protecting the environment. When asked if they felt like that they had strongly contributed to the practice of environmental conservation following participation, over a third of respondents strongly agreed (34.6%) that they had, with a further 48.8% also in agreement, but to a lesser degree. Significantly smaller proportions of respondents felt that their participation had not supported preservation processes, while 12.8% were indifferent to the statement. This demonstrates that the vast majority of volunteers felt confident that the time and resources they gave to their current citizen science project had directly supported environmental work. Similarly, well over half of the respondents stated that they felt some degree of empowerment following participation. A total of 78.6% of participants agreed that they felt like a valued member of a project which produced scientific knowledge,

justifying their decision to participate. Empowerment through citizen science is understood as an important aspect of participation (see Chen, 2019; Pagès et al., 2018) and demonstrates how projects can socially impact upon volunteers.

***Figure 6.14** - Personal development post-participation*



Significantly, these findings highlight how citizen science projects, by and large, recognise the importance of creating social engagement amongst their volunteers. As discussed in *chapter 5*, citizen science coordinators and management staff commonly create project structures which cater for the development of learning outcomes at the participant level. This is illustrated when analysing the survey findings, which show how the large majority of respondents agreed that participation with their current citizen science project led to learning and personal development. What is also evident from the findings of the survey is that some of the personal outcomes which obtained by volunteers, such as empowerment and feelings of collective contribution, are not necessarily outlined as project goals by organisational staff. Nevertheless, these personal developments reflect an important component of citizen science for many respondents. So, while supporting the claims of research which suggest that citizen science projects are often faced with a trade-off between objectives focusing on knowledge production and those prioritising participant engagement (Chase and Levine, 2016), the survey findings suggest that volunteer advancements can also

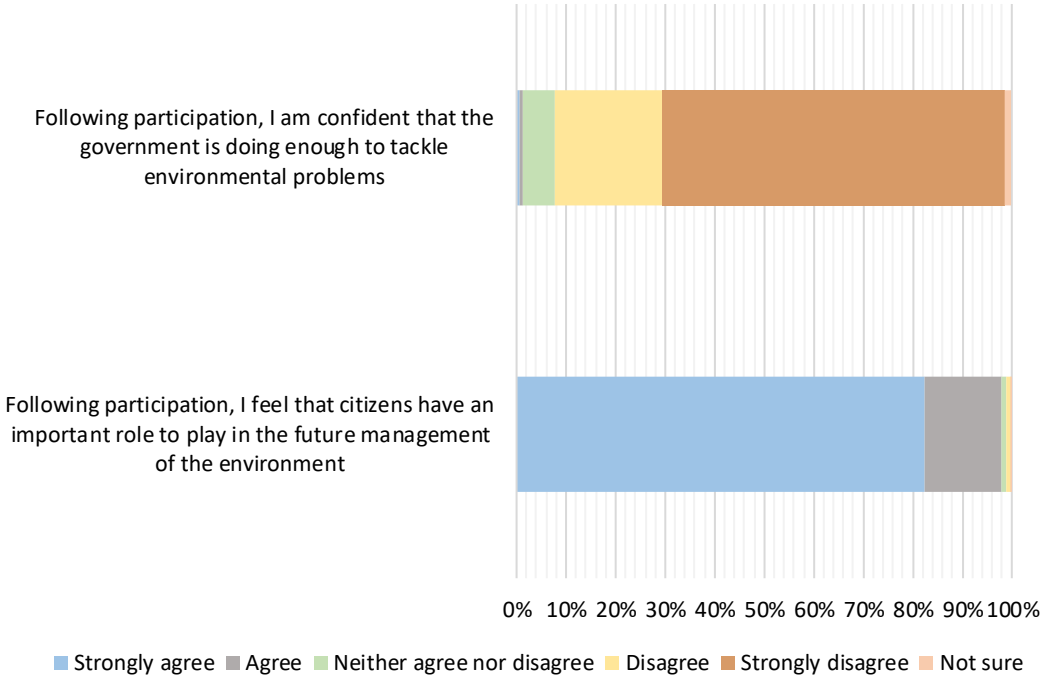
occur even when they are not intentional goals of projects. Simply by carrying out tasks and engaging with the topic investigation, respondents illustrate how this can advance their understanding of environmental and scientific issues, as well as enhancing their role in conserving the environment and facilitating the development of personal outcomes.

Perceptions of future environmental management

Delving deeper into the theme of personal outcomes, it is interesting to analyse how participation with citizen science instigated changes in the perceptions of volunteers (*figure 6.15)*. In particular, this relates to shifts in the consciousness and judgement of respondents in regards to the topics of conservation and environmental governance. This is an aspect of participation which has received limited attention by research, but, as the findings demonstrate, it is of crucial significance to discussions on the transformative potential of citizen science. The survey results show how the vast majority of respondents, following participation, have little expectation that current government arrangements will legitimately tackle the many environmental concerns society face. Indeed, when asked if they were confident that the government is doing enough to conserve the environment, almost three-quarters of respondents (69.2%) strongly disagreed, with only 1.4% agreeing that were satisfied with current arrangements. This is a striking finding, which highlights how participation with citizen science challenged respondents' political perceptions of the role of government in processes of environmental management. While some participants may have held pre-existent concerns with current environmental governance regimes, hence their drive to participate, a significant proportion highlighted that their perception changed following engagement with their current project. On the contrary, participation led 82.4% of respondents to strongly agree with the statement that citizens have an important role to play in the future management of the environment. There is an interesting relationship between these two statements. Respondents illustrate how participation has developed their perception of the government and its inability to conserve the environment, leading to a strengthened belief that citizens have an important role to play in correcting for such failings. This demonstrates the power of citizen science to alter the mentality of volunteers;

not only in regard to their political perceptions, but also in their self-recognition of their ability to instigate change.

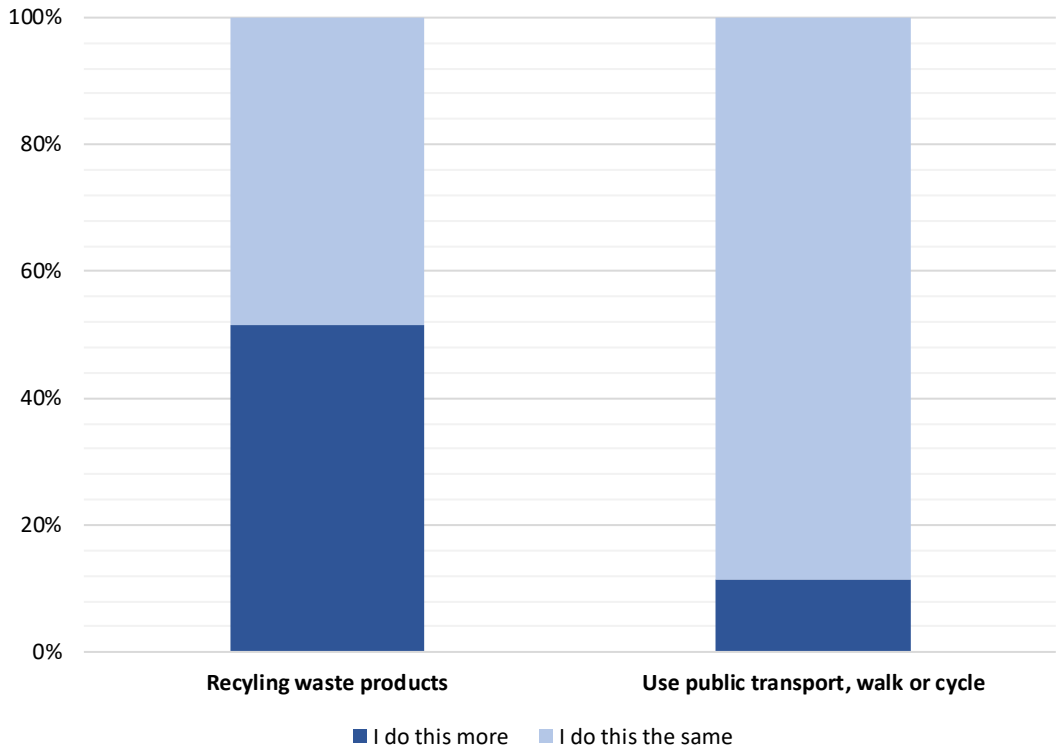
Figure 6.15 *- Participants' perceptions regarding the future management of the environment*



Added to this, participants also responded to a range of statements which questioned the degree to which their participation influenced change to their practical actions. Two of the statements posed regarded the impact which participation had upon their sustainable lifestyle (*figure 6.16*). Slightly over half of the respondents (51.6%) noted that they recycle waste products more frequently than they did before engaging with their current citizen science project. No respondents suggested that they recycle less following participation, with the remaining 48.4% stating that their tendency to recycle remained the same. Much lower levels of change were apparent in regards to participants' transport behaviour. When asked how participation impacted their use of sustainable transport modes – for example public transit, walking and cycling – only 11.5% of respondents stated that they use these means more frequently than they did prior to participation. While no respondents suggested that they use sustainable transit less, the vast majority (88.5%) suggested that their usage remained unchanged. Interpreting their responses, participants suggest that citizen science does not necessarily influence change to their sustainable lifestyle. This is potentially due to a high level of pre-existent environmental ideals inherent within many citizen science

volunteers. As such, while it is possible, respondents highlight how participation will not inevitably instigate more sustainable behaviour.

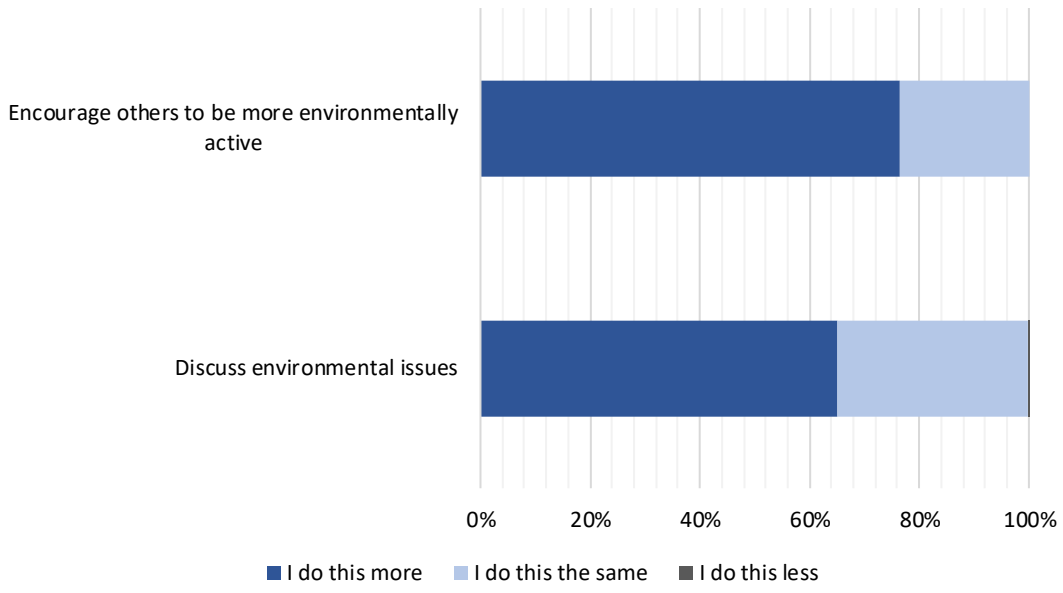
***Figure 6.16** - Changes in the sustainable behaviour of participants*



When asked about the degree to which participation affected the manner in which they discuss environmental issues (*figure 6.17)*, participants noted two clear developments. First, almost two thirds of the respondents (65.1%) stated that they discuss topics related to environmental concern more frequently following participation. Second, slightly over three-quarters (76.5%) of participants stressed that they encourage others to be more environmentally friendly as a result of their engagement with citizen science. In comparison to the relatively limited impact which participation had upon the sustainable behaviour of respondents, a much more profound impact was made to the participants' willingness to engage themselves and others with discussions on environmental matters. Perhaps what is most notable in these findings is the vast proportions of respondents who had been impacted, with well over 60% of participants responding positively to both statements. This suggests that participation with citizen science influenced a significant number of participants, including those who were already environmental conscious and keen to follow sustainable lifestyles, to critically engage with environmental discourse and attempt to

instigate transformative change in others. This is a key outcome of participation and is a clear illustration of the capacity of the practice to instigate citizen action beyond the boundaries of projects. They carry on the message of their current projects and attempt to spread it amongst others.

Figure 6.17 - *Changes to the way participants discuss environmental issues*

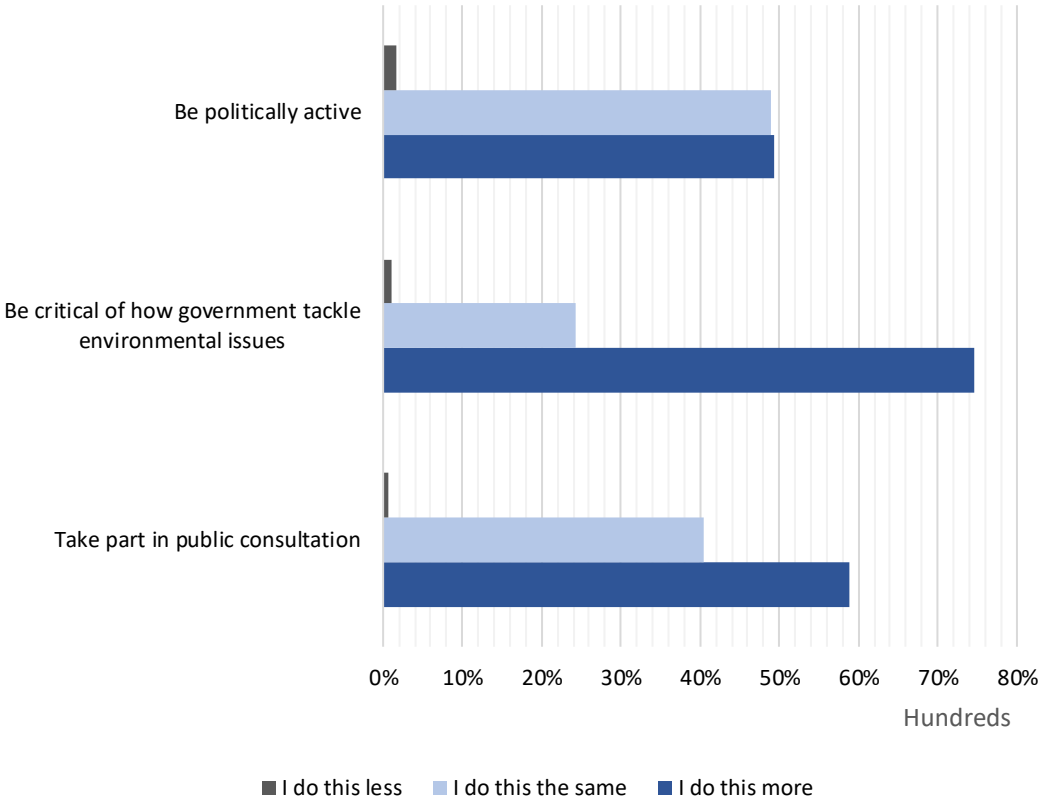


Building on this, participants also demonstrated significant changes to their political consciousness and action as a result of their engagement with citizen science (*figure 6.18*). Linking to the aforementioned finding that participation led volunteers to express a lack of confidence in the government's ability to tackle environmental challenges, a high proportion of respondents also stated that they have become more critical of government. A total of 74.7% of participants stated that they question the government's approach to environmental management more frequently than they did prior to participation, with a much smaller percentage (24.2%) signalling that their critical nature has remained the same. Respondents discussed how they were *"certainly not as confident in the government's ability, or desire, to conserve the environment as I was before participation"* (Male, 18-24, student), and coming to the conclusion that *"the Irish government doesn't really care about protecting what we have"* (Male, 65+, retired). This suggests two issues of interest. One, that a significant proportion of citizen science projects engage with the wider realms of politics, justice and democracy. Two, that many schemes incorporate critical approaches, which question current mechanisms of environmental management. When considering how this enhanced

critical perspective could be transformed into action, the findings of the survey highlight how over half of the participants (58.9%) take part in more public consultation following their participation, while 49.3% discuss how they have become more politically active. This included actions such as participating in elections, writing to local politicians and supporting political parties.

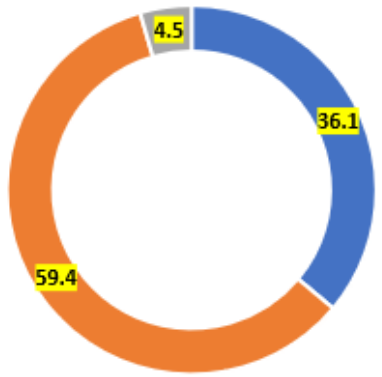
Added to this, the findings demonstrate how participation with citizen science has led to a clear increase in the belief of participants regarding the role of individuals in instigating change to current arrangements. Respondents discussed how their participation made them feel that *"nothing will really be achieved until government puts resources behind it" (Male, 45-54, dentist)* and that *"citizen support and drive are crucial to make things happen in regards to environmental conservation … without it, we're going nowhere"* (Male, 34-45, community group leader). Ultimately, this suggests a clear link between citizen science engagement and transformative political action. In turn, this shapes new understandings amongst participants, which is seen to lead to citizen-led action which criticises and challenges the government's position on and management of environmental challenges. As one respondent stated, they have become *"more willing to give up time to participate in monitoring dives, because I know how important it is and that it won't be done by government"* (Female, 34-45, ecologist). By engaging with decision-making processes and challenging government opinion, citizen science volunteers are learning from the insight and experience which they receive during participation, and transforming it into action. This is summarised by one respondent, who discusses that *"now I understand the incompetence of government and the reasons for it, I can see more appropriate ways of challenging them"* (Male, 35-44, university lecturer). This relationship between the development of critical consciousness and transformative action is crucial to the potential of citizen science. However, it is an issue which is relatively underexplored in literature and, as such, is a key insight of this study.

***Figure 6.18** - Changes of political consciousness and action*



It is also important to evaluate how respondents discuss the impact which their participation has upon their inclination to engage with other citizen science projects (*figure 6.19*). Interestingly, the majority of participants (59.4%) state that they engage with the same amount of projects as they did prior to participation with their current scheme. Slightly over one third of respondents (36.1%) suggest that they participate in more projects, while 4.5% insist that they participate in less projects. Interpreting this, it appears that participation in one project is not necessarily a precursor for engagement with another. While the survey revealed how a high number of respondents have taken part in a range of projects throughout their lives, participation is advanced as a context-dependent issue and, inherently, links to the motivational drivers of individual participants. It is important to analyse this issue further, as it presents crucial information about the character of respondents. By analysing what participants seek to gain from engaging with projects, for example do they use citizen science as a stepping stone to other work or interpret the practice as an end in itself, it becomes possible to construct typologies of volunteers.

Figure 6.19 - Participation in other citizen science projects



Added to the Linkert-type list of statements posed to participants, volunteers also responded to an open-ended question which asked for any further outcomes obtained as a result of citizen science participation to be stated. A range of topics were mentioned by participants, some expanding on previously referenced themes and others introducing alternative issues. Their responses are illustrated in the world-cloud diagram below (*figure 6.20*), which reflects the most commonly referenced terms. Drawing from this, it is noticeable that a substantial proportion of respondents discuss how participation has improved their 'understanding' and 'recognition' of both the causes and effects of environmental challenges. For example, participants noted how they had developed *"an awareness of the wider aspects linked to environmental problems … the politics of it all and the economic drivers which disrupt conservation"* (Male, 35-44, self-employed), thus making them realise that *"we can't just rely on government to protect the environment"* (Female, 55-64, teacher) or *"sit back and do nothing"* (Female, 18-24, student).

Added to this, respondents were keen to discuss how this heightened awareness then led to a change in their thought process regarding the role which they can play a part in tackling environmental concerns. This included the *"realisation that we can make a useful contribution to science"* (Female, 65+, retired), as well recognising *"the power individuals*

have to do things like this and support conservation projects" (Female, 25-34, ecologist). In total, 26.6% of respondents made reference to the topics of recognition and realisation following participation. This suggests that participation was an *"eye opening experience"* (Male, 45-54, sales manager) for a number of respondents, forcing them to acknowledge the vastness of the environmental challenges that exist. In turn, many respondents learnt about the politics which disrupt more sustainable governance approaches and the capacity of individuals to challenge this. This is, perhaps, epitomised by one respondent, who asserted that *"participation certainly made me think differently about how we can find solutions to ecological challenges and how important citizens taking part is"* (Male, 65+ retired).

Figure 6.20 – *Word-cloud diagram of most frequently mentioned outcomes of participation*

Furthermore, when discussing the positive impact which participation had upon their environmental knowledge and research skills, a significant number of respondents highlighted how they viewed such advancements as being beneficial for their career. For

example, when stating how participation provided *"hands on experience"* (Male, 25-34, NGO policy officer) and opportunities to improve *"organisational skills of working collectively"* (Male, 18-24, student), participants emphasised how this provided them with *"experience for future projects, contacts and awareness of similar organisations"* (Female, 25-34, charity communications manager). Other respondents discussed how participation had represented *"crucial experience for my CV"* (Male, 18-24, student) and *"benefited my career options"* (Female, 25-34, student), with other volunteers asserting how their participation enabled them to progress to a stage where they now *"work for and engage with appropriate NGOs and the Scottish Government"* (Female, 25-34, NGO programme coordinator) and have advanced to become a *"coordinator of surveys … getting practically involved with running/managing of the monitoring projects"* (Male, 35-44, civil servant). This suggests that, for some volunteers, citizen science is used as a means of improving one's career opportunities. It presents the possibility of gaining experience of data collection, analysis and dissemination, as well as improving team work, identification and organisational skills. Similarly, citizen science can be understood as a networking tool and a useful way of learning about other projects and initiatives. In total, 7.2% of respondents discussed the theme of participation functioning as a useful means of experience for future career opportunities.

On a personal level, a group of respondents (10.1%) made reference to feelings of satisfaction and enjoyment following participation. This is interpreted as an important outcome for many participants, as it is seen to justify their commitment to projects and encourages further engagement. Issues such as engaging with new people, spending time outdoors and working in collective environments were all referenced as important aspects of participation. While some volunteers require outcomes which benefit their career to feel satisfied with their participation, the development of personal outcomes gives meaning for many participants. This suggests that citizen science is used by some participants as a way of escaping daily routines and engaging with new activities, something which creates personal gratification and fulfilment. These include statements such as:

> *"I enjoyed the project, and felt more socially active after spending time with like-minded people"* (Female, 65+, retired).

> *"Meeting new people from different walks of life and sharing ideas and experiences was an important outcome"* (Female, 55-64, teacher).

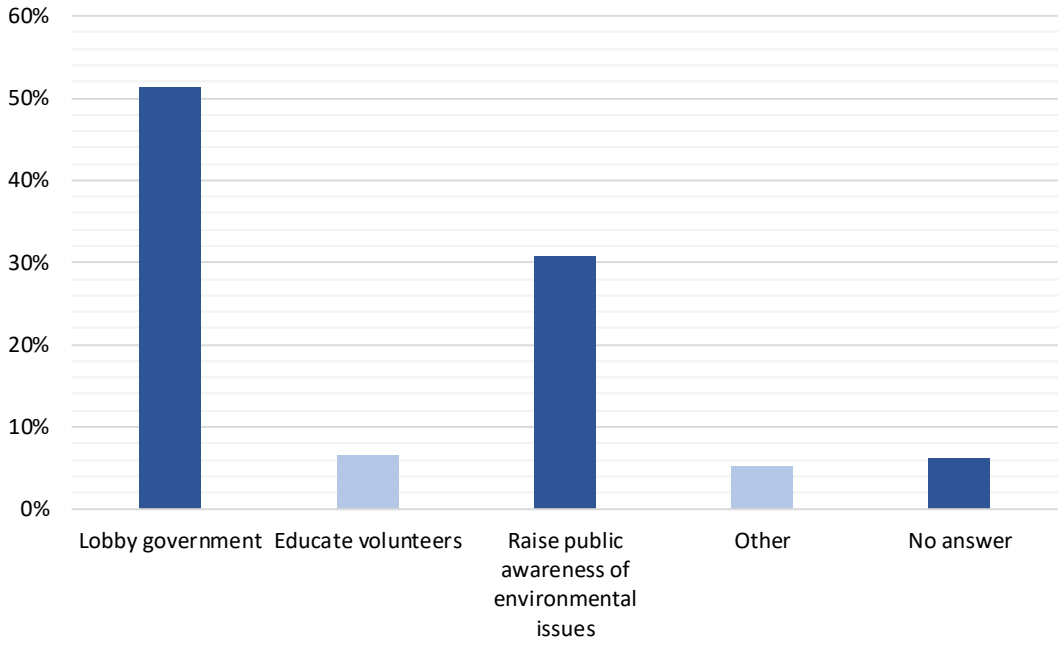
"any engagement with nature and the environment is a most rewarding personal experience" (Female, 35-44, media).

These assertions of satisfaction link to two similar themes. First, respondents also talked about the confidence and pride which they take from participation with citizen science. One participant acknowledged how their engagement induced a *"sense of achievement"* (Male, 35-44, mechanical engineer), while another highlighted how they felt proud of being a *"part of something useful to the scientific community, and something that helps care for the environment"* (Female, 25-34, teacher). In other words, participation allowed a number of citizens to feel confidence in their ability to conduct research and contribute to scientific projects. Second, many participants recognised the benefit which their participation had at a community level. Respondents spoke about their enjoyment of engaging with schemes which *"are bigger than me"* (Male, 35-44, self-employed) and represent important avenues through which *"community togetherness can be strengthened"* (Female, 65+, retired). As one participant noted, their participation *"has encouraged me about the future of local coastal towns across Ireland, there is a desire from people to protect what we have"* (Male, 45-54, senior lecture). This demonstrates how citizen science has the capacity to create outcomes within individuals, such as enhanced confidence and fulfilment, as well as instigating action at a community-wide scale.

A final outcome of note regards the manner in which participants feel knowledge can most effectively create change to systems of environmental management (*figure 6.21*). This presents an intriguing insight to the mentality of respondents and, in particular, their understanding of the full potential of citizen science. Over half of the respondents (51.3%) feel that lobbying government is the most effective use of knowledge produced through citizen science. This suggests that a large quantity of participants interpret knowledge as a powerful means of challenging the conceptualisations held by decision-makers. In turn, this can lead to policy or management changes which more accurately represent their opinions and concerns of citizens. Knowledge, in this sense, is a form of capital which carries power and can influence the actions of decision-makers. These respondents recognise the power of knowledge and interpret the most effective form of citizen science as a process which constructs knowledge that can directly challenge current practice. This is clarified by one participant's comments about their motivations to engage with projects: *"adding scientific*

evidence to environmental activism is crucial, policy listens to us when we have the data to support our concerns … I am sure citizen science will play a big role in shaking up Northern Ireland's current negligent approach to conservation management" (Male, 35-44, forest warden).

***Figure 6.21** - How knowledge can most effectively create change to systems of environmental management*



On the contrary, slightly under one third of volunteers (30.8%) argued that the knowledge which citizen science produces, if it is to transform the approach of management systems, should act as a means of raising the public awareness of environmental issues. This suggests that a significant proportion of participants interpret the ability of citizen science knowledge to develop public consciousness as a key aspect of the practice. These respondents understand citizen science as a means of broadcasting evidence on environmental problems to wider society, a process which can instigate enhanced public engagement and protest against governance approaches. This interpretation suggests that citizen science knowledge, in and of itself, is not enough to change governance regimes. Rather, there is a need to engage with wider society and enhance the environmental education of members of the public.

A much smaller group of respondents (6.5%) felt that the production of knowledge is most effective when it educates project volunteers. This suggests that some participants feel that they can develop the capacity to instigate action which can transform management approaches if, through their participation, they can improve their knowledge and recognition of environmental problems. Some participants also presented alternative interpretations of how knowledge can most effectively create change. The majority of these suggestions focused on a combination of the three aforementioned options – knowledge, awareness, education. For example:

> *"I think it is a combination of producing knowledge to lobby government and raising public awareness … positive decision making usually has to be forced on decision makers through lobbying and campaigning, this isn't how it should be. This has to change. Politicians are mindful of public opinion so individually we all have a role to place to try and get decision making and policy to major on environmental restoration and protection"* (Female, 55-64, community initiative project organiser).

> *"In our case there is a volunteer/public awareness continuum and the information/data/experience is collated in regular reports so the data generated is used to lobby government and other relevant institutions"* (Female, 25-34, civil servant).

6.4 Conclusions

In conclusion, there is much that can be learnt from these survey findings. The motivations of participants illustrate the diversity amongst volunteers. While some are driven to protect their local environment and meet new people, others interpret citizen science as a means of improving their research skills and challenging environmental governance regimes. These aspirations are then reflected in the outcomes which participants obtain following participation. Respondents discuss how their engagement helped career prospects, improved their knowledge of environmental issues, enhanced their skillset and led them to become more politically engaged and active. These findings expand upon current research on citizen science participation, adding new dimensions to existent thought. In particular,

they provide crucial insight to the transformative potential of citizen science. They illustrate how projects can significantly enhance the environmental consciousness of participants and how, in turn, this is instigating transformative action that seeks to further the intentions of citizen science by actively lobbying for the creation of more socially and environmentally just governance regimes. Likewise, it is of interest to evaluate how participants interpret the capacity of knowledge to create change. While smaller proportions of volunteers view the most effective use of knowledge as a means of enhancing public consciousness or educating volunteers, over half of the respondents recognise knowledge production as a powerful tool that can challenge decision-makers. This highlights the diversity amongst participants and how they can interpret the function of the citizen science, as well the potential of the knowledge which projects produce to create change, in different ways.

While this chapter's analysis has presented a broad overview of the participation process and demonstrated a general understanding of the transformative capacity of citizen science, the use of descriptive statistical analysis and thematic analysis are not capable of fully interpreting the findings. While interesting insights have been revealed, there are complex and contradictory trends within the data. Accordingly, this means that a more robust analytic approach is required to comprehensively interpret the responses of participants. This can make the findings relatable to both the wider argument of this study, as well citizen science research more generally. To realise this, an exploratory factor analysis approach is followed, with the findings presented in *Chapter 7*. This approach is advanced as a means of gaining a deeper insight of the different perspectives through which volunteers perceive and value citizen science, leading to the creation of profiles of citizen science participants.

Citizen science, in and of itself, is a collective movement and a means of enhancing the participation of members of the public in scientific projects. However, as this chapter has illustrated, it is important to move beyond thoughts of citizen science as a one dimensional practice and it of value to create distinctions between citizen science participants. By better understanding how the perceptions, motivations and outcomes of volunteers come together to form specific types of participation, it becomes possible to craft more insightful overviews of who engages with citizen science and why. In turn, this can improve communications strategies and our understanding of the strengths of particular types of participants when we need to draw upon them. This is crucial for both citizen science practice and theory.

7

PARTICIPATION PATHWAYS AND VOLUNTEER PROFILES

7.1 Introduction

To achieve the sustained participation of volunteers in citizen science, projects aim to satisfy the motivations and desired personal outcomes of their participants. Evaluating participation is, therefore, crucial, with projects seeking to assess volunteers' motivations for engagement and the complex outcomes that they achieve through their participation (Druschke and Seltzer, 2012; Shirk et al., 2012). Many assessments have, however, ineffectively examined the relationship between volunteers' motivations and how they relate to the personal outcomes that they wish to pursue (McAteer et al., 2021). 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. Responding to these claims, this chapter presents the results of an exploratory factor analysis of an online survey completed by citizen science volunteers. By critically assessing volunteers' roles, motivations, outcomes and experiences of participation, this chapter identifies patterns amongst volunteers' responses and classifies 4 separate profiles of marine citizen scientists: *Activists*, *Conservationists*, *Professionals* and *Hobbyists*. This chapter outlines how categorising volunteers in this manner more accurately reflects the factors that support or inhibit the realisation of volunteer intentions.

To begin this chapter, a brief outlines of the factor analysis process that was followed is presented (*7.2*). As a full review of the methodological procedure has been presented in *Chapter 4* of this thesis, only specific elements of the procedure are discussed in this chapter. Following this, the four profiles of volunteers that are extracted from the survey data are examined in detail. Each profile represents a grouping of participants that share similar characteristics and perceptions about their motivations for participating in citizen science and the outcomes that they want to achieve by volunteering. This chapter then comparatively analyses the profiles. This involves questioning what the profiles tell us about participation in citizen science and discuss how categorising volunteers in this manner can help to reveal insight on the specific factors that can support and inhibit the fulfilment of a volunteer's engagement (*7.3*). A brief conclusion then assesses how the results of this chapter's factor analysis expand upon current research on citizen science participation *(7.4)*. It is suggested that projects, should they better understand their participation processes,

must broaden their evaluative scope and work to embrace a wider range of volunteer pathways to participation. Linking back to the literature review of this study, *Chapter 2*, which posted concerns regarding current research assessments of the participation process, the findings of this analysis showcase how improvements to both a project's management of volunteers and its capacity to realise project and volunteer outcomes, can be made.

7.2 Profiles of volunteers

An exploratory factor analysis was used to reveal latent concepts of how participants discuss the roles they carry out, their drivers for participation, the outcomes that they seek to obtain following engagement, and their general perceptions of their engagement with citizen science. The outputs suggest that the citizen science volunteers, participating in the 8 assessed projects, are best represented by four factors which, cumulatively, explain 59.5% of the variance within the data. The four factors (or profiles as they are referred to in this study) that were extracted were termed as: (i) *Activists*; (ii) *Conservationists*; (iii) *Professionals* (10%); and (iv) *Hobbyists* (8%). Each profile, which will be sequentially explained in order of variance accountability, represent a typology of citizen science participant. Interpreting and naming the four profiles called for a critical understanding of how each factor reflected three key components of citizen science participation. First, the roles carried out by volunteers. Second, the drivers for participation. Third, the outcomes obtained following participation. Similarly, a suitably critical interpretation of the profile of the participants who closely associate with each factor was necessary.

To sketch the profile, subsets of the participants with a high score (>0.6) in only one factor were selected as representatives of the corresponding factor. To elicit the perspective underpinning each of the factors, the statements with most and least agreement were advised and quotes from the open questions within the survey were used to give context to the factors. The overall load of each statement, which illustrates the linear combination of items for each profile, is given in *Table 7.1*. A discussion of how the 12 statements load in each factor, which illustrates the linear combination of items for each profile, is referenced within the text in parenthesis (s1, s2, s3 etc.). This was seen to enrich the narrative that the specific volunteer profiles relate to. The questions of the survey that correlate with the noted statements are referenced in *Table 7.1* in parenthesis (=Q3, =Q7, =Q8 etc.). Responses of

volunteers to open questions are also included to add further context to the definition of each profile.

Table 7.1 *– Subset of citizen scientist profiles*

Component Matrix[a]

	Component			
	Activist	***Conservationist***	***Professional***	***Hobbyist***
	27%	**14%**	**10%**	**8%**
S1. (=Q3) I carry out data collection tasks	-.044	-.024	**.622**	**.659**
S2. (=Q3) I carry out data analysis tasks	.055	**.674**	-.216	.296
S3. (=Q3) I carry out data dissemination tasks	.267	**.788**	-.023	.041
S4. (=Q3) I carry out project design tasks	.161	**.682**	.293	-.301
S5. (=Q5) I participate to learn more about nature and environmental issues	**.743**	.289	.071	.038
S6. (=Q7) I participate to take more of an active and practical role in protecting the environment for future generations	**.779**	-.088	.067	.247
S7. (=Q8) I participate to play my part in raising the awareness and knowledge of a particular environmental problem	**.775**	-.039	-.062	.216
S8. (=Q9) I participate to produce local knowledge as a way of engaging with local and national government	**.657**	.024	-.243	-.165
S9. (=Q15) As a result of participation, I have learnt that not enough attention is paid to local environmental issues	**.607**	.042	-.331	.065
S10. (=Q16) Following participation, I believe that individuals have an important role to play in the future management of the marine environment	**.660**	-.220	-.062	-.108
S11. (=Q17) I have engaged with other volunteers and met new people	.274	.246	**.556**	-.299
S12. (=Q18) I discuss environmental issues more often with others	.330	-.074	.487	-.457

Only correlations with r>0.5 are shown in bold. For the correlations, positive/negative values indicate that the attribute is more/less associated with the statement.

The specific value of exploratory factor analysis for the purposes of this examination links to its capacity to account for a number of key issues that problematised in this study's literature review, *Chapter 2*. 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 survey 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 citizen science initiatives.

Table 7.2, below, presents the socio-demographic differences between the four extracted profiles. This includes information on the citizen science projects that the volunteers of each profile participate in, as well as an illustration of their gender, age, employment and education. Also presented is the response of volunteers to a survey question that asked *'how can citizen science best support marine conservation?'*. The differences between the four profiles are expanded upon in the following sections and are reflected upon in this chapter's conclusion. Each of the profiles list the percentage of the total variant that it represents and the number of survey respondents that load on that profile. The number of survey respondents is shown within parenthesis in the first row of the table. For instance, the *Activists* factor represents 27% of the total variant, with 83 survey respondents aligning with this factor. This is useful information to consider, as it illustrates the most common volunteer profile amongst survey respondents.

Table 7.2 – Socio-demographic differences between factors

Survey variable		***Activists*** *27% (n = 83)*	***Conservationists*** *14% (n = 43)*	***Professionals*** *10% (n = 30)*	***Hobbyists*** *8% (n = 25)*
Project of participation	Seasearch (Diving Group)	37%	29%	27%	12%
	IWDG (Ferry Survey)	5%	13%	10%	24%
	UW (Sea Deep)	2%	12%	13%	28%
	KNIB (Marine Litter Survey)	6%	2%	7%	0%
	RSPB (Beached Bird Survey)	8%	14%	13%	20%
	CDCA (Beach Care Group)	18%	2%	7%	4%
	CI (Coastal Survey)	23%	23%	16%	4%
	BTO (Wetland Bird Survey)	1%	5%	7%	8%
Type of project of participation	Contributory	16%	44%	43%	80%
	Collaborative	66%	54%	50%	16%
	Co-produced	18%	2%	7%	4%
Gender	Male	54%	53%	53%	48%
	Female	42%	47%	44%	52%
	Other	3%	0%	0%	0%
	Prefer not to say	1%	0%	3%	0%
Age	18-24	8%	5%	23%	8%
	25-34	6%	9%	13%	16%
	35-44	19%	14%	7%	24%
	45-54	22%	16%	7%	28%
	55-64	20%	14%	13%	8%
	65+	13%	28%	37%	12%
	Prefer not to say	12%	14%	0%	4%
Employment	Employed	59%	60%	30%	68%
	Self-employed	8%	7%	3%	12%
	Student	5%	5%	23%	8%
	Retired	18%	23%	37%	12%
	Prefer not to say	10%	5%	7%	0%
Education	Lower secondary education	89%	95%	93%	88%
	Upper secondary education	75%	81%	77%	68%
	Post-secondary non-tertiary	30%	30%	23%	32%
	Short-cycle tertiary	25%	35%	33%	36%
	Bachelor's degree	46%	51%	47%	44%
	Master's degree	23%	35%	27%	24%
	Doctorate degree	8%	19%	17%	8%
How citizen science can best support marine conservation	Produce knowledge	49%	12%	23%	40%
	Educate volunteers	10%	48%	44%	28%
	Raise public awareness	36%	35%	33%	24%
	Other	5%	5%	0%	8%

7.2.1 *Activists*

The first profile, accounting for 27% of the variance, is labelled *Activists*. This type of participant engages with citizen 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. In regard to their role in citizen science projects, *Activists* have a stronger link to data dissemination tasks (s3) than those of collection or analysis, illustrating their desire to actively use citizen 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 7.2* (above) 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 predominant age group of *Activists* (46.7%) is between 35-54. A further 16 activists are over the age of 55, while only 5 are under 35. *Activists* are highly qualified participants. In total, 46% of activists have graduated with a Bachelor's degree or equivalent, with 23% also holding a Master's degree and a further 8% holding a Doctorate degree. This high level of education amongst *Activists* is reflected in their employment circumstances, with 59% in full-time employment. The remaining *Activists* are either retired or students. The most common employment positions for *Activists* include university lecturer, marine ecological scientist and environmental charity/NGO officer. This suggests that the majority of *Activists* have developed a pre-existent awareness of and interest in environmental issues through their work, and advance citizen science as a means of adding action to their beliefs.

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). Other *Activists* share similar perceptions, stating that:

> *"I don't think citizens are given enough of a voice to shape policy. Local people have so much insight, so it's important to get it out there"* (Male, 45-54, self-employed).

> *"I'd love to see more of a push by fellow citizens scientists to use their participation as a way of calling for change to how the maritime environment is currently looked after. It's worrying how badly mis-managed some of the coast is here. I think we need to realise the severity of not acting"* (Male, 55-64, senior lecturer).

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. This factor aligns with the manner in which scholars have interpreted environmental activism through a value-belief-norm model. In this scenario, citizen activism is said to begin when individuals endorse specific environmental values, believe that the conservation processes are threatened, and are driven to transform their actions (personal norms) into a collective movement that can challenge oppressive power relations and lead to the creation of alternative, more democratic and just arrangements (Stern et al., 1999). This resonates with the transitive learning-action continuum that representatives participants of the *Activist* factor illustrate. 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 citizen science, achieving satisfaction when *"challenging the status quo" (Male, 55-64, senior lecturer)*.

Finally, it is of interest to highlight how *Activists* interpret their participation as a continuous process. *Activist* participants strongly associate with statements that link to desires of continually learning more about environmental issues (s5), as well as discussing environmental topics with others to encourage them to become more active (s12). This includes motivations to *"get more of the younger generation of environmentalists involved"* (Female, 55-64, teacher), as well as beliefs that innovative or *"more aggressive approaches are needed … to get the message through that we need to collectively act now"* (Male, 35-44, web designer).

7.2.2 *Conservationists*

Conservationists are participants who engage with citizen 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 citizen 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 7.2* 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 predominant age group of *Conservationists* was between 45-64 years of age. Only one *Conservationist* was under the age of 24, suggesting it is a typology most relevant to middle-age citizen science participants. Similar to *Activists*, the majority of *Conservationists* are well qualified and educated citizens, with 51% graduating with a Bachelor's degree, 19% with a Master's degree and a significantly high 19% holding a Doctorate degree. A total of 60% of

Conservationists are in full time employment and a further 7% are self-employed. Interestingly, no *Conservationists* currently work in the environmental sector. This suggests that citizen science participation is separate from their personal work and advanced as a passion carried out in their free time. This is illustrated by *Conservationists* who describe their engagement with projects as *"my way of feeling active in a world away from work"* (Male, 55-64, architecture).

The strong association that *Conservationists* show with the motivation of engaging with others (s11) reflects their desires to learn about environmental issues in a collective manner. *Conservationists* discuss how they *"have met fantastic people and got further involved on projects"* (Female, 65+, retired), which has encouraged some volunteers to become *"a member of a couple of NGOs and environmental charities"* (Male, 55-64, architect) and *"give more time to community projects"* (Female, 45-54, civil servant). This collective mentality is a key component of the *Conservationist* profile, both in regards to the motivations for and outcomes of citizen science participation. It links to the sociological theme of togetherness and emphasises how *Conservationists* view social engagement as a key element that any successful citizen science initiative is dependent upon.

Many *Conservationists* specialise in specific research tasks that align with their skillsets and interests. For example, they discuss how they focus on *"the collection of data that otherwise might not be obtained"* (Female, 45-54, civil servant) and *"using my experience to lend a hand to validating baseline data submitted by other volunteers"* (Male, 55-64, insurance broker). While *Conservationists* are not necessarily motivated to participate as a means of improving their knowledge and skills, they demonstrate how participation has led to developments of their *"practical monitoring skills"* (Male, 35-44, self-employed) and *"awareness of what birds are common in my local area"* (Female, 65+, retired). These advancements add further expertise and experience to the skillsets of *Conservationists*, which are then applied to future roles carried out in citizen science projects. In this sense, participation is not seen as a stepping stone for *Conservationists*. They do not participate in projects to further their career, integrate with radical activist movements or take their environmental activeness to a further level. Ultimately, their participation with citizen science is, in itself, the primary objective of *Conservationists*. For example, *Conservationists* discuss how they take satisfaction in *"protecting an area that I love"* (Male, 35-44, self-employed) and *"feel empowered and proud as a result of taking part"* (Male, 55-64, architect).

The responses of *Conservationists* suggest that citizen 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. *Conservationists*, to the opposite of *Activists*, are driven to contribute toward, as opposed to challenge, regimes of management. Ultimately, participants who are represented by the *Conservationist* profile interpret citizen science as an objective in itself and do not necessarily advance their participation as a means of instigating transformative change to wider environmental issues.

7.2.3 *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. This type of volunteer is divided into two separate elements, those who are motivated by career development and those that view citizen 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 citizen 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 demographic makeup of *Professionals*, there is high variation amongst their age. This includes 10 participants aged 24 or younger, 21 between the ages of 35-64, as well

as 15 over the age of 65. Of all the participant profiles extracted by this chapter's factor analysis, the *Professional* factor includes the highest number of retired participants (14). It also comprises students, self-employed individuals and those in full-time employment.

Professionals who participate in citizen science as a means of developing career opportunities are seen to take it upon themselves to build experience and expand contact networks that can assist career progression. For example, *Professionals* of this type discuss how they have *"worked hard to become a coordinator of surveys … getting practically involved with running/managing of the monitoring projects"* (Male, 35-44, civil servant), which is vital experience for professional advancement in the realm of environmental conservation. Others mention how, through their involvement with projects, they have *"picked up a lot of good knowledge on how to organise citizen science projects and how to get the best out of volunteer groups"* (Female, 35-44, national museum data coordinator). On the other hand, *Professionals* who are seen to engage with citizen science projects as a means of continuing their career objectives and interests post-retirement, discuss how they are motivated to participate because they are *"able to commit more time to the meat and bones of projects now, really engaging with the data collection process. Cetacean monitoring is both an activity I love and something I'm skilled at, so I didn't see the need to pack it in after stepping down from daily work"* (Female, 65+, retired). This type of a *Professional* volunteer demonstrate how they are keen to continue the ethos and motivations of their previous work by continuing to participate with citizen science. An enhanced level of freedom to vary the roles that they play in projects and to advance the manner in which they support the development of schemes appears key.

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 citizen 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 interest of *Professionals* in project design tasks (s4) reflects a desire amongst older volunteers associated with this factor to share the insight that they have developed by engaging in previous scientific practices. It also suggests that younger

Professionals are motivated to gain experience of how to design citizen science projects. 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+)*. Citizen 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. It is revealed that respondents associated with the *Professional* profile are common in both contributory and collaborative projects (*Table 7.2*). 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. It is suggested 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.

7.2.4 *Hobbyists*

Hobbyists account for 8% of the variance. They are volunteers who informally engage with maritime activities that bring them pleasure and advance citizen science as a way of giving meaning to their hobbies. The survey findings illustrate how respondents' hobbies include angling (onshore and offshore), diving, bird and wildlife spotting, beach walking and wildlife photography. Citizen 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 citizen 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 7.2* demonstrates how *Hobbyists* are highly prevalent in contributory projects, where their engagement is unlikely to develop beyond data collection tasks.

Analysing the demographic composition of the *Hobbyists* profile demonstrates how there is a generally even spread of participants across all age ranges, with the majority between the ages of 35 and 54. Predominantly, *Hobbyists* are well educated individuals, holding a range of both academic and vocational qualifications. There is significant variation amongst the disciplines of employment for *Hobbyists* who currently hold full-time or self-employment positions. There is no distinctive pattern or correlation amongst the jobs held by *Hobbyists*, with the most commonly noted positions including teachers, technicians, surf instructors and town planners. This illustrates how *Hobbyists* view their engagement with marine environments as something entirely separate from their profession. Like *Conservationists*, *Hobbyists* discuss how their participation with citizen science is *"an escape from the daily grind"* (Female, 35-44). Their engagement with participatory research is not related to their job, nor do they interpret citizen science as a means of advancing their career. Quite simply, they carry out activities which bring them a sense of satisfaction that their work does not offer. It is also important to note that hobbies are commonly time and money intensive, due to the necessary equipment, travel and training which they include. As such, defining personal factors of a *Hobbyist* are free time, disposable income and commitment to their hobby.

While *Hobbyists* share similarities with *Conservationists*, in the sense that they are both non-professional amateurs who gain satisfaction from their citizen science participation and are motivated to engage as a result of their personal interests, they are differentiated based upon their environmental knowledge, awareness and drive. *Conservationists* gain enjoyment by doing their part in preserving marine areas, engaging with nature and contributing to ecological knowledge. While not entirely altruistic, largely as they are keen to learn and develop in a personal manner, *Conservationists* view their engagement as something that can benefit others and the environmental itself. *Hobbyists*, on the hand, are not motivated by desires to play their part in conservation processes or by concerns they have about the sustainability of marine environments. Rather, they simply interpret citizen science as a well organised process which offers them a valuable opportunity to carry out their hobbies in professional environment. As hobbyists discuss, *"(citizen science) gave another dimension to my diving … it lets me explore new areas and attempt new things, but with the comfort of knowing I'm with highly skilled and qualified tutors"* (Male, 45-54, dentist).

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. Additionally, *Hobbyists* are seen to 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)*. This is reflective of seminal literature on the topic of hobbies, which clarifies how activities are, predominantly, carried out in an individual manner (Gelber, 1999). While *Hobbyists* may take part in larger groups or be associated with specific clusters, citizen science schemes being one example, their participation is mainly solitary in nature. Their participation with citizen science is, therefore, self-serving and intrinsically-driven.

A final aspect of the *Hobbyist* profile, which is a key feature differentiating it from other factors, is the lack of environmental drive that representative volunteers have. This is demonstrated by the limited association that *Hobbyists* make with variables regarding the role of citizens in the future management of the environment (s9, s10). While they are motivated to contribute toward conservation practice and gain satisfaction from doing so, *Hobbyists* interpret governance processes as something that is beyond the realm of citizens. *Hobbyists* do not feel that local environmental issues are overlooked by governance decision-makers, nor that the knowledge and opinion of citizens should receive great recognition than it currently does. For example, *Hobbyists* discuss how they *"feel happy that I can use my experience to guide others, but I'm no expert"* (Male, 55-64, writer) and think that *"some volunteers get too frustrated with the state of the environment … they can take the fun out of participating. I'm happy to help out when asked and leave things there"* (Female, 55-64, self-employed). There is no lack of commit amongst *Hobbyist* when participating in projects, but they advance their engagement as a contributory role, not as a force to lead a movement that can instigate change.

7.3 Comparative analysis of volunteer profiles

This chapter has responded to citizen science research that assesses participation by exclusively focusing on either volunteer motivations or outcomes, illustrating how there is a distinct need to assess a wider scope of the participation process. The findings presented in this chapter reveal the prominent types of individuals who engage with marine citizen 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. It is revealed 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 findings on the motivational drivers of surveyed volunteers are largely reflective of studies on volunteerism, the assessment of how these are linked to specific perceptions and outcomes of participation reveal valuable insight that adds to current thought.

The findings expand beyond the motivational labels of Batson et al. (2002), as outlined in *Chapter 2*, 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 citizen science. For instance, it is found that some volunteers (*Activists*) perceive citizen 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. This style of evaluation should be followed by marine citizen science practitioners, 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 citizen science resources can be limited, projects must be designed with the intention of getting the most out of participants. The methodology followed in this chapter's analysis illustrates the value of examining several elements of participation simultaneously. It is possible 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 citizen science participation by ensuring that different types of volunteers are supported based upon their individual motivations and desires. As citizen science continues to grow, engaging more diverse citizenries will be crucial if projects are to tackle concerns regarding exclusive recruitment tendencies (Walajahi, 2019).

Additionally, by focusing on the complex composition of participant cohorts, factor analysis reveals intriguing insight on 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 (2007) 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 citizen 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 (Mach et al., 2020). For *Activists* the focus is on practice as a form of self-organisation that is fluid, dynamic and emergent. There is an evident need to pay increased attention to the link between participant's participation motivations and desired outcomes, and the nature of knowledge that 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.

7.4 Conclusions

Understanding participants' motivations in conjunction with their outcomes and broader perceptions can help project organisers decide the most appropriate approach to maximising participation. As existent literature has suggested, there is a 'fine line' between supporting and abusing volunteers (Measham and Barnett, 2008). It is important not to disregard this and risk losing vital volunteer contribution. The findings of this analysis 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 should be utilised by citizen science coordinators when possible, as satisfying volunteers' desires directly supports both recruitment and retention. It is important to note that, although the factor analysis process revealed well defined profiles of volunteers, this is not suggest that projects should seek to value one type of volunteer over another. Instead, the extraction of volunteer profiles illustrates how citizen science projects, going forward, need to pay greater attention to the alignment between a participant and the aspects of participation that they are most interested in. This study has conducted a wide-ranging review of how citizen 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. It appears that citizen 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.

8

OPPORTUNITIES AND BARRIERS TO TRANSFORMATIVE CITIZEN SCIENCE

8.1 Introduction

The findings of this explorative study illustrate crucial insight on the opportunities and barriers to citizen science projects instigating transformative change to marine governance processes. The analysis of interviews with citizen science actors, added to the assessment of volunteer responses to survey questions, demonstrate the key factors that influence the evolvement and potential impact of citizen science projects. The findings highlight how power/knowledge arrangements are deeply embedded within the field of citizen science. Uneven balances of power are seen to be common between governance actors, practitioners and volunteers, with specific measures used by those in governance positions – the setting of objectives, the employment of standardised practices and regulations, and the creation of short-term timeframes – pushing initiatives to operate in specific, pre-determined manners. The findings of this study also illustrate the importance of critically assessing the participation process. The results of surveys with volunteers indicate the importance of projects responding to the needs and requirements of participants, with responses also reinforcing the findings of interviews that hint at a 'narrowing' of citizen science. Additionally, survey findings demonstrate the need to broaden participation pathways and to critically examine the nature of knowledge that volunteers are interested in.

The following chapter pulls these findings together and explains what they tell us about the transformative potential of citizen science in marine governance processes. This discussion is broken down into three themes. One, the politics of citizen science *(8.2)*. This theme discusses the role of power arrangements within citizen science, assessing how the 'professionalisation' of projects is hindering their scope to instigate transformative change and why the apparent narrowing of citizen science is disrupting the active participation of volunteers. Two, the nature of citizen science knowledge *(8.3)*. This involves a discussion of how citizen science knowledge is used and how it can create impact, as well as an analysis of the differing perceptions of knowledge that are held by practitioners, governance actors and volunteers. Three, the opportunities for transformative citizen science *(8.3)*. This theme learns from interviews with practitioners and governance actors, as well from volunteer responses to surveys, reflecting their thoughts and perceptions of the key opportunities to transformative citizen science going forward. Fundamentally, an argument is presented for the (re)politicisation of citizen science. The '(re)' is significant, as it signifies how citizen science, and participatory processes more generally, has traditionally been dominated by

depoliticised discourses that uses rational arguments to invoke universalised ideas of what is 'the best' solution. This suggestion asserts that citizen science, should it successful engage with and instigate processes of transformation, must become aware to the fact that projects are positioned in politically and power active arenas. Space is also provided to discuss potential solutions to the challenges facing citizen science, with a focus placed upon the potential to establish networks of projects and create critical feedback loops. The chapter closes by briefly clarifying how the assessed findings of this study respond to the gaps of knowledge outlined earlier in the thesis *(8.5)*.

8.2 The politics of citizen science

The findings of this study demonstrate how relations of power, which are revealed as being uneven in many cases, flow throughout the realm of citizen science. There are clear indications that these relationships are heavily influencing the scope and potential impact of projects. Governance actors, deemed as the more powerful participant either due to their role as funding commissioners or as a result of their positioning as policy-makers, use specific methods to ensure that they can drive the evolution and desired output of projects. The information revealed through analysed interviews illustrates how three measures – (i) objective setting, (ii) the employment of regulations and standardised processes, (iii) and the creation of short-term funding timeframes – are seen to significantly influence the boundaries of what projects can achieve. These measures are perceived in two guises by practitioners. On the one hand, they are interpreted as offering projects a potential bridge to governance arenas and a pathway to influencing policy and decision-making. Practitioners speak of how, by abiding by the regulations and rules set by governance actors, the outputs of their projects can align with other policy data and contribute to current management approaches. On the other hand, these measures can also be perceived as enabling governance actors to police how projects can operate. In this sense, established relationships between projects and governance actors can limit the control that practitioners have over the evolution of projects. This can significantly lessen the capacity of practitioners to both facilitate participation process that are responsive to the needs and requirements of volunteers, as a result of the implementation of standardised participation practices by governance actors, . In total, unstable relationships between practitioners and governance

actors is revealed as being a valuable reflection of how politics and arrangements of power/knowledge are embedded within citizen science.

This study's analysis of how politics operate within citizen science represents a major advancement on current research. As evidenced in *Chapter 2*, power and politics remain relatively neglected concepts amongst scholarly reviews of citizen science. This issue was problematised earlier in this study and the argument was posed that, should research become truly capable of understanding how citizen science can instigate transformative change to marine governance processes, power analysis must be incorporated into evaluative studies. Current models of the participatory and governance structures of citizen science (see Bonney et al., 2009b; Conrad and Hilchey, 2011) fail to acknowledge how flows and arrangements of power can shape the evolution and output of projects. Although there is an acknowledgement of the different types of actors who engage with citizen science, there a critical lack of consideration in relation to how these actors, who each hold differing interpretations and are driven by divergent objectives, may work to support or constrain the evolution of projects. Conrad and Hilchey (2011) naively suggest that governance frameworks develop around projects. In reality, the truth is the opposite. The governance structure and organisational framework of any citizen science project is heavily shaped by the power/knowledge arrangements that constitute its development. Projects, in and of themselves, are nothing more than empty objects. It is only once competing actors begin to engage with projects, funding relationships are established and objectives are set, that their governance structure can begin to form. One of the core conceptual principles that guides this study is the notion that "power is ever present in social relations and a society without power relations can only be an abstraction" (Foucault, 1982, p. 222). Thus, for any model, conceptualisation or critical analysis of citizen science to develop a truly reflective comprehension of the practice, an analysis of the power/knowledge arrangements that are shaping projects is essential.

Narrowing the scope of citizen science

By conceptualising the field of citizen science and decoding the power/knowledge arrangements that dictate how projects operate, a general process of 'professionalisation' is revealed. This is a process whereby citizen science projects, by being increasingly pushed by governance actors to follow strict scientific standards and principles, are operating less like participatory efforts and more like professional scientific endeavours. This process of

professionalisation is interpreted as part of a wider process of narrowing the scope of what citizen science is and what it can achieve. As revealed in *Chapter 5*, there remains critical differences between the interpretations of practitioners and governance actors regarding the role and value of citizen science. Whilst practitioners acknowledge a wide scope of aspects linked to citizen science, from producing knowledge, instilling learning and social outcomes within volunteers, as well as the potential to encourage increases in the stewardship and civic participation of volunteers, governance actors carry a more restricted perception of the practice. For many practitioners, citizen science is almost exclusively valued as a cost-effect means of contributing environmental knowledge, with learning and social outcomes viewed as additional or unintended consequences. This difference of interpretation is crucial, particularly when considering that governance actors can have a much greater capacity than practitioners to push their agenda and objectives onto projects. This is a key finding and reveals a worrying trend for the future of citizen science. Perhaps most crucially, a narrowed version of citizen science, where the focus is on supporting projects to produce specific types of knowledge in a professional manner, will drastically cut the transformative potential of the practice. With projects implementing rigid participation processes in line with professional standards of data collection and analysis, the scope for social learning and transformation, as well as the production of alternative forms of knowing, is significantly lessened.

This process of narrowing the scope of citizen science also reveals a broader example of how power/knowledge arrangements can shape the operations of citizen science. Although the process of governance support for citizen science projects may appear as a transfer of power to coordinating organisations and their volunteers, in reality, it signals the creation of new arrangements that can turn projects into both objects and subjects of governance actors. As has been exemplified, this is achieved through the implementation of strict project objectives, standardised practices and, more generally, a professionalisation of initiatives. It is important to be aware of this reality and to assess how it challenged. The professionalisation of citizen science means that projects can, paradoxically, end up reproducing, rather than mitigating, the existing unequal arrangements of power/knowledge that they intend to change. At the basis of this process lies a strong tendency within both literature and practice to depoliticise citizen science. As has argued within this study, by failing to address the political and power dimensions of citizen science, the practice is at continued risk of reinforcing and strengthening traditional and professional modes of

knowledge production and dissemination. Ironically, the professionalisation of projects can be interpreted as a process of removing the 'citizen' from citizen science.

Limiting the pathways to participation

The impact of an increasingly professionalised citizen science paradigm is also having a negative impact upon the potential contribution of volunteers. This is a result of the manner in which participation is more commonly becoming regulated and conducted in line with standardised practices. The analysis of the survey responses of citizen science volunteers suggests that specific pathways to participation are being supported. Evidently, not all volunteers align with these pathways. This leads to the marginalisation and exclusion of some volunteers who carry diverse interests and motivations. This reinforces the claim made throughout this thesis that the needs, requirements, concerns and specific interests of participants must be heard and actively responded to. This is crucial should volunteer engagement be maximised, and can assist both the recruitment and retainment of participants.

Additionally, this topic further hints at a narrowing of citizen science, wherein projects are 'narrowing' the range of volunteers who can participate in projects. Importantly, this should not be understood as a purely governance inflicted issue. In interviews with practitioners, it is revealed how projects are focusing on advancing certain participants, by way of encouraging them to take part in leadership roles within projects and to broaden the tasks that they take part in. There is additional reference made to how certain 'types' of volunteers can be more relevant to some projects than others. As such, volunteers can, effectively, be excluded or discouraged from participating in citizen science. It is crucial that this trend is challenged and that all volunteers are facilitated with the opportunity to fully engage and contribute to citizen science. Should projects reach their potential and instigate transformation, after all, it critical that volunteers are encouraged to maximise their potential contribution.

8.3 The 'nature' of knowledge

Responding to the limitations of current citizen science literature regarding its analysis of knowledge, this study has conducted a critical and conceptually-informed examination of

how citizen science knowledge is produced, used and has impact. By acknowledging the power/knowledge nexus, and by being guided by assertions of how power and knowledge are inextricably linked, this study has revealed crucial insight regarding the mobilisation of knowledge within the field of citizen science. These findings have illustrated how the knowledge that is produced by projects can be shaped by specific power arrangements, stemming from differing perspectives on the use and potential value of citizen science knowledge. Thematically analysing the responses of practitioners and governance actors, two dominant interpretations of knowledge were noted. The first relates to the notion that citizen science knowledge is a means of contributing toward current management approaches of the marine environment, as a means of maintaining the *status quo* of marine governance. This framing of citizen science knowledge exemplifies how projects are regularly bound to professional data collection protocols and standards, with alternative ways of thinking commonly prohibited from being incorporated into projects. The second perception is that citizen science is an opportunity to challenge current conceptualisations through the active production of alternative knowledge, referred to in this study as knowledge 'for action'. This is a more radical interpretation of how citizen science can produce knowledge and is construed as an attempt to challenge the way in which decisions are made within marine governance processes. Key to this form of knowledge production is the mobilisation of pluralism, qualitative knowledge and contestation. With a consideration in mind of how the transformative potential of citizen science can be realised, the following section discusses how a movement toward this more radical means of producing knowledge could be operationalised by projects

Moving from knowledge for 'knowing' to knowledge for 'action'

In addition to filling gaps of knowledge and contributing toward our general understanding of marine governance processes, some citizen science actors suggest that projects are capable of instigating action through the knowledge that they produce. Knowledge 'for action' necessitates action from both those involved with citizen science projects, including practitioners and volunteers, as well as those in governance positions. This involves action by volunteers and coordinators to collect data, analyse its meaning and share it with potential end users, and action by governance actors to respond to this knowledge and to instigate change in their approach. An example of how citizen science can produce knowledge 'for action' and can instigate transformative change to marine governance processes is revealed in *Chapter 5* this study.

The case of the Waterfoot MCZ exemplifies how governance actors are willing, under the right circumstances, to engage with alternative knowledge, to change their knowledge bases when prompted to do so and to truly facilitate shifts of power. This is interpreted as a powerful example of citizen science using active approaches to calling for change. Discussions on this case reveal an interesting dynamic between the use of citizen science knowledge for purely contributory purposes, and for more activist-like functions. It is important to reflect upon this example as it reveals insight on how the power dynamics in operation within citizen science can successfully be shifted through a critical awareness of the different types of knowledge that exist and by way of acknowledging the different pathways through which knowledge can be mobilised. It also represents a strong example of how policy changes can be made to allow projects to more effectively transform the degree to which local knowledge and insight can influence marine governance decision-making. The case also shed light on the notion that citizen science can produce knowledge that, in some ways, is reflective of Aristotle's model of Phronesis. As discussed earlier in this chapter, Phronesis includes aspects of a situation, critical analytical reflection and scrutinising knowledge systems, practices and the impacts of goals that are taken for granted. The capability of citizen science projects to find the 'right answer' by way of producing knowledge 'for action', learning from theory and practice, and engaging with local culture and socio-political knowledge, is much greater than in the case one-dimensional flows knowledge as a contributory arrangements.

Understanding volunteers' perceptions of knowledge

Analysing citizen science knowledge should not only take place when considering the outputs of projects. It should also be measured in relation to individual volunteers. *Chapter 7* illustrated how, by focusing on the complex composition of participant cohorts, the nature of the 'science' that volunteers are engaged with, as active producers of knowledge, can be revealed. For some volunteers, the depth of research is not the primary issue of interest and their motivating factors are associated with non-knowledge production aspects of projects. However, for other volunteers this is the opposite, with the scientific components of projects and the manner in which knowledge can be mobilised and have impact representing driving forces for participation. This reveals how some volunteers, which include the *Activist* and *Conservationist* profiles presented in *Chapter 7*, perceive a need to move beyond 'science' as a technical project and, instead, to value the type of knowledge that is being produced,

its epistemological basis and how it can ultimately have impact. For *Activists*, the interest is shown to relate to knowledge that connects heterogeneous elements (social, political, environmental) in an attempt to expand existing modes of knowing and to inform future action. The focus here is on practice as a form of self-organisation that is fluid, dynamic and emergent. This leads this study to suggest that assessing the nature of knowledge that volunteers are interested is an additionally useful means of decoding the experiences of participants and of revealing how they can be supported to maximise their potential contribution to projects. Whilst assessments of participants in citizen science, and indeed in the wider field of volunteerism, have traditionally focused on the practical attributes of the volunteer, this study has demonstrated the need to follow more holistic examinations of participation and to consider a wide range of participation related issues. Assessing how the interests of volunteers relate to different categories of knowledge, in and of themselves, should be at the core of future investigations.

8.4 Opportunities and recommendations for citizen science

A final theme of discussion in this study relates to the major opportunities facing projects. Importantly, these discussions hint at potential alternative futures for citizen science in the realm of marine governance and reveal how projects can be made to do more in their pursuit of transformative change. These suggestions can, therefore, be understood as potential solutions that can correct for the barriers and persistent challenges that projects commonly encounter. These recommendations are drawn from interviews with citizen science actors, surveys with volunteers and the critical review of literature covering power/knowledge and participation related topics. To begin, the case for (re)politicising citizen science, in both a conceptual and practical sense, is argued. This is followed by two innovative recommendations on the manner in which projects can evolve into the future. These include the case for citizen science networks and evaluative feedback loops.

(Re)politicisation of citizen science

Although governance support of citizen science has a range of suggested benefits, this study has revealed how, in reality, it can significantly limit the potential of projects from contributing to transformation in the realm of marine governance. To the opposite of project

intentions, governance support for citizen science is shown to actually strengthen the status quo of marine governance, as existing power differences are replicated. It is crucial that research on citizen science acknowledges this contradiction, so that strategies can be set up to address power dynamics across a broader scale. Learning from the findings of this critical review of the role of power in the field of citizen science, the concluding argument is that research must be (re)politicised. Recognising the politics of citizen science and calling change, as this study has done, requires a need to rethink the very of nature citizen science practice and not solely produce a checklist-type approach of 'do's and don'ts' for practice. This study suggests that, for starters, research must understand citizen as participatory approach to knowledge production that is deeply embedded within unequal power relations. Although imbalances of power are, clearly, not easy to rectify, it is crucial that they are recognised and appreciated. Whilst it is appreciated that a (re)politicisation of citizen science can present risk and is a difficult task, the argument of this study is that it entirely essential for citizen science to realise its transformative potential. In a practical sense, research assessment must place power at the core of their assessment, while practitioners must seek to critically engage participants with the political nature of projects.

In addition to generating knowledge in a contributory manner, citizen science must produce knowledge that is explicit in its composition and capable of invoking critical reflection. This must involve acute analysis of knowledge systems and practices, so as to ensure that knowledge is truly reflective of current conditions and comprehends how they can be altered. Should citizen science be advanced solely as a means of contributing to the status quo of marine management, projects will be forced to focus on what is, rather than on what could be. Learning from the findings of this study, it is likely that imbuing citizen science projects with a critical interpretation of the power/knowledge configurations that shape their development could help to reveal pathways through which initiatives can better understand how and why transformative outcomes are often inhibited, and how such eventualities can be overcome.

Operationalising a power-aware paradigm will require changes to both citizen science theory and practice. Informed by social theory, research can develop closer working relationships with projects and help to map out the field of power that they are operating within. Foucault's theory of power/knowledge, as this study has argued, may be one option to inform future research. The theory presents as a useful means of understanding how power

and knowledge relate to each other within the realm of citizen science. In particular, the power/knowledge framework can guide evaluative assessments of the power dynamics that operate between citizen science practitioners and governance actors, and reveal the degree to which this balance influences the organisational design of projects. By revealing cases of governance actors suppressing the transformative capacity of citizen science, it becomes paramount for research to help to create alternative pathways for projects going forward. Practitioners can learn research such as this to broaden pathways to participation for citizen science volunteers, so that the specific motivations and desired outcomes of different volunteers can be responded to and supported. This can help to maximise the potential contribution of volunteers and to enhance their likelihood to sustain participation, both aspects that can benefit the potential transformative outputs of a project.

Power-aware citizen science practice should also support new models of learning, wherein critical reflection should be key. Although educational advancement and literacy-building are core outputs of many citizen science projects, this study has illustrated how this is largely restricted to volunteers. The impact that citizen science has upon powerful figures, such as governance actors, is not comprehensively addressed by research and there are no apparent mechanisms in place to contribute to their transformation. By not engaging with, nor challenging the consciousness and actions of governance actors, the transformative capacity of citizen science is likely to be lessened. As a response, research that evaluates learning within citizen science should extend its focus to actors beyond volunteers. This should involve surveying governance actors to understand how they interpret citizen science and the degree to which their values and norms may be challenged by the knowledge that projects produce. Such evaluations could reveal valuable insight to learn from and to incorporate in future initiatives. To arrive at a more reliable and transparent measurement of the transformative potential of community science, evaluations of learning should be built into projects as an inherent step in the process. This is of particular relevance due to the fact that learning in citizen science commonly occurs in unexpected manners and induces transformations at various levels, including changes in the values, beliefs, emotions, and actions of learners. Thus, the findings of this study suggest that volunteers, practitioners and governance actors should be equally involved in the process of learning evaluations through self-assessment and reflection.

(Re)politicising the field of marine citizen science will, undoubtedly, bring challenges and may not result in actionable knowledge in an instrumental sense amongst all forms of projects. Similarly, it is important not to ignore the wider challenges that face citizen science. It is important to consider how power-aware community science may respond to these. Most notably, these include the ability of citizen science to consistently produce valid scientific knowledge, to avoid participant bias and to fully engage with marginalised or lower-class individuals. Such limitations have already been suggested as factors that make it difficult for citizen science to challenge social inequalities (Bela et al., 2016), and it is crucial to factor this into a power-aware paradigm. It is also imperative to appreciate that some citizen science projects may prefer to function as contributory endeavours that distance themselves from critical approaches and, therefore, will see less benefit in becoming politicised. However, a (re)politicised conceptualisation of citizen science offers the broader potential of improving our collective understanding of transformation in the field and this may help to instigate critical reflection amongst all categories of projects. Citizen science has a strong potential to introduce new ways of knowing to marine governance, to revise inaccurate assumptions that have misled management and to facilitate more active participation. This study has highlighted how, for these transformative objectives to be fulfilled, it is vital to conceptualise the field of power that projects operate within.

Citizen science networks

Stemming from interviews with practitioners, as well as the responses of volunteers to survey questions regarding future options for citizen science, the creation of networks of projects was promoted as one potential option. This idea suggests that citizen science projects involved with marine conservation issues could establish strategic links between one another. The concept behind the creation of citizen science networks is that projects can establish knowledge sharing capacities, source alternative funding streams (that are separate to governance funding) and create an open platform that allows volunteers to experience different projects. This collaborative idea represents an innovative notion of how citizen science projects can bound together and use their collective strength, resources and knowledge to more effectively call for the type change that they seek to realise.

Evaluation feedback loops

The creation of evaluative feedback loops within citizen science projects was a suggestion put forward by several practitioners. The idea is that critical assessments of the operations

and outputs of projects should be conducted on a regular basis. At the core of this notion is that collective learning is imperative for the future evolution of citizen science. Importantly, it is suggested that the creation of feedback loops would not only involve processes of learning at the volunteer and practitioner level, but also amongst governance actors. By reporting on the strengths and weaknesses of how projects support participation and produce knowledge, as well as presenting insight on challenges faced and considering potential opportunities going forward, feedback loops would create a direct means of knowledge share between projects and governance actors. Insight on the specific types of valuable outputs that project can offer governance actors could be shared, as well as suggestions on how changes could be made to participation standards to ensure that the needs of volunteers are responded to. The key value of this suggestion lies its proposed ability to encourage learning at the volunteer, practitioner and governance level. As highlighted throughout this thesis, learning and action at all three of these levels is crucial for the transformative potential of citizen science to be realised.

8.5 Conclusions

By assessing the research findings of this study, crucial insight on the opportunities and barriers to transformative citizen science have been revealed. Projects are seen to be deeply embedded within networks of politics and power, with governance actors becoming increasingly dominant and influential in regard to the shaping, operationalisation and evolution of initiatives. This has had a direct impact on the capacity of projects to establish methodologies that actively involve participants and seek to generate transformative outputs through the knowledge that is produced. A process of narrowing is discussed within this chapter, with findings from both interviews and surveys suggesting that the general role of citizen science is slowly being constrained and lessened. Chiefly, this process is being operationalised through efforts to professionalise citizen science. Although the promise of citizen science has been built upon the active engagement that it supports, there are increasing examples of how projects are being moulded around professional scientific structures and principles that limit volunteers to contributory roles. Whilst this can be seen to enhance the policy-relevance of some citizen science and to regulate the manner in which knowledge that is generated, it is also considered as an exclusionary effort that is placing the participatory foundation of the practice in danger. Practitioners discuss how they have lost

valuable volunteers, and their potential input, as a result of the implementation of regulations and standardised practices that create templates of how citizen science projects should operate.

Ultimately, this study suggests that the potential of citizen science to truly transform marine governance processes will be dependent upon a (re)politicisation of the approach, both in regards to theory and practice. The need to establish power analysis within citizen science is evident, with the vast majority of current literature blind to the workings of power/knowledge arrangements. Such research is incapable of understanding how alternative opportunities and solutions to citizen science can be found, as dominant arrangements of power/knowledge can only be overcome by truly reflective and conceptually-informed understandings of how power can be challenged. The examples of citizen science projects producing knowledge for 'action' illustrate that success is possible through contestation and the creation of alternative forms of knowledge. As power/knowledge arrangements continue to shape the scope of projects, it will soon be the case that, if change is not forthcoming in regards to how citizen science is conceptualised and examined, there may be a need to reclaim the 'citizen' of citizen science.

9

CONCLUSIONS

9.1 Review of study

By conceptualising the field of citizen science, this study has operationalised a research design that aimed to examine the transformative potential of citizen science in marine governance processes. In particular, this aim was born out of the need to find solutions to two key challenges that are hindering the democratic capacity of marine governance processes: (i) the rationalisation of knowledge and (ii) the marginalisation of local communities. What followed was a critical examination of the current standing and potential future of citizen science. The findings of this research illustrate how there are significant barriers that prevent citizen science from operating in a manner that could consistently instigate radical change to governance problems. By way of assessing the power relations within the realm of citizen science, uneven arrangements between citizen science practitioners and governance actors are uncovered as being central to the organisation and evolution of projects. These uneven balances have the ability to not only constrain the degree to which citizen science projects can operate with agency, but also enable governance actors to guide the development of projects toward specific, often pre-determined ends. This is an example of how projects can, paradoxically, reinforce, as opposed to mitigate, the very balances of power that they seek to transform. It is through these instances that the capacity of projects to instigate wider societal transformation can be restricted. This is a significant revelation and emphasises the depth of the challenges that face citizen science projects seeking to construct active and reflective participation processes in pursuit of instigating transformative change.

This study has highlighted how transformation is misunderstood in current citizen science research. Mainly, this is due to a lack of theoretically-informed studies on the relationship between power and knowledge, two crucial elements of any transformative process. To develop a better comprehension of how transformation can occur within the realm of citizen science, and to reveal the barriers and challenges that can prevent transformative outcomes from being realised, this study developed a conceptual framework based upon Foucault's theory of power/knowledge. This concept discusses how power and knowledge are inherently linked to one another, illustrating how any study on social relations that ignores the workings of power and knowledge can only be interpreted as an abstraction of reality. Foucauldian thinking also outlines how power, which should be interpreted in both productive and regressive manners, is not a zero-sum game. Power can be challenged and,

through such contestation, arrangements of power can be transformed and new realities can develop. Learning from the employment of the power/knowledge concept in other fields of research, as well responding to limitations of the theory, this study created a Foucauldian-informed framework for analysing the transformative potential of citizen science in marine governance processes. To achieve this, two key examinations were conducted. First, an assessment of the organisational dynamics of projects, an exploration the relationship between practitioners and governance actors, and evaluating the manner in which knowledge is produced, used and has impact. This was achieved by carrying out semi-structured interviews with two key types of citizen science actors; practitioners and governance actors. Second, by critically examining the participation processes that projects facilitate and considering how the barriers that prevent volunteer input from being maximised can be challenged. This was realised by way of conducting an online survey with the volunteers of several citizen science projects.

Decoding the collected information, this study puts forward a range of practical and theoretical recommendations that suggest how citizen science, by moving beyond one-dimensional flows of knowledge production, supporting a broader range of participation pathways and facilitating learning amongst all actors in the field, can strengthen its capacity to act as a solution to the issues of knowledge rationalisation and the marginalisation of local communities that commonly underpin marine governance processes. It is clear that citizen science, due to the active form of participation that it facilitates, has a strong transformative potential. This potential is, however, constrained by regressive power/knowledge arrangements. Learning from an examination of these arrangements, this study argues that it is possible to challenge them and to instigate change to how citizen science operates within marine governance processes. By becoming power-aware and conscious of the barriers to transformation that exist, citizen science projects can develop new approaches and grow to be more efficient and effective in their attempt to actively tackle governance problems. Networks of projects, alternative funding streams and evaluative feedback loops are suggested as potential practical recommendations that can help the continued evolution of citizen science. In a more conceptual sense, this study argues that it is crucial to allow for pluralism, to highlight differences and to facilitate the contestation of perceptions and knowledge claims. Furthermore, there is an evident need to better comprehend the mechanisms that have realised successful transformation in citizen science and similar

participatory approaches, so that those mechanisms can be connected to, or embedded within, broader processes of societal transformations.

9.2 Contribution to knowledge

As this study conducted a critical review of current literature in the fields of marine governance and citizen science, specific limitations and gaps of knowledge were problematised. These shortcomings were then factored into the research design of this study, with the intention being to respond to them and to contribute new thoughts on these issues. To summarise the key contribution that this study makes to knowledge, the following four points consider how the findings of this thesis respond to specific limitations in the field and have contributed to new conceptual insight on the role of power/knowledge within citizen science. It is hoped that this study has contributed valuable knowledge on important issues relating to the transformative potential of citizen science. The first point justifies the conceptual framework that was developed in this study and clarifies how it links to the research design that was employed. In turn, the a brief discussion of how the research design facilitated the uncovering of important insights regarding power amongst citizen science actors is presented. Two of the discussed additions to knowledge in this section have already been translated into peer-reviewed academic publications (see McAteer et al. (2021) for a paper on the need to link volunteer motivations and outcomes; see McAteer and Flannery (2022) for a critical discussion paper on the influence of power/knowledge upon the transformative potential of marine citizen science), while two further contributions are in the process of being prepared for journal submission. One of these upcoming publications, which has been accepted to be part of Routledge book on the transdisciplinary co-production of knowledge for marine sustainability, reviews the professionalisation of citizen science. A further paper, currently in draft, will assess the findings presented in chapter 5 of this thesis, stemming from interviews with citizen science actors. This paper will critically illustrate how the power balances between practitioners and governance actors can hinder the transformative capacity of projects.

Power/knowledge as a research framework

Whilst reviewing the field of citizen science, and in particular how its transformative capacity has been examined, it became evident that the role and influence of power is largely ignored

within the literature. This limitation was identified as a potential barrier to fully understanding why citizen science projects often fail to create transformative outcomes and, importantly, how challenges could be overcome. Informed by the Foucauldian concept of power/knowledge, this study then developed a research design that facilitated the examination of power within citizen science. As the concept of power/knowledge contains limited methodological guidance, as with much of the conceptual work of Foucault, it was decided that an exploratory approach that enabled a critical examination of the workings of citizen science would be required. This was supported by a review of how the power/knowledge framework had been used in other research, including studies on natural resource management and environmental management that employed similar approaches and research methods (see *Chapter 3*, section 3.3). Following a range of scoping interviews with citizen science actors, it was found that, to gain a comprehensive understanding of how the transformative potential of projects can be realised, it was necessary to engage with three tiers of actors: governance actors, practitioners, and volunteers. It was decided that semi-structured interviews with governance actors and practitioners would yield vital insight on the balances of power between these key actors, and how such dynamics may be influencing the scope and output of projects.

Posing critical questions regarding the organisational dynamics of projects – how initiatives are funded, how objectives are set, how (and what type of) knowledge is produced, are other types of knowledge opposed, how volunteers are managed – led to the uncovering of evidence relating to power imbalances and the existence of power/knowledge arrangements that are seen to constrain how practitioners seek to instigate change. Due to the larger number of citizen science volunteers, in comparison to governance actors and practitioners, it was decided that a survey would be created to assess interpretations of participation. Although questions were less explicit in their examination of power, important findings regarding the degree to which volunteer engagement can be shaped by more powerful actors was revealed. This included insight on how specific participation pathways, particularly those that align with the desires of governance actors, can be supported at the expense of other pathways, such as more activist-like volunteers. Ultimately, the mix-methods approach taken by this study was directly informed by the conceptual framing presented in Chapter 2 of this thesis. It facilitated the critical examination of power within citizen science and supported the uncovering of power/knowledge arrangements that are seen to significantly influence the output of projects and their utilisation of volunteers. The

link between the conceptual framework and research design also enabled the development of valuable contributions to knowledge and shed light on how the power/knowledge concept can be used to assess the field of participatory research. Whilst alternative conceptual framings were considered, including assemblage theory (which was considered to be too elusive and wide ranging to accurately dissect the field of citizen science), discourse theory (which was found to be too dependent on policy documents and reports, which are relatively limited in relation to citizen science), and governmentality (which, again, relies heavily upon policy documents and reports. The theory also requires archaeological assessments of how power balances have changed over time, which is difficult to examine in the field of citizen science as government support for projects is a relatively recent development), it was evident that power/knowledge represented the most appropriate theory to learn from.

Organisational dynamics of citizen science

This study has revealed insight on the politics of citizen science, demonstrating how relations and flows of power are embedded with the development and evolution of projects. There are uneven balances of power between practitioners and governance actors, with evidence of contrasting perceptions on the role, value and space for citizen science emerging. The general theme of governance actors using specific measures – objectives, standards and regulations, and short-term timeframes – to shape how projects can employ volunteers, support participation pathways and produce knowledge are crucial insights that demonstrate the barriers to citizen science instigating transformative change. Power/knowledge arrangements are revealed as influencing how projects generate knowledge and how such knowledge can have impact. There is also evidence of a reluctance amongst governance actors to support and make use of qualitative knowledge, with little scope provided for pluralism or the contestation of knowledge. Although these findings demonstrate the diverse range of challenges to transformation that citizen science projects are forced to manage, there is value in translating these into learning lessons. Indeed, *Chapter 8* discusses both scholarly and practical recommendations that stem from these revelations.

Participation in citizen science

A broad representation of the major motivations, outcomes and perceptions of citizen science participation is presented in *Chapter 6* of this thesis. Diversity amongst citizen science participants is evident, yet there is also evidence of threads of similarity amongst

volunteers. Primarily, a large majority volunteers are motivated to participate with projects as a means of enhancing their engagement with the marine environment and of actively supporting its conservation. While there are various collections of motivations that underpin their participation, leading to the realisation of a range of different internal and external outcomes, there is a common belief that citizen science represents a useful and important practice to be a part of. Similarly, it is advanced as a vital means of furthering the environmental participation of participants. Citizen science, in and of itself, is a collective movement and the findings presented in *Chapter 6* illustrate how it is functioning a means of enhancing the participation of members of the public in scientific projects.

Linking the motivations and outcomes of participants

To establish sustainable levels of participant retainment and recruitment in citizen science projects, practitioners must attempt to speak to the needs and requirements of volunteers. Evaluating their participation experiences is, therefore, crucial, with practitioners and researchers being seen 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 desired personal outcomes that they wish to pursue. *Chapter 7* responds to this limitation by presenting the findings of a factor analysis of the results of a volunteer survey that assessed a wider scope of citizen science participation. This analysis considered volunteers' expectations, concerns and perceptions of engagement, as well as assessing the degree to which participants' motivations were fulfilled. Assessing these findings via a factor analysis approach facilitated the opportunity to reveal patterns of participation and, by grouping volunteers who were conceptually in their responses to survey questions, to create profiles of volunteers. These profiles highlight how a diverse range of participation pathways can exist amongst participants and reveals how each can be associated with different perceptions on the role of marine citizen science. Whilst findings on the motivational drivers of surveyed volunteers, largely, reflected seminal studies on volunteerism, this chapter's assessment of how these are linked to specific perceptions and outcomes of participation reveals valuable insight. Importantly, the information presented in this chapter demonstrates how the creation of volunteer profiles sheds light on the factors that support or inhibit the realisation of participation intentions. Learning from this, it can become possible to comprehend how to manage the 'fine line' between supporting volunteers and taking advantage of them. This analysis represents both a valuable contribution to scholarly

work on citizen science, by presenting a holistic method of evaluating how participant contribution can be maximised, as well as generating important recommendations for practice, in relation to how pathways to participation can be broadened and recruitment and retainment strategies can be improved.

9.3 Limitations of research

Despite encouraging a conscious effort in the research design of this study to allow space for emergent factors to be assessed, it is inevitable that some factors have not been actively explored and have 'slipped through the net'. This study, therefore, is not claimed as a fully comprehensive understanding of the transformative potential of marine citizen science. Rather, it can be interpreted as an initial step into this realm and a valuable assessment of some of the major opportunities and barriers that citizen science faces when attempting to instigate transformative change. For example, in *Chapter 2*, it's noted by other research into citizen science that addressing the lack of socio-cultural diversity and supporting citizen 'social' science are important pathways forward the practice, yet these were not factors that were strongly emergent in these findings. The use of open-ended interviews was intentional to create space for all factors to emerge, yet practitioners and governance actors failed to mention these topics. Admittedly, the survey method of this study somewhat accommodated for this limitation, as crucial insight regarding the participant diversity, or lack thereof, was revealed. It is hoped that the most significant factors relating to the transformative scope of citizen science have been uncovered, although it is acknowledged that future research will undoubtedly uncover additional influences. Other limitations of study are mentioned below.

Context of study

This study focused its investigation of the transformative potential of citizen science in marine governance processes in the small coastal nation of Northern Ireland. Whilst this presented an interesting and valuable context to explore the current standing and future potential of marine citizen science in, it is acknowledged that a comparative approach could have been followed, whereby the key topics and findings of this study could have been assessed against those which emerged in other contexts. Additionally, a specific limitation of focusing exclusively on Northern Ireland related to the relatively small quantity of

governance actors that could be engaged with. By examining multitude nations, this issue could have been avoided. Despite this limitation, a strong basis of data was collected from Northern Irish governance actors, who revealed insight on the organisational dynamics of citizen science that is applicable to a much wider scope.

Unexplored factors

It is noted that the online survey did not pose questions regarding dissatisfactions or frustrations to volunteers. In hindsight, it is appreciated that this could have revealed useful insight on the challenges to participation that volunteers encounter and, in turn, may have spawned recommendations on how these be overcome. Furthermore, measuring the development of motivations as participation in citizen science deepens is a factor that was not examine. Only after the running of the survey was it recognised that this is an increasingly important aspect of volunteer engagement. It is a limitation of this study's survey to not examine this issue. In relation to interviews and, as noted above, factors relating to the need to address socio-cultural diversity and the potential to develop citizen social science initiatives did not emerge from the data and, thus, were not explored. Additionally, topics relevant to transformation, including how projects handle uncertainty and facilitate resiliency, were noted by literature, yet were not discussed in interviews and were not examined in this study.

Feedback focus group

Due to COVID-19, a proposed focus group with citizen science actors, where the research findings of this study were to be presented, was unable to occur. This intended focus group was envisioned as an opportunity to engage practitioners and governance actors in a collective space and to instigate discussions on the future of citizen science by showcasing the findings of this study. Although this would have added a further methodological tool to this research and produced potentially interesting feedback, it absence was not seen as detrimental to this project's development and had no significant impact in regards to the quality of the research. To compensate, finding reports were sent to both practitioners and governance actors, and it is hoped that, post-COVID, some form of integrative meeting between actors can be arranged.

Mixed-methods

The choice of mixed methods in this study is justified as giving multiple perspectives to a complex and little studied topic. However, in taking this approach it is acknowledged that the work does not sit firmly within specific quantitative or qualitative disciplinary practices and the results may not be as deep as they might be if a single method were employed. The inductive nature of the study was chosen to allow significant themes to emerge and to signpost areas of interest for future study that might focus on more select methodologies. The findings, therefore, are offered as a springboard for future research that empirically investigates select areas of interest.

Following the volunteers of citizen science

As the analysis of the collected findings began, a decision was made to place significant focus upon the participation process and motivations of volunteers. Covered in *Chapter 6* and *7*, these findings revealed insight on the engagement of participants and the existence of pathways to participation. These findings highlighted the critical role that volunteers have upon the transformative potential of citizen science and, importantly, indicated how the participation process can be shaped by power/knowledge arrangements imposed by governance actors. As discussed in *Chapter 8*, this stems from an apparent movement to professionalise citizen science, meaning that the amateur nature of participation is compromised and practitioners are forced to implement greater regulations over the manner in which participants conduct tasks and produce knowledge. Ultimately, it was felt that following the participation and motivations of volunteers could reveal crucial insight regarding the practical impact of unbalanced power arrangements within the field of citizen science and offer the greatest opportunity for this study to contribute to current knowledge. These findings are central to the conclusions of this study and inform recommendations on how projects can support a wider range of participation pathways and oppose the current trend of 'narrowing the scope' of initiatives. The findings also indicate important barriers to transformative citizen science that have not been revealed in other research and further emphasise the value of actively managing and responding to the needs of volunteers, should the potential impact of projects be maximised. These findings also informed a paper that was published in Marine Policy (see McAteer et al., 2021).

As a result of focusing heavily on the participation process, it was not possible to additionally follow the knowledge outputs of citizen science projects to the same degree. This decision

was largely influenced by time and financial constraints. This study received funding for 3-years, rendering it difficult to look into both dimensions of citizen science in equal depth. It is felt, however, that the findings of research interviews held with citizen science actors (presented in *Chapter 5*) provided adequate insight to influence of power over the use and production of knowledge by citizen science projects. The interview findings opened the door on a previously under-researched aspect of citizen science and illustrated both how dominant power/knowledge arrangements operate in reality and how they may be overcome. These findings also encouraged a further investigation of the participation process, due to the evidently important role that volunteers play in the wider transformative potential of initiatives, hence the aforementioned decision made to follow the motivations and outcomes of participants. Although it is acknowledged that conducting further assessments on the knowledge outputs of projects would have been beneficial, it was simply beyond the scope of this study. It is recommended that the knowledge outputs of citizen science receive greater attention in the future, particularly as this angle of exploration could reveal further insights on how changes can be made to the organisation of initiatives, so that their capacity to instigate transformation is enhanced.

9.4 Future research directions

While this thesis has facilitated a number of useful insights into the transformative potential of citizen science in marine governance processes, it inevitably has raised additional questions and lines of enquiry that cannot be fully explored here. It is worthwhile considering these as a way of appreciating how this thesis fits within the broader fields of citizen science and marine governance research. It is proposed that further investigations may be carried out in a number of key areas of inquiry, which would be posed as direct extensions of the thesis. As this study represents one of the only critical assessments of the organisational dynamics and participation processes of citizen science, whereby the issues of politics and power and their impact upon transformation have been evaluated, it is hoped other research will learn from these insights and begin assessments of their own. Although this study merely scratches the surface of how citizen science can truly transform significant governance challenges, it opens up a range of avenues of thought and study that could be built upon. These are summarised below.

Power-aware research of citizen science

As highlighted throughout this thesis, current citizen science research contains a distinct lack of awareness or acknowledgement for the role of power in the process of transformation. This severely limits the strength of argument and accuracy of studies that attempt to evaluate transformative scope of projects or the role that social transformations through participation can have upon wider realms of governance. To rectify this, the increased use of power analysis within research efforts is recommended. By being conscious of power, citizen science research can begin to clarify and learn from the reasons as to how and why projects often fail to instigate transformation, and how such barriers can be overcome. Additionally, current assessments of the use and impact of knowledge in regards to citizen science remain weak. Largely, this is due to a prevalence of studies to assess knowledge production through linear or one-dimensional viewpoints. In other words, examining how knowledge progresses from problem definition to information production. This reflects a limited appreciation of the flows and arrangements of power that interact with and shape bodies of knowledge, as well as the actions required for citizen science knowledge to instigate transformative change. Such linear conceptualisations ignore the degree to which transformative action requires shifts in power balances, learning amongst governance actors, and the empowerment of volunteers beyond mere data collectors. It recommended, therefore, that research places a greater emphasis upon conceptualising the field of citizen science and using methods of power analysis examine how project can operate in transformative manners.

Model of transformative citizen science

Although not considered a potential output of this study, the creation of a model or framework that suggests how transformative forms of citizen science operate could be an option moving forward. Such a model could outline the opportunities and barriers to transformative citizen science, illustrating how projects can engage with governance processes and the different types of knowledge that project can produce to create change. Current models of citizen science present useful, although relatively basic, overviews of how initiatives can differ based upon the participation or governance structures. Yet these fail to account for the role of power in governance frameworks. Constructing a power-aware model that reflects the organisational dynamics of projects and outlines the divergent ways in which volunteers can be supported and inhibited in their participation, could represent a valuable

addition to research. The model could be used as a template to review project against, wherein opportunities could be developed on specific challenges could be overcome.

Broadening of participation pathways

This study has highlighted how, by uncovering patterns amongst participants and creating profiles of volunteers, it becomes possible to learn what supports and inhibits volunteers from maximising their potential contribution in citizen science efforts. This, in turn, reveals insight on a how there are distinct pathways to participation. By analysing pathways, projects can learn how to support volunteers to fulfil their potential by paying attention to the aspects of participation and types of knowledge that they are most interested in. This study only reveals a small range of potential pathways within a select range of projects and, by no means, suggests that these are the only pathways that exist. It is recommended that research sets up methodological frameworks that can examines a much broader range of pathways and understand how participants can be supported to maximise their participation on a much wider scale.

Additionally, this study has revealed how participation in citizen science, in terms of the demographic background of volunteers, continues to dominated by middle- to upper-class individuals. There is limited inclusion of lower-class, less educated or marginalised members of the public, which goes against the very principles of what participatory research is about. This is damaging to not only the reputation of projects, but to its potential output as well. Incorporating diverse ways of understanding and practicing science is more likely to enhance community investment in citizen science and cultivate a more inclusive public in scientific research. Doing so more accurately embodies the 'citizen-driven' nature of citizen science and ensures that there is genuine co-ownership of a research project between researchers and community members.

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Appendix 1 – Participant information sheets

INFORMATION SHEET FOR INTERVIEW PARTICIPANT

Title: 'Exploring the transformative potential of citizen science in marine governance processes'

What is the purpose of the study?
The purpose of this study is two-fold; **(i)** to examine the organisational dynamics of citizen science projects, and **(ii)** to explore their participation processes. By understanding this, it is the intention of this research to map out the challenges and barriers to citizen science operating a transformative manner and to learn how changes can be made so that projects can more effectively inform marine governance processes.

Why have you been chosen to take part?
For the purposes of this study, you are considered to be a marine citizen science stakeholder. You have been chosen because of your skills, expertise and knowledge-base gained from working or being otherwise actively involved within the realm of marine governance, or because you have valuable knowledge of what marine citizen science is and how it may work in the future.

Do you have to give consent to take part?
Yes, consent is needed for taking part in all aspects of the study, including:

- Participating in a semi-structured interview (face-to-face or by telephone);
- For that interview to be recorded by Dictaphone;
- For transcripts being typed up verbatim from the interview, with your identity and responses made not directly attributable to you.

A consent form has been drawn up with a series of tick boxes to be completed when agreeing to participate in all or part of the study.

What will you be asked to do?
To take part in a semi-structured interview, discussing a range of themes linked to your work, interest and expertise.

What are the possible disadvantages to you taking part?
The researcher does not anticipate that there are any disadvantages.

What are the possible benefits to you taking part?
There may be potential benefits from participating in the research, as it is anticipated that the discussions used in the course of the research may contribute to production of tangible

policy recommendations regarding marine governance and citizen science, academic publications and presentations at workshops and conferences.

Will your participation be kept confidential?
Yes, all responses to the interviews will be kept anonymous. Any responses used in the publication of research will not be made directly attributable to you. For instance, quotes used from the transcriptions of interviews will be presented as: "an environmental NGO stated", "a professional scientist noted", "a government policy expert explained".

What will happen to the results of the study?
They will be part of a larger academic discussion regarding power and knowledge in the realm of citizen science and marine governance. If the study results in significant findings, then the research may also be published in peer reviewed journals. Likewise, as suggested, it is anticipated that the results of this study can be translated into policy guidance and recommendations.

Who is organising and funding the study?
This research is being undertaken as part of a Department of Employment and Learning (DEL) PhD studentship and has been organised through the School of the Natural and Built Environment (SNBE) of Queen's University Belfast.

Who has reviewed the study?
The student has received ethical approval form The Engineering and Physical Science Faculty Ethics Committee.

What if there is a problem?
If there is a problem you can contact Dr. Stephen McKay, Director of Education who is independent of the study, who may be contacted at: s.mckay@qub.ac.uk

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INFORMATION SHEET FOR SURVEY PARTICIPANT

Title: 'Exploring the transformative potential of citizen science in marine governance processes'

What is the purpose of the study?
The purpose of this study is two-fold; **(i)** to examine the organisational dynamics of citizen science projects, and **(ii)** to explore their participation processes. By understanding this, it is the intention of this research to map out the challenges and barriers to citizen science operating a transformative manner and to learn how changes can be made so that projects can more effectively inform marine governance processes.

Why have you been chosen to take part?
You have been chosen because of your skills and expertise gained from being actively involved with citizen science projects.

Do you have to give consent to take part?
Yes, consent is needed for taking part in all aspects of the study, including:

- Participating in an online survey
- For the information on your completed survey to be used as part of this research study and any resulting publications.
- For your survey information to analysed and translated into visual representations, with your identity and responses made not directly attributable to you

A consent form has been drawn up with a series of tick boxes to be completed when agreeing to participate in all or part of the study.

What will you be asked to do?
To take part in a questionnaire survey, answering questions regarding the citizen science project which you have participated in.

What are the possible disadvantages to you taking part?
The researcher does not anticipate that there are any disadvantages.

What are the possible benefits to you taking part?
There may be potential benefits from participating in the research, as it is anticipated that the discussions used in the course of the research may contribute to production of tangible policy recommendations regarding marine governance and citizen science, academic publications and presentations at workshops and conferences. Additionally, the citizen science project that you participate in will take on board your feedback and filter this information into future projects.

Will your participation be kept confidential?
Yes, all responses to the survey questionnaires will be kept anonymous. Any responses used in the publication of research will not be made directly attributable to you. For instance, extracts or figures taken from the surveys will be presented as: "a project participant stated", "this figure highlights how citizen science participants felt regarding", "the results illustrate how a majority of participants are motivated by".

What will happen to the results of the study?
They will be part of a larger academic discussion regarding power and knowledge in the realm of citizen science and marine governance. If the study results in significant findings, then the research may also be published in peer reviewed journals. Likewise, as suggested, it is anticipated that the results of this study can be translated into policy guidance and recommendations.

Who is organising and funding the study?
This research is being undertaken as part of a Department of Employment and Learning (DEL) PhD studentship and has been organised through the School of the Natural and Built Environment (SNBE) of Queen's University Belfast.

Who has reviewed the study?
The student has received ethical approval form The Engineering and Physical Science Faculty Ethics Committee.

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If there is a problem you can contact Dr. Stephen McKay, Director of Education who is independent of the study, who may be contacted at: s.mckay@qub.ac.uk

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Appendix 2 – Participant consent forms

CONSENT FORM FOR PARTICIPATING IN INTERVIEW

Title of Project: 'Exploring the transformative potential of citizen science in marine governance processes'

Name of Researcher: Ben McAteer

Research Supervisors: Dr. Wesley Flannery and Prof. Brendan Murtagh

PLEASE TICK

1. ☐ I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. ☐ I understand that my participation is voluntary and that I am free to withdraw during the process of taking part in the interview.

3. ☐ Should I withdraw from the interview, I consent to the data collected, to the point of my withdrawal, to be used.

4. ☐ Should I withdraw from the interview and do not consent to the data being used, I agree to the researcher declaring the data invalid.

5. ☐ If, sometime after my participation in the interview, I decide that I wish for the data to be made void, I understand that there is a three-month period within which I must notify the researcher of my desire to do so.

6. ☐ I agree to having the interview taped and transcribed.

7. ☐ I agree to the data I submit being used as part of the research study and any further publications.

8. ☐ I agree to the researcher contacting me, via email, to feedback research findings.

9. ☐ I agree to take part in the above study.

PLEASE SIGN AND DATE

PRINT NAME:

SIGNATURE:

DATE:

CONSENT FORM FOR PARTICIPATING IN SURVEY

Title of Project: 'Exploring the transformative potential of citizen science in marine governance processes'

Name of Researcher: Ben McAteer

Research Supervisors: Dr. Wesley Flannery and Prof. Brendan Murtagh

PLEASE TICK

1. ☐ I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. ☐ I understand that my participation is voluntary and that I am free to withdraw during the process of taking part in the interview.

3. ☐ Should I withdraw from the interview, I consent to the data collected, to the point of my withdrawal, to be used.

4. ☐ Should I withdraw from the survey and do not consent to the data being used, I agree to the researcher declaring the data invalid.

5. ☐ If, sometime after my participation in the survey, I decide that I wish for the data to be made void, I understand that there is a three-month period within which I must notify the researcher of my desire to do so.

6. ☐ I agree to the data I submit being used as part of the research study and any further publications, including knowledge share with the coordinators of your citizen science project.

7. ☐ I agree to the researcher contacting me, via email, to feedback research findings.

8. ☐ I agree to take part in the above study.

PLEASE SIGN AND DATE

PRINT NAME:

SIGNATURE (electronic accepted):

DATE:

Appendix 3 – Sample of interview transcript

Interview – Project coordinator #4

BM (Ben McAteer)
PC4 (Project coordinator #4)

BM So first off, I thought I could ask you for your definition of citizen science? I guess, building on the objectives of the citizen science projects you've been involved with and more general definitions of what citizen science actually is. So yeah, I guess my first question would be, in your experience, would you define citizen science as a context based activity? In the sense that some projects would be more focused on more trivial kind of acts and projects and tasks and getting people involved in nature. While other ones can be more technical and scientific based.

PC4 Well, citizen science has those two roles. It has the data collection role and the community engagement role, the public engagement role. So projects require a flexible and adaptive set of methodologies that need to be constantly reviewed, meaning that you really need to think about what you want to achieve with the project with the project. So if it's being used for community engagement, you might have to, not dumb it down, but simplify it. Because you're going to be using lots of non-experts. Therefore, you have to make it as user friendly as possible. Whereas if you're focusing on the data collection side of it, then you might decide as part of that citizen science project to invest time and money training people up to a higher standard. That isn't necessarily possible in community engagement projects. Therefore, you're investing in those people and you are expecting a higher standard of data from them and, therefore, you are going to ask more of them. So that's really why you would differ in your approach, I suppose. Citizen science is a collective endeavour that can improve formal and informal learning. By that I mean it has the ability to harness and better connect scientific evidence to policymaking, social innovation and even social learning and activism. And yeah, some of them are, you know, for example the IWDG's ferry surveys were designed to fill a data gap. Because we had no easy way of doing offshore surveys, because vessel costs, charter costs are astronomical. So using the ferry surveys was a good way of getting people involved in platforms of opportunity, so that's any vessel you're not actually chartering, it's doing something else and you're putting someone on to do a survey. So it was a good way of getting the public involved in that. It's less of a community engagement type of thing, because most of our surveyors come on board and one of two things happen. They do a survey and we never see them again, because people realize that actually stationed serving is quite boring, because mostly you see nothing. And then we have a small core group who do most of our surveys. So they are the ones who keep coming back. So we're not really reaching a huge audience, but that's not the purpose of the survey. The purpose of the survey is to get as good a data set as we can and to ensure the longevity of the project. So it lasts. We're able to do monthly surveys pretty much forever. That's the theory. So, you know, whereas an example perhaps of a more community engagement style project might be something like Coastwatch. Coastwatch collects quite low grade data or simplified data on a variety of things around the coast. It's designed to be done by the complete novice. Each year you might have a completely different set of people doing it, so it's designed for that approach. So there are two approaches to citizen science.

BM OK, great. And is there a clear link between the two, in terms of a lot of people who take part in the community engagement projects, well not everybody but some, would begin there and then move to the data collection projects?

PC4 Yeah, you can do. That does happen. You could get involved in, for example you might get involved in Coastwatch surveys and then decide to go onto the Keep Northern Ireland Beautiful OSPAR survey, which is a completely different kettle of fish. That's far more involved and it basically involves micro-analysing the litter on a given sample beach. And it's not everyone's cup of tea. It's quite, you know, the Coastwatch surveys are easily done in an hour. They have three different areas that are quite interesting to do, I suppose. That's the comments we get back. For the OSPAR survey, you would have to be really interested in the subject to do it well. Because if marine litter isn't your thing, you might find it boring after a while. Because if you get a beach heavy litter load, it takes a long time to sort it out and get the high quality data that's required. So some people might move from one to the other, yeah.

BM So in that sense, is there a good networking relationship between different projects and different coordinators?

PC4 Not really, that's the thing. I mean, I suppose it's the nature of funding. Quite often you'll find projects working in the same area or going for the same funding, so everyone fights for the same pot. Sometimes there is cross collaboration. I mean, the ferry surveys are kind of, well they're not really funded at all. They were at one stage partially funded by state agencies, now really they're purely voluntary. Well, obviously sorry, they're funded by the ferry companies. Because it's a cost to them to have us on board. Only to some degree though, it's not very much, but they do give us free passes. You know, in other areas, I'm trying to think, there's not really any major cross-collaboration. You know, from a kind of outside perspective, when you look at Coastwatch and Keep Northern Ireland Beautiful's OSPAR surveys, I think that the impression you get is that there's competition there, maybe. Or that one sees the other possibly as competition. They may see it as competition for funding or something like that, but I don't know. But you do get that sense, that there's not a great deal of collaboration there. I'm trying to think of other examples. I mean, the marine biology stuff, there tends not to be. There's nothing else like Seasearch really. There's nothing else like the ferry service. I mean, we have had in the past, you know, UK based groups trying to establish on the island Ireland their own citizen science projects. I suppose the IWDG have always resisted that. I suppose that's due to funding related issues as well. It's too small a pot of money to be seen. And also, there is an issue that if you have something that's working, and this is something I always raise with the data hubs like CEDAR and the National Biodiversity Data Centre, if you have something that's working, why would you come along and set up a separate project that's going to dilute the scheme that's working? That's going to split the efforts in that area? So, for example, you have casual sighting scheme for cetaceans and that's working well and over the course of 20 years everyone kind of knows that, let's say the IWDG are the people to send your sighting data to. If suddenly tomorrow Ulster Wildlife decides to set a sightings scheme, are they adding to either the effort or the data? My argument would be possibly not, indeed probably not. They might be detracting from the existing schemes. So that's always a consideration for citizen science schemes. If you're proposing a new scheme, are you in fact detracting from an existing scheme? Would you not be better investing your time and your efforts supporting the existing scheme? The BTO schemes would be a good example for that. You'd be mad to come along and set up a separate Garden Bird Survey or a Wetland Birds Survey. You'd just be detracting from the

existing schemes. So I see no benefit to it. But not everyone's head works like that. So people just want to go out at do it. England is a good example. It just seems chronic in England with competing NGOs all competing for the same funding, the same people, the same data. And they're all fighting with each other and they won't share data with each other. And that's the kind of a situation I'm keen to avoid, I suppose. In fairness, I think a fair few citizen science projects would be keen to avoid that level of competition. Because it doesn't help, it just makes things a mess and a nightmare. I suppose the other issue is that there's very little point establishing a citizen science scheme, if you're not prepared to share data. You know, what's the point? I really don't see a point. I've always argued that if you're doing citizen science work you should be making your data preferably freely available, but if not you should be collaborating with everyone that wants to collaborate, to try to maximize the return of the data. But, unfortunately, again that's not always the case. Some people just sit on mountains of data. Indeed, in the past you talk to the guys in the records centres, you know, you can get people who die. And their wives or husbands come in with volumes of data that was collected during their life and none of it was ever used for anything. Because it was never shared. People just accumulate data and sit on it. Don't do anything with it themselves. What's the sense in that? It achieves nothing. I mean, OK you've now got a historical record, a baseline. But still, it would have been more useful if they shared at the time.

BM Yeah. And I guess that's the whole idea of citizen science, it's all about sharing?

PC4 Yeah, absolutely. We always figured, I mean the IWDG has had an up and down relationship with this idea. At one stage, when money was tight, the temptation is always to make data pay. It's very hard to make data pay. It's really, really hard to make, especially citizen science data, pay. Because nobody wants to buy it. They'll take it if it's free and they'll use it. But if you ask them to pay, they'll just come back say "it's alright, we'll use whatever else". They'll just downgrade. So if you're a consultancy doing an environmental impact assessment and you want to find out the distribution of common dolphins in the Irish Sea. Let's say you go to the IWDG and say "do you have this data" and we say "yes, that'll cost you whatever amount". And then what we've found time and again is that they'll go "it's OK, we'll come back to you". And what they do is they just go to some published report, where there is some far less robust data, but they'll use it because it's free. So, you know, there's this kind of perception that you can get citizen science data to pay. I'm not convinced you can. Therefore, that's another reason that perhaps it's better off if it's freely available. The idea to maximize the data. Plus, in a way you've received the data for free from people's volunteer efforts. So it's kind of nice to let it back out there. So when the IWDG had a website that was at its peak, you know, we used to make all the data freely available online. That was one of the biggest feedback loops for effort. People could see their data online the day after it was done. That promoted they're willing to collect more data. There's a loop there. Positive feedback. The problem was that our mapping system stopped working and there were all sorts of issues and now the data isn't as freely available. That's one of the biggest comments we get, "well, what are you doing with my data? I can't see it". So people like to see their data and the stuff they've collected being used.

BM That's a topic I've discussed a lot. I suppose it's quite simple in many ways, because with any piece of work you carry out, it's important to get some recognition and awareness for the time you've put in and the effort you've put in. And particularly with citizen science on the participant side, that seems like a massive thing. The people who are giving their time up to collect the data and take part in these projects and if they are to be encouraged to stay

within future projects, as well as if they are to really instill some sense of environmental awareness or to take something mentally from the project, it seems like feedback is important?

PC4 Of course, feedback is hugely important. I mean, like I said the mapping system used to our feedback method. And it's not even big feedback. They don't necessarily want to see their data in published reports, just dots on maps will keep most people happy. It was often a criticism of the ferry surveys, that people felt that the data wasn't being used. And, I'm freely admitting, a lot of that was my own fault. What I wasn't doing was stressing exactly how the data was being used. What it was being used in was reports and publications that aren't really publicly accessible. But I wasn't emphasizing that enough, you know. It can be a bit tricky sometimes to try and get that message that the data is been used. We've added a bit into our talks now to show the different uses of the data. So we show the reports, the maps, the assessments that it's been used in. So at least they know what it's been used for.

BM I suppose that links back to the first topic we mentioned there, about the objectives of a citizen science project. In the case of the ferry survey, the real aim is to use the data to be able to put it into reports, to lobby for designations of protection zones or any kind of legislative move. But it's important that the participants realize that that is the outcome and that's impact they are having. But like you say, it can be difficult to get that across. For instance, if their impact is highlighted in a report or something more technical, it may not be as appealing or as satisfying for them.

PC4 Yeah, it's hard. I mean, we've tried over the years with the ferry survey various different ways of getting the feedback across. We tried setting up a blog, and that was grand. But individual survey reports aren't that exciting. Certainly on the Irish sea, because you're dealing mainly with one species. So that didn't work too well. I was thinking of setting up a Facebook page, but then you might have long periods when you have no updates. And that never looks good on Facebook. So yeah, it's a hard one to bring some sort of balance to feedback, without committing yourself to trying to maintain something that's not maintainable with the level of activity you're doing. But I would say that virtual forums and virtual meetings are helping the promotion and formation of our meet ups. They are really useful for quality checking as well, as volunteers can put forward their records or sightings and others will respond with their thoughts.

BM I'm sure we'll talk more about it, because that's an area in particular I'd like to look into. And from talking to and surveying the participants themselves, to ask about feedback, not in terms of whether they liked the project or not …

PC4 Well, that might be an appropriate thing. They might just tell you that I'm crap. And to some extent they might well be right. The other unfortunate thing is that citizen science, if it's not your main job, it gets as much attention as you have time to give it. Which is an issue as well. But we do try. I always try to delegate where I can, just to get others more involved. So, for example, I just got an email from one of our surveyors in Dublin. They feel that they need some fresh blood in the surveys. So I was trying to explain to them what we've done here. We've done a couple of training days and trialled those. So I'm trying to get them to do that. And they might be a bit wary of that, because only one or two of them are trained researchers or whatever. So they might be a bit wary of running a training course by themselves. But there's absolutely no reason why they can't do it and they're more than capable of doing it. So what I'm trying to do is to supply them the materials and then try to

get them to do the groundwork. If, on the day I'm free, I'll go down and give them a hand. But like all citizen science, it's very hard to make citizen science work from the top. You need people to take ownership of it and to run with it. Otherwise, you know, if you're relying on, and that's where a lot of projects do grind to a halt, if you're relying on one or two people at the top, the second they get distracted with something else, the whole thing grinds to a halt. You need good people willing to run with it all the way down the line.

BM Yeah. And I suppose like we talked about earlier, the idea of people taking part in entry level projects and moving up the ladder of participation.

PC4 Yeah, that's true. So for the ferry survey, you start as just a Joe Bloggs surveyor. And then after doing 'x amount' of surveys, we try to encourage you to take a lead on surveys. We push them to organize it, they take the data, they send the data back to myself or whatever. And then ultimately, I want someone else to take over the thing. Because I just don't have the time I need to give it. You know, so it would be nice to have someone willing to take over. But people also don't necessarily want to do that. People are comfortable with a certain level of commitment. Some people will always just want to be ordinary surveyors. They don't want to lead. So some people are happy leading, but they wouldn't want to coordinate or do the data sets. So, unfortunately, the number of people, the pool of people gets minuscule as you go up the line, because it's more commitment and more time.

BM I suppose it's like most things in life. You might really desire something, but the responsibility of actually doing it might put you off.

PC4 Yeah, that's a big issue. And sometimes we've had false starts. So I've tried to get people to take on some of the data management side. But it's never worked. It's not a fun job. We're talking about thousands of pieces of data and sorting them out, just sitting there churning your way through it. What I need is more time, more days in the week.

BM Yeah, I think most people would say that too. But there does seem to have been a big increase recently, in my understanding, of people having an interest in the environment, particularly the marine aspect. I suppose mainly due to things like Blue Planet. And just higher awareness of the issues that are there.

PC4 Well, I think that what you meant to say, Ben, is that through our good work as Living Seas in Ulster Wildlife, there has been an increase. No, I'm joking. Blue planet has had a huge impact. And that's why we have to make hay while the sun shines.

BM I think it's a really interesting example, because of course the work you do here with Ulster Wildlife and all the work of the environmental bodies has always been there. And obviously a lot of people have been interested in that work and given up their time to volunteer with them. But it takes something that appeals to a massive audience, such as Blue Planet. And then, in turn, that is something which leads to lower level action by citizens.

PC4 Yeah, for sure. You know, in a good year we might engage with, let's say, up to eight or nine or ten thousand people. Most of those engagements would be at festivals, where you're talking to someone for a minute, two minutes. So really low level engagement. The higher level engagement stuff where you get them at an activity or an event, you might not even be talking about 2000 people a year. That's all you can manage. And that's doing 50 or 60 events a year. So you're only able to hit a very small percentage of the population. And then you'll

be restricted by the areas you're working in and then you'll be restricted by the timeline of the project. Most projects last three years. And then the next project may not have follow up on that. So you might work in an area for three years and then the follow on project doesn't work in the area. It's like instant amnesia. You go back two years later and it'll feel like you've never been there before. It's a hard one to keep going. So, unfortunately, levels of marine awareness in Northern Ireland are very low. Certainly in my experience. But in Ireland in general, they are very low. So it takes a lot of work to get people up to a level where they are aware enough to be concerned. A lot of people aren't concerned because they're not aware. They don't realize the problems; they don't realize what's in the sea for a start. I mean, if you look at the process for doing anything around marine conservation, the biggest stumbling block is awareness. That's the number one. Because it stops you doing everything else you want to do. You can't ask people to protect something when they don't know it's there and they don't understand what's in it. So, it's like "let's protect the sea … why? It's just grey, wet stuff!" So then you have to explain to them what's in the sea and you have to explain to them the ecosystem processes and you have to explain to them what are the potential consequences of not protecting the sea. And it's only then can you ask them to start worrying about conserving the sea. And then you have to start talking to them about all the different problems facing the sea. So awareness is, unfortunately, what funders forget. They want to fund the other end of things. They want to fund the action, outcomes. "Let's do this, let's do that". But they don't understand that the biggest block to any of that is step one: which is awareness. So really what should be funded is massive amounts of awareness. And then smaller amounts for the rest of the stuff.

BM Yeah, of course. In turn, the activism will come, if the awareness builds, obviously.

PC4 That's the idea, yeah. But because it's not sexy enough, they want to fund the other stuff and not fund the awareness. It is a big problem. It's a big issue. Awareness isn't seen as achieving anything, but it is. It's just a slower process.

BM Yeah. Effectively you're going back a step and saying "well if you want the activism to happen, obviously there has to be a base level of interest and awareness."

PC4 Yeah, yeah. And any mean of analysis will show you that awareness and a lack of awareness is the number one. That's the number one to everything. It's the number one to developing a Marine Spatial Plan that works. It's the number one to developing offshore industry. It's the number one stumbling block to anything you want to do. So why? Look at the Marine Spatial Plan, how many people in Northern Ireland are aware that there is even a Marine Spatial Plan in draft? Very few I would say, very few. How many people, even if there are aware, care enough to read it? A tiny fraction. So how are you going to get buy-in from anyone into a Marine Spatial Plan if nobody's aware of it and nobody cares about it. That just won't work. So a Marine Spatial Plan, like management plans for SACs, like anything else in the ocean, needs buy-in by people. You know, it's the same for offshore industry. If you want to go out and develop offshore industry, one of your first blocks will be that everyone will say no. Possibly. Or worse, they will just show a general apathy and they won't be a priority in funding. If it's not a priority for public, then it's not a priority for government. They want votes. Nobody cares about offshore industry and nobody cares about whatever else you are trying to do in the sea. Then no. The government aren't going to make it a priority. Anyway, that's my rant over.

BM No, no. That's exactly what my research wants to highlight. Because in academic writing it seems that when they talk about citizen science, the key things written about it seem to define it as a means of data collection. Which, like we said, of course it is. But they seem to really ignore the social side of it and, in part, definitely ignore the importance of awareness of wanting to take part in the first place. And actually trying to carry out the data collection and play their part in producing knowledge. And it doesn't really look into the aspects of how the collecting data and the big outcomes, in terms of changing legislation or lobbying legislation, how that's a really good example of the power of citizen science. How it can really change balances of power at the environmental governance level, of who's knowledge is relied upon and does it always have to be professional knowledge that policies are based upon or can it be citizen science. Effectively that's what I want to showcase, to highlight the power that citizen science does have and definitely will have in the future as it grows. I was wondering if you would view citizen science as more than just a means of data collection? Perhaps we've already mentioned that. But is it really a means of changing the balances of power in decision-making?

PC4 Well, it depends. I mean, it's both. It is. It is a method of data collection. The reality is: can decisions be made solely on professional data collection? Nowadays no. Because there isn't enough money to pay people to collect the kind of data that citizen science can collect. You know, a good example would be the offshore marine SACs for harbour porpoise in the UK. None of that could've been done, well it could've been done professionally, but there's no way you would've got the funding to do it, so it was based mostly on citizen science. It was based on NGO surveys offshore and cumulating and combining datasets from lots of different citizen science projects, as well as dedicated survey work as well. There's no point saying we'll only base our decisions on professional survey work, if you can't afford to pay for that. The reality is, in general, conservation is such a low priority for a government. So you're never going to fund the level of research needed. So could you do a web survey professionally? Yes, you could. But it would cost you millions of quid to do it, in terms of hiring consultants to go out and do the dedicated servers. That's why webs is used so much, because it's almost inconceivable that you could do that professionally. Just in terms of cost. So yeah, it's very important for data collection, especially in ecology and where you're trying to cover large areas over extended time periods. Because you can't fund that kind of stuff professionally. I would struggle to name one instance of professionally paid long term, wide scale monitoring. It's not done. Monitoring is done for one, two or three years. And then it stops. But if you want long term population monitoring, then citizen science is about the only way to achieve it. Realistically speaking.

BM Building on the idea of citizen science being able to change power balances and relations of power, which took me a long while to get my head with supervisors forcing me to read a lot of philosophy and what power actually is and how it interacts with knowledge and effectively how knowledge and power are intrinsically related, because you couldn't have a body of knowledge that isn't in some way backed up by power, while likewise you couldn't have a relation of power that isn't supported by knowledge, so it took me a long time to get these kind of concepts and ideas into my head. And then from meeting people like yourself to understand how in reality these philosophical kind of issues are in existence and how the knowledge produced by citizen science, for instance, is a power in itself, and is then put up against another relation of power in terms of the decision-makers and kind of conflicts of times. It doesn't necessarily have to be a conflictive relationship.

PC4 Well, there's nothing that scares policy-makers and politicians more than the educated masses. So, I mean, if you're a policy-maker or a politician, you can do a public consultation and go into a room and tell them that you're going to protect things and deliver the sun, the moon, the stars. And if they know no better, they'll go "grand". And off you go and that's great. The problem is, if you try to do that in in a room full of people who have engaged and who are marine aware or engaged in citizen science, they're going to see through the bullshit. And they're going to say "well actually, no. How are you going to do this? How's that going to be achieved? Where is it that happening?" They're going to start asking questions and that's where it all starts to unravel. Suddenly they then have to explain themselves and holes are picked. So yeah, I mean, of course if you do citizen science you can't help but gain a better knowledge of the subject that you are researching. Even if it's at a small scale. So the next time someone tries to spin you a lie or convince you of something that they want you to believe, you're more likely to say "well actually, no. I did the beach clean last week and there was this amount of stuff". Yeah.

BM Exactly, that's really interesting. Thanks. And what I think is the interesting thing there is the wider kind of issues that the volunteers then start to question and start to be interested in. So at the start it will obviously be an environmental issue that would attract them in, for instance on the beach clean you'll physically see something in terms of plastic on the beach, but then it will be the next step of actually questioning "why isn't the government doing anything about this and why aren't they putting in measures to stop this?" And then they may develop different ways of being critical of political issues and really start questioning them. That in itself, and this is what I would like to showcase in this research, that in itself is another way that citizen science can change power relations. In the sense that it's instilling this critical consciousness within participants. And, like I said, volunteers don't just question the environmental issues, they link it to wider political issues. Would that be something you would say citizen science projects are set up to encourage or does that just come as a result of their development? Or this an thing at all?

PC4 No, I don't. I don't think any citizen science projects have been set up to encourage political activism or to encourage people to challenge stuff. I think it's designed, as we were saying, either for awareness raising or data collection. I suppose in the background of awareness raising, there is that idea that if more people are aware, then more people will campaign. But I don't think it's a primary goal. I suppose a lot of projects are designed to raise marine awareness, mostly because, you know, if that's your focus, it's mostly in recognition of whatever else you want to do. You need people to be marine aware. I suppose it depends. Maybe if you're a campaigning organisation, then yes. That's a benefit. If you've got a more marine aware population, they are going to be more useful to you when it comes to campaigning whatever issue. But I don't know if that's ever necessarily been a primary goal of a citizen science project I've come across. As a dividend, however, definitely so.
BM Yeah, that's true. And I suppose you can't force someone to be more critically aware and, likewise, you can't expect someone to take part in the ferry survey, for instance, you can't expect them to then come out and be more critically aware.

PC4 But that's something that happens regardless. Because if you have people, let's say you're doing some sort of shore survey, an intertidal shores survey and you're doing it year in year out. And then some year you notice that all of a certain species have gone off your shore. Well, you're going to start asking some questions, aren't you? Why are those gone? Or you notice something having an impact on your stretch of shoreline. You're not going to ignore it. You're not going to have spent, let's say ten years of monitoring the same stretch

of shoreline, and then let's say the local industry starts dumping something in the bay and it starts killing everything on the shore, you're not going to sit back and say "oh well, that's interesting isn't it? I'll record that and then go home and have a cup of tea." You're not. Because you are going to start campaigning the next morning to shut it down. So it's a natural dividend of doing citizen science. Because you're doing it, you develop an interest in it. Because you've got an interest in it, you start caring about it. Because you start caring about it, you're going to start getting active about it. So, I mean you, you would have to be the most cold blooded of scientists to sit back and just go "oh well, look at the shore. It was trashed, it took ten years to happen and I record it year on year." That's just not going to happen, you know, people will campaign.

BM Particularly if it's in their environment or their area.

PC4 Oh yeah, yeah. Because people doing citizen science also means you're taking ownership. So if you're doing a particular survey., you take ownership of it. You want to protect that little patch of yours, if that's your thing.

BM Yeah, for sure. I think that's what the critical nature would come in. You want to protect something, but then you realize the barriers which are in the way to achieving that. Just for example, I watched the film 'The Pipe' recently.

PC4 The one based in Mayo was it?

BM Yeah, that's it. I thought it was really interesting, because you could really, well from my perspective anyway, I could really see the issues of power and knowledge and activism in action.

PC4 I met someone who worked for Shell in Malaysia. I actually met her in the Galapagos. She told me that Shell HQ uses the Broadhaven project as an example of how not to do a Shell project. I mean, it's now used as a classic example. Shell aren't exactly short of classic examples. You can look at Nigeria and all sorts of other cases. They walked in like they were walking into some third world country. They thought if they were pals with the politicians, that they could just go off and do whatever they wanted. They soon learnt different, of course. But then it went to the other extreme and some people, towards the end, it didn't matter what Shell did. If Shell was to lace the ocean with dolphins and plant rain forests all over, it wouldn't have mattered. They had made their enemies at that stage and there was no going back. So they could have done the sun, the moon, the stars. It wouldn't have made a difference. So it's an interesting example of how things can go badly wrong, if you do ignore the public or rile the public. I suppose, in that area, it wasn't even the marine-y side that really kicked it off. I think it was a social issue. It was initially the issue of going across people's land, that kicked it off. And then all sorts of other shit came in.

BM Again, this kind of initial something that will grab your attention. Whether it will be the interest of taking part in a project, or the environmental issue. But it's the things that lead out of that. In the example of the film, first of all there was the issue of the pipe. A very dangerous pipe, of course, going through their land.

PC4 Well, this is the whole issue. I'm not sure it was a dangerous pipe.

BM Oh really?

PC4 I think, you know, there's pipelines like that running all over the country. There's never an issue about any of it. There's pipelines carrying jet fuel that run under major cities. There's pipelines everywhere. There's nothing really that says it is a major issue. I think the issue was trying to bulldoze that pipeline against people's wishes. And, perhaps, the initial issue was not taking time to explain what you were doing, why you were doing it and how you were going to make it safe. But just taking a shortcut through not consulting with local communities and trying to bulldoze your projects through, that was the issue. I don't think safety was the issue, I don't think environment was the issue. In terms of, you know, there's far more polluting things out there and there's far more dangerous things out there. I think it was an issue of lack of consultation and trying to overstep your power. That was what set people off. And, as I said, once they got started and once people's backs got up, there was no going back. You know, they would almost have been as well walking away. I mean, they won't make a red cent of it. They'll be lucky if they break even. It incorporated everything, it incorporated politics. And, you know, a lot of the protesters weren't even from the area. There was guys from the south of England and stuff like that. There was so much anger.

BM Yeah, for sure. And the link to the idea of becoming more aware political things, that's what I found interesting in the film. Because after the initial scare, I guess, over the danger of it, which like you say in reality maybe isn't that dangerous, but it was the idea that they then saw the political side of things. I assume it was Bertie Ahern at the time who would have been in charge? So they would have seen him and realized that his government and his administration would have been really behind the idea. And unless they were maybe already very critical of him, which they might have been, they would have really started to question things like, "well it's clear that you would much rather economic benefit over our local homes and prosperity".

PC4 I think if they would have invested a couple of million in community consultation initially, they might have avoided the whole thing. But they didn't see community consultation and community awareness raising as something they needed to invest in. That cost them 20 billion. You know, so there's a good example of what a lack of consultation at the start could cost you at the end. As the same for everything else.

BM Yeah. I was going to say when we we're talking about awareness of citizen science; in terms of how the awareness has to come first, before the activism. It's the exact same thing if you consult, if you lay out the issues and people are intrigued, then they'll go with it or against it. So yeah, that's the main issues I want to look into. The project side and then the participant side. Although I think I've maybe got the order slightly wrong, because the way I have kind of framed it is that people have an interest in nature and the environment, so they take part in entry level projects. From there their interest can then grow, not for everybody but for some select numbers, and then they'll take part in other projects and take on more responsibility and carry out more technical or scientific tasks. And then from that, not only their environmental awareness and their education of the particular marine environmental aspect they're looking at will then grow. And they'll start to question more political and governmental level kind of questions and topics that they can link to the environment and then broaden from that.

PC4 Yeah, because I don't think there actually is a hierarchy. I don't think it's necessarily a thing that you start out and move up like that. A lot of community activism is at the ground level. It's people who probably never do anything more than the occasional Coastwatch

survey or whatever. But they are, you know, they have enough of an interest in the environment to get out there and protest at something or other. But there are, of course, people who will advance and get more involved with the particular subject. Perhaps they will go on and maybe spearhead those kind of campaign. But a lot of people will stay active at a very low level. They lend their support when the issues come up. They may not drive the local topic, but they'll turn up to a meeting and get political at that level. But probably not progress beyond that.

BM Yeah, of course. Like you said earlier, some people would be happy to be at the level they are, in terms of the data they collect and the role they play. Like most things in life, there are certain people who don't want to increase their responsibility. And, in many ways, you don't necessarily need to do that, because not everybody could be the leader. Not everybody could be the personal who's driving the thing, there needs to be a hierarchy in some way or another. I definitely agree. I don't want to portray it as if what the research project is about is how citizen science can lead to everyone becoming critical of government.

PC4 Yeah, I mean, that's the other thing. Some people will never get involved in politics and policy, because they oppose the whole concept. You know, unless they're forced it by some event, they'll just focus on the science side of it. So I suppose, it's horses for courses. That's lot of people who get involved for their own reasons.

BM That's why I'd like to survey the participants themselves, to see that. I don't plan to ask them "do you now feel more politically aware?" But to really probe them on what was the driver to get them involved in the first place. And I guess it will be context dependent on the project that they were involved with. If it was in their local environment, maybe they wanted to learn more about their area and wanted to be able to protect it or so on. But if it was something, say for instance a diving survey, it's maybe a hobby of theirs so they got into it because they wanted to keep the hobby up. And it's maybe easier or cheaper to take part in projects like Seasearch. Some people have said that.

PC4 I'm not so sure, in regards to Seasearch. I think most people get involved with Seasearch because they've maybe been diving, well some of them are new divers, but a lot of the Seasearchers are interested in photography. So they might be photographing stuff and noticing stuff and ID-ing stuff themselves for a long time. And then they Seasearch as a way of using the information that they have. I suppose, giving their hobby an added value. As well as that, they might want to learn more about species ID. So it's a feedback loop. The more you learn the more you want to contribute. It works that way. It also gives you a way of forming groups, I suppose, some citizen science stuff. It's a social thing as well. Citizen science is a big social issue. You know, you could get up every day of your life and stand on a head land and survey whales on your own. And that's grand. But it's always more fun to do in group. So there is big social side to citizen science. Not all citizen science. But I'd say pretty much all citizen science has a social aspect. And some projects actually promote social events like social evenings and so on. Even with the IWDG, we've gone to a scheme of creating local groups. And we've tried to get those local groups to do social events, maybe a boat trip or whatever. Just to get like-minded people together. It's like anything social, you want to share your space with people of the same interest as you.

BM Exactly, that's the kind of area which academic writing on citizen science often seems to ignore. The social component of it and the importance of that.

PC4 Yeah, yeah. You know, in the absence of an umbrella project, you can do projects which are a pretty lonely existence. Doing plant surveys on your own, for instance. That sounds like an impression of the old Victorian scientist who went off into the hills for days on their own. So you can easily see why they might want to form a group and do it that way instead. So that would certainly be an interesting aspect to look into. The social and mental wellbeing value of citizen science.

BM Absolutely, yeah. That could showcase in itself the drivers which participants would mention regarding why they got involved. And I think if I can discuss the social side and mentality side, which would really highlight why they wanted to get involved and why they wanted to take it to the next step. For instance, of creating their own diving group or whatever it might be. And then, what they wanted to achieve from that and what they wanted to achieve from taking the next step. So that would be an interesting addition to academic writing. To fill the holes which some academics are creating in regards to the importance and potential of the practice.

PC4 Well, really I'm not so sure it is ignored anymore. I think a lot of academics have woken up to the fact that it's the only way to go for wide scale research in so many areas. And also government have woken up to that. I don't think government understand citizen science as well as they should. So, for example, they might ask too much of citizen science projects without understanding what they are. So there's no point trying to get highly accurate intertidal biodiversity and species ID from Joe public, because they're not going to be able to do it. So to be able to collect that kind of data, you need the training and the investment and the upskilling of people. But what you can ask Joe public to do is to maybe record the presence or absence of a variety of really recognisable species. Therefore you can use Joe public to do wide scale monitoring at a much lower data level, you know. You have to ensure that you're looking for a species that can't be confused. And even at that, you'll get people who will get that wrong. But that's just the nature of science. So, you know, sometimes public agencies and governments expect too much from citizen science, because they don't understand the limitations of it. They also sometimes ignore the most important step in citizen science, which is validation. So you have to be able to validate the data collected. You can collect any amount of data on any amount of stuff, but it's all rubbish unless you can validate it. Unless you can stand over it. So that's the most important step. Quite often you get people who question "why do we have to bother with that?" The point is that you can't just collect loads of data without actually validating it. It's like a biodiversity data centre sticking up a web page and saying "send us all your sightings of everything". The problem there is that unless you can validate those sightings, it's useless, completely useless data. So there's no point collecting it. Now you can say "send us all your data of everything accompanied with a photograph", at least there you've got a prospect of validation. But unless you can validate your citizen science data, it's absolutely worthless. And later on, if you do invest in an upskilling project, similar to the way we work the ferry surveys, if you're sending in a casual sighting, you need accompany that with either a really accurate description or a good picture. For it to be accepted. People often get annoyed because their sighting aren't accepted. But unless we chuck out the stuff we can't validate, then the database would just be full of rubbish. But later on, if you get involved let's say you go from doing casual sightings to constant effort sightings and then you've got a big track record of sending in really good quality data, then you will find at some point that you're on the trusted list. Now you are a trusted surveyor, so people are far more likely to accept sightings with no photo ID. There are still some species, like even for me, there are some species that I wouldn't believe if I see a reported sighting of it. Like, for instance, if I went out tomorrow

on a ship and I said “I saw a great whale in the sea”. I mean, it depends, it probably wouldn't be accepted into a database without a photo. People might believe me, but they would be very reluctant to accept it. Because there's only been two great whale records in the Atlantic. It's such a rare species that we would need a photo. And that’s the way it should be. No one's infallible, everyone makes mistakes. So yeah, I think that's an issue you come across. That people expect too much of citizen science. You have to understand it to understand its limitations, to understand how to use it and it's how you can use it and how you can’t.

BM Yeah. I think that issue of validation links really closely to the conceptual issues that I talked about of power and knowledge. Particularly in terms of how they are inextricably linked. Because in the sense of collecting data in a citizen science project, you may struggle to get validation in terms you don't have someone like yourself to back it up and say “yeah, this is what they saw and the photos prove this and so on”. And without that relation of power from an established coordinator or whoever it might be, the knowledge is not useless but it's more difficult to channel it to a level where it can be validated.

PC4 Well, I think in the era of these things [mobile phone], it's really changed the game. Because, you know, prior to smartphones, very few people carried cameras, unless they were on a dedicated survey. So it was very hard, because all you were going on is descriptions. So not everyone, I mean, even if they've seen something, they're not necessarily going to describe the salient points of the species to meet your satisfaction. But camera phones have been a real game changer and this means that everyone can go out with zero experience, go into the field or go on a boat, see something, take picture of it. Even if it’s the rarest species in the known universe, but because they have a picture of it, it's a completely valid and indisputable record. That couldn't have been done before, even with the best verbal description in the world. Because no one would believe them or they would think they looked it up in a book. But now with the wide scale availability of cameras in your hand, it just means that you now have an automatically validated data record, any time you can get a good shot of what you are reporting. That's a real game changer. And that's a big difference to citizen science even 10 or 15 years ago. So even as we keep telling people during training courses, “your worst photo on your worst day can still validate a record”. We have multiple endless examples of that. So that bit of kit has probably done more to change citizen science in the last 10, 15 years than anything else. You can’t dispute a photograph. Well, you know, you can if you suspect they haven’t taken the photograph where they said they had taken it. But by and large, you don't need to argue with a photo. So that's been a big game changer. That's taken a lot of the responsibility off the validators, in that their decision making has become easier, to a large extent. Because they have the information there to see.

BM I’ve asked a lot of people about the increase of technology in citizen science and just in general in environmental research and participative research. And by and large, obviously, it's a really key tool and it will prove to be a key tool. It already has, but of course as it develops further and different means of using it for validation measures or whatever it might be, it's going to become even more of an important and useful component of citizen science. And at the same time some other people have mentioned that the whole idea or the more general sense of technology, while it has its benefits in terms of validation, is it in some ways off-putting for some people? I think these are maybe more classical researchers who would prefer to write things down and have discussions, rather than having to use an iPhone or a smart application. The two sides of technology. I think, by and large, regarding the impact on knowledge, it is useful and it will continue to be.

PC4 Times are changing, move over grandad. No, no. But it depends. I suppose you can have people who are either scared of the technology or just don't want to change the way things are being done. I do have some concerns that, if everything becomes solely operated and logged through technological devices, it might eventually push away our participants. I mean that either they will feel like their contribution is less important than that of a virtual mapping tool or by becoming disillusioned with the sheer lack of social engagement. So I would accept that I do fear that technology could damage the real meaning of civic science, but I think that is a long way of yet. And, to be honest, the project coordinators that I know won't let that happen. But I think I would struggle to think of even the longest running researcher who doesn't see the benefit of technology. Of not having the data at hand. But there's no arguing that technology has greatly enhanced the value of citizen science data being collected. So, I mean, I think it would be hard to argue against. So you can hanker for the past, but you have to realize that the present is that. The fact is where something does really improve the data you are collecting, you would be a complete fool to ignore it. Especially, if you take Seasearch, the use of underwater photography and the wide availability of it. It used to be that if you wanted to take underwater photos, you would have had to invest thousands in an underwater camera rig. And that was way beyond the scope of most casual divers. Nowadays you can get a rig set up for a few hundred quid, maybe even cheaper. And that has just astronomically improved the dataset, because there's such a myriad of species. Previously, people would have had to describe what they saw and if you are doing that for maybe 30 species in a record, it's just a nightmare. I don't know how people did Seasearch before underwater photography came about. You know, you were taking a big leap of faith in people's ability to identify stuff. The camera has just completely altered that now. You've got these hugely accurate and verifiable data sets. So on a single dive you can indisputably verify maybe 30 species. So anyone who says that crawling around in the mud with a notebook and a slate would be better pastime, they're not thinking straight. I can certainly understand a hankering for the past. And we have lost that skill of describing species characteristics and all the terminology that went around that. Yeah, that has been lost. There's no disputing that. Of course there's a complete lack of qualified taxonomists who are able to describe and analyse taxonomy at that level, with the proper descriptions for physiological features of species. All of that is very much a dying thing. That's a big issue, because we still need them. Because it's one thing saying "I took a photo of this blobby thing and it's obviously a new species". But to get that past the scientific threshold, you need to be able to describe the blobby thing and describe the features of the blobby thing. It's the one area of science that is potentially disappearing. Taxonomy. You know, it's due to the sheer lack of taxonomists. You can see a point in time where species won't be described based on taxonomy anymore, but on genetics because it's easier to do. You know, to verify species according to its genetic code. But I completely agree, it's a great shame that the taxonomy side of the drawings and the reasons as to why this is a new species. But it's a tough one. If you find and go through old notebooks, they are incredible. And that field drawings, all of that is gone. And that's a complete shame. But I'm a bit of a mercenary now. Number one my drawings are awful and two we have so much more capacity with photographs. That's maybe just the way it's going.

BM I find of interest to hear people say they see the downside of technology, but, like you say, it's so beneficial.

PC4 But it's not a downside for the science. It's a downside for other reasons. Maybe the style of things and the fact that very few naturalists have notebooks. Yeah, there are downsides.

BM I wonder, do people question if there's more of a reliance upon taking photos of things, that, in turn, that it leads to a real loss of education? I don't agree with that, I was just wondering if you've come across that?

PC4 I don't know. For instance, at the end of a Seasearch dive or if I see something and take photos of it, I still have to go and find a textbook and identify what it is.

BM OK, of course, yeah. But I wonder on the participant side, if they just take photos of things, there will be less questioning or querying there is. But perhaps not, because people who volunteer in projects obviously have an interest and want to learn more, so they will question things.

PC4 That's the thing. I'm not sure. I'm sure there might be people out there who would just submit a photo and go "I found this, don't know what it is, good luck". But I think most people, their natural inquisitiveness is to try and identify things. Now they might identify things wrong. We do find that quite a lot. And I do it. By no means is my knowledge of marine mammals perfect. But that's how you learn and that's great. You'd have to have a terrible ego altogether to not take that criticism on board. Some people take it well and some people try to argue that they're right. You should be able to take your medicine as well as giving it out. But the point is, you still need the reference books to identify things and to refer back to. A picture in itself is no use, unless you have the knowledge or at least the capacity to go and find the information required to identify what it is. So you still need that background.

BM There's one more question, if you have time, to link it back to the political side one last time. I know we mentioned a little bit so far, the idea that government don't really fully understand citizen science. The question I was going to ask was about, well, I mean, it's quite obvious that the main thing a government in general would fear would be a critical population that would question things, maybe starting from an environmental side. Do you think that's a potential reason as to why citizen science isn't as promoted by government?

PC4 Well, the important thing to remember is that a government isn't a thing. It's not an entity. A government is the people in it. So a lot of the criticism of citizen science, perhaps within state agencies, comes from the people in it, who might have a background in academia. And in their day, 40-50 years ago, everything was done by academics and they've not really caught up with the new world, in a way, that citizen science is now a powerful force. Whereas, the younger generation, although it's not all age either, because that's quite ageist to say that. Because some of the best citizen science promoters and citizen science drivers are in their 80s or 90s. But if I was to generalize a bit, you might say that if you are academically trained when citizen science wasn't such a big thing, you might see academic science as the only way. Whereas if you come back in 30 years' time, you'll find a new generation who will be far more open to citizen science. Because that's how they've been trained. They've been trained as academics, but they've been trained in an era where academia is embracing citizen science and sees its value and is far more involved. You can't go through academia now without getting in some way involved in citizen science, unless you're locking yourself in a box. So that will change in time. I've no doubt. And once that changes government will change. Because government isn't a thing, government is people. So once the people in government change their views on these things, then government will have changed. We've already seen that. I mean, JNCC, the nature conservation committee, big government agency, using government funds, was involved in the joint station protocol

which was one of the biggest uses of citizen science for policy decisions in recent times. So that's a really strong indicator. You know, I'm sure at some stage someone sat down and went "how much is it going to cost to collect the data?" And then they went "no, we won't be spending that 10 million or 20 million that will be needed to collect that level of data". And, you know, there were people working within the agencies who saw the value, they came out, they talked to us, they asked about how it was collected, how it was validated. All of that conversation was gone through. Then, in the end, they decided that this was a data source they could use to make policy decisions. And they did. And we now have five extremely large SACs for Harbour Porpoises, based with a significant contribution forms citizen science. So that's an indication that it's changing. I mean, you know, you can see it right across the board in different areas, citizen science is becoming more of a major player. And it's important to realise how policymakers and government struggle to cope with such a lack of resources. I mean, there's a huge lack of in-house resources now to do this kind of work. They've little choice but to rely more on external agencies and citizen scientists, as budgets get cut and resources decline. I think there's little or no choice in the matter, they'll have to rely on citizen science. But to do that properly, the important thing is that they don't over rely on it and don't try to make it to do what it's not capable of doing. So they have to understand that to use it as a tool. It's a great tool, but you have to know its limitations.

BM I think that's really what I want to showcase. That there already is, and there certainly will be in future, a long term change in terms of the reliance placed upon citizen science. But it's really important, like you're saying, not to overuse it or use it for what it's not. To not use it for something that it won't be beneficial for or use it in the wrong context.

PC4 Yeah. To not use it for circumstances were it's not capable of delivering. You know, generally the kind of things it's not very useful for is highly specialized surveys. The more specialized you get the less citizen science friendly it is. Generally, citizen science isn't really of great benefit in very short-term surveys. Citizen science isn't of great benefit in very localized surveys. So there's no point doing a citizen science project to survey one bog in Fermanagh. Where's the bloody benefit in that? When you can get a highly trained researcher or consultant to do the job, but more efficiently. So the benefits of citizen science, or the better context for its use, is wide-ranged, long lived and research which is giving you a much wider temporal scale and giving you a much wider spatial scale. And the sacrifices, perhaps, is that you lose the high definition stuff. So for example, in marine mammal surveys, the tendency would be that rare species would go unidentified, because people don't know what they are. Unless they have a picture of them, rare species might go unidentified. Or, if it was a plant survey, people tend to identify lots of the common stuff that they know, but they may not recognize everything. You know, there's an art in itself in seeing what's there. You might look over at a grass patch and see grass. I might go over to a grass patch and see grass and buttercups. A trained botanist of thirty years' experience might come into a grass patch and see 10 species of grass and 20 other plant species living in amongst it, plus moss species. You know. It's the same in Seasearch dives, you know, a new Seasearch diver might come in and they might dive with someone else. And if they don't communicate during the dive and they're not showing each other stuff, one person might come in with a species list of ten species. While the other person, who has been doing it for ten years or sixteen years, might come in with a species list of 50 species. So they've both done the exact same survey, but there's a skill in spotting the different species.

BM Again, like we said, it's all about sharing. Sharing of the data and the different approaches.

PC4 Yeah. Although it's not even that, because when I go back over the ferry survey stuff I find out that some people start off poor and they get better. Which is what I expect, that with time they get better. Some people start off quite good and they stay good and get better. Some people start out shite and they stay shite. And there's no real explanation for it. Some people just never seem to improve to any significant degree. Another art in citizen science is trying to get rid of those people or, at least, alter how you use their data. While trying to maximize your use of the other data. So that's another aspect of citizen science. So, for example, in some analyses, we would have to throw out a lot of data from people. In some cases in datasets, I've had to bin data from people I just don't trust. And that's par for the course. So you can't accept everything and part of that is the validation process. So some people improve, some people are quite good to start with and just have a natural aptitude for it, some people never improve. And you have to realize that and you have to understand that when you're planning citizen science. Some people will always be duff surveyors. So you have two choices, one is to get rid of them. But you don't necessarily have to do that, as long as you are aware of that. So you can take their duff data and you can go "well it's your man's data, so we'll just minimize the use of that or we'll downgrade it to the lowest level, but still use it." Because, you know, you're still conscious of the fact that if you just get rid of them, then you're depriving the social aspect and the marine awareness aspect and maybe that's a priority as well. So, you know, you don't want to lose people and you don't want to put them off, even though you know they're not getting better. There's a balance to be had, which you wouldn't have in academia. Because if you're a duff academic, you're out the door as quick as you like. Because there is no value in keeping a duff academic in a department or whatever. So, it's a slightly different system.

BM Yeah, definitely. I suppose that's the role of the coordinator, like you're saying, to realize that and to make sure it doesn't harm the project in general.

PC4 Yeah, yeah. That's it.

BM That's great, thanks a lot for your time. I appreciate it.

Appendix 4 – Copy of online survey

Q 1 **From the list below, please select the primary project which you currently participate in?**

Seasearch (Seasearch diving)	☐
Irish Whale and Dolphin (Ferry survey)	☐
Ulster Wildlife (Sea Deep Project)	☐
Keep Northern Ireland Beautiful (Marine Litter Survey)	☐
Royal Society for the Protection of Birds (Beached Bird Survey)	☐
Cloughey and District Community Association (Beach Care Group/Coastal Erosion Group)	☐
Coastwatch Ireland (Coastwatch Survey)	☐
British Trust for Ornithology (Wetland Bird Survey)	☐

Q2 **How did you hear about this project? Tick (✓) all the relevant boxes**

Directly from project coordinators – membership newsletter, official project social media, official project website, personal email/phone call, discussion with management staff	☐
Recommendation by friend, family, colleague, community group	☐
Online – Social media, news	☐
TV, radio, newspaper, magazine	☐
Other (please state): Click or tap here to enter text.	☐

Q 3 **What type of roles do you most commonly carry out in this project? Tick (✓) the relevant boxes**

Collection of data	☐
Data analysis	☐
Dissemination of the data	☐
Designing of the project	☐
Other (please state): Click or tap here to enter text.	☐

Q 4 **Prior to the start of the project, what type of training was provided? Tick (✓) the relevant box(es)**

Instructor-led training with management/coordination staff	☐
Instructor-led training with external guest/expert speaker	☐
Web-based training	☐
Written handouts/guides	☐
Training was done while carrying out tasks	☐
None	☐
Other (please state): Click or tap here to enter text.	☐

Q 5 **I participate to learn more about nature and environmental issues**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 6 **I participate to improve my knowledge of scientific skills (i.e. research and data gathering skills)**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 7 **I participate to take more of an active and practical role in protecting the environment for future generations**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 8 **I participate to play my part in raising the awareness and knowledge of a particular environmental problem**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 9 **I participate to produce local knowledge as a way of engaging with local and national government**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 10 **I participate to engage with other volunteers and to meet new people**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 11 **If there are any further motivational reasons as to why you participate in citizen science, please state these in your own words.**

Click or tap here to enter text.

Q 12 **Following participation, I have enhanced my knowledge of nature and environmental issues**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 13 **I have enhanced my scientific skills (i.e. research and data collection skills)**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 14 **Through my participation I have actively protected the marine environment for future generations**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 15 **As a result of my participation, I have learnt that not enough attention is paid to local environmental issues**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 16 **Following participation, I believe that individuals have an important role to play in the future management of the marine environment**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 17 **I engaged with other volunteers and met new people**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know
☐	☐	☐	☐	☐	☐

Q 18 **I discuss environmental issues more often with others**

Strongly agree	Mostly Agree	Not sure	Mostly disagree	Strongly disagree	Don't Know

☐ ☐ ☐ ☐ ☐ ☐

Q 19 **If there are any further learning or social outcomes that you have received as a result of participating in citizen science, please state these in your own words.**

Click or tap here to enter text.

Q 20 **Reflecting on the project, would you recommend that anything should be done differently in the future?**

Click or tap here to enter text.

Q 21 **In general, what is the best/most effective way in which citizen science can support marine conservation? Tick (✓) one box**

Produce knowledge to lobby government	☐
Educate volunteers	☐
Raise public awareness of environmental issues	☐
Other (please state): Click or tap here to enter text.	☐

Q 22 **What gender are you? Tick (✓) one box**

Male	☐
Female	☐
Prefer not to answer	☐
Other (please state): Click or tap here to enter text.	☐

Q 23 **What age group do you fall within? Tick (✓) one box**

18 or below	☐
19-24	☐
25-34	☐
35-44	☐
45-54	☐
55-64	☐
65+	☐
Prefer not to answer	☐

Q 24 **Which of these qualifications do you have? Tick (✓) the relevant box(es)**

1-4 O Levels/CSEs/GCSEs (any grades), Entry Level, Foundation Diploma	☐
NVQ Level 1, Foundation GNVQ, Basic Skills	☐
5+ O Levels (passes)/GSEs (grade 1)/GCSEs (grades A*-C), School Certificate, 1 A level/2-3 AS levels/VCEs, Higher Diploma	☐
NVQ Level 2, Intermediate GNVQ, City and Guilds Craft, BTEC First/General Diploma, RSA Diploma	☐
Apprenticeship	☐
2+ A levels/VCEs, 4+ AS levels, Higher School Certificate, Progression/Advanced Diploma	☐
NVQ Level 3, Advanced GNVQ, City and Guilds Advanced Craft, ONC, OND, BTEC National, RSA Advanced Diploma	☐
Degree (for example BA, BSc)	☐
Higher degree (for example MA, PGCE, PhD)	☐
NVQ Level 4-5, HNC, HND, RSA Higher Diploma, BTEC Higher Level	☐
Professional qualifications (for example teaching, nursing, accountancy)	☐
Other vocational/work-related qualifications	☐
Foreign qualifications	☐
No qualifications	☐
Other (please state): Click or tap here to enter text.	

Q 25 **What best describes your current situation?**

Employed	☐
Self-employed	☐
Unemployed	☐
Student	☐
Retired	☐
Other (please state): Click or tap here to enter text.	☐
Prefer not to answer	☐

Q 26 **If employed, what is your current/last occupation?**

(Please state): Click or tap here to enter text.	
Prefer not to answer	☐

Appendix 5 – Ethical approval

Date:	21 May 2018
To:	Dr Wesley Flannery / Mr Benedict McAteer
Faculty REC Reference Number:	EPS 18_79
Full Title:	Power/knowledge in marine governance: Can citizen science change how our oceans are governed?
Decision:	**APPROVED**

Thank you for your application which was reviewed by the EPS Faculty Research Ethics Committee (Faculty REC) in accordance with the Proportionate Review process.

Your application was considered and some clarification and revisions were requested on 09 May 2018. You submitted the requested information on 18 May 2018 and this was forwarded for review.

The clarification and revisions have been reviewed and deemed satisfactory. The application has been **approved**.

Conditions of the Approval

The Faculty REC approval is subject to the following conditions:

(i) The study must be conducted in accordance with all relevant legislation. All relevant management approvals from organisations involved in the research must be obtained.

(ii) When the research involves human volunteers the study must be entered on the University's Insurance Database.

(iii) Monitoring and auditing process must be complied with including submission of annual progress reports to the Faculty REC.

It is the Chief Investigator's responsibility to ensure the study is conducted in accordance with the conditions stipulated.

Any future changes to any part of the submitted application, protocol or supporting documentation must be notified to the Committee prior to these changes taking place.

Approved documents

The documents approved by the Faculty REC are listed in the table below.

Documentation Received	Version	Date
Application Form		Received 02 May 2018
Covering Letter addressing Committee concerns		Received 09 May 2018
Research Protocol	1.0	02 May 2018
Participant Information Sheet (Interviews)	2.0	09 May 2018
Consent Form (Interviews)	2.0	09 May 2018
Interview Questions	1.0	02 May 2018
Participant Information Sheet (Questionnaire)	2.0	09 May 2018
Consent Form (Questionnaire)	2.0	09 May 2018
Questionnaire	1.0	02 May 2018

If you would like to discuss this further please contact the Research Ethics Officer, Miss Kathryn Taylor, at facultyreceps@qub.ac.uk or by telephone on 028 90972529.

Yours sincerely

PP Dr. Brendan Murtagh

Chair, EPS Faculty REC