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Can citizen science work? Perceptions of the role and utility of citizen science in a marine policy and management context

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ABSTRACT

Citizen science is often envisaged as a means to promote community participation in marine resource management. However, its potential contribution in this field is limited by stakeholders' perceptions on the value and utility of data collected in this way. This is exacerbated in the Australian context by insufficient resources to inform management regarding the country's extensive coastline. The present study employs a systems thinking methodology to map stakeholders' conceptual models of citizen science in Western Australia. This shows that a fundamental policy shift must occur in order to encompass the views of all stakeholders and converge on a common understanding of its role and utility of citizen science beyond the current science-centric discourse.

1. Introduction

An increasing number of scientists are advocating for the role of non-expert volunteers in the collection and analysis of data to help address scientific research objectives, commonly referred to as 'citizen science' [1,2]. Similarly, many managers see citizen science as a way of engaging with the general public and increasing the uptake and understanding of management actions [3,4]. Those individuals and communities that engage in citizen science often perceive it as a way of increasing their knowledge about a particular science or discipline, learning more about their local environment, and engaging in management decisions in a proactive manner; often while participating in activities that they classify as recreation [5–9]. Citizen science is not new, but there is an increasing number of papers reporting on scientific outcomes that include data collected by volunteers [10–21]. The potential utility of citizen science necessitates that volunteers, scientists, decision-makers and managers come to a shared understanding of the role it might play in policymaking and natural resource management. It has often been cited as an effective framework to address public policy and management necessities [22–26], particularly in developing countries. However the impact of citizen science in this way has rarely been reported and there is still much to be understood about the dynamics of how citizen science might influence or impact marine policy and management. Understanding the attitudes of the key stakeholders, both the participants and agencies associated with the collection and use of citizen science data, will help to bridge these knowledge gaps. We use a case study on marine based citizen science programs in Western Australia to explore perceptions about the perceived value, purpose, utility and limitations of citizen science from the perspectives of government agencies, Natural Resource Management (NRM) bodies, citizen science organizations, researchers and community groups.

Previous studies suggest that the utility and uptake of citizen science in a policy and management context reflect perceptions around data quality [5,27]. We are also interested in documenting the characteristics of citizen science programs that make them successful. Western Australia (WA) has a large coastline covering 20,781 km from the tropical north to the cool temperate zones of the south. Much of the coastline is uninhabited, with around 92% of the state's total population of 2.5 million concentrated in the South West. There are a large number of Western Australian and southern Australian faunal and floral endemic species, with the South West of the state recognized as a global biodiversity hotspot [28–30]. Management of WA's marine resources is an enormous task if only because of the sheer size of the coastline and diversity of marine environments. The Department of Fisheries (DoF) is responsible for implementing ecosystems-based fisheries management in the state's six bioregions [31] and the Department of Parks and Wildlife (DPaW) undertakes management of Western Australia's marine parks and marine megafauna [32,33]. There are a number of state and federal agencies that are responsible for maritime transport, oil spills and fisheries management in Australia's territorial waters alongside councils and other

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organizations that focus on managing marine and coastal resources at a local level [34].

1.1. Citizen science in context

There are a variety of marine and coastal citizen science programs across Western Australia which provide information to facilitate decision-making, conservation and management of marine ecosystems. These include projects involving observations, physical samples, monitoring and the provision of anecdotal data [35–38] relating to parameters including reef quality, coastal erosion, shorebird health, turtle breeding, marine mammal presence and behavior, exotic/invasive species occurrence, water quality and fish stock abundance. They differ in the degree of involvement and responsibility volunteers may have, and the scientific, societal and individual outcomes they generate (Table 1). The most common types of citizen science in WA are either Contributory style programs, whereby volunteers participate in data collection; or Co-creation and Colleague style programs, wherein volunteers establish their own citizen science projects and programs often in collaboration with an expert. The majority of reviewed citizen science programs reviewed in the literature also fall within these models [13,39].

The body of work on citizen science has largely focused on its outcomes for science [5,12–21], although this has expanded to cover aspects of well-being, sustainability learning, scientific literacy, environmental stewardship and participation in environmental democracy [6,8,41,42], There has been growing emphasis on the outcomes for society including partnerships between the public and scientists and managers [43–45], conservation and management actions [22,23,43,44] and increased public engagement in policy processes [3,41,42]. However, there still remains a large gap in our understanding of the utility of citizen science in marine policy and management contexts within Australia, despite a number of international studies [6,14,25,46]. A recent survey of nearly 200 volunteers, researchers, and managers across Australia found that 84% of respondents had used citizen science data to make management, planning or policy decisions in Australia's coastal and marine environments [40]. Conversely, the results also suggested there was a relatively low degree of engagement overall by natural resource managers and researchers in citizen science programs. We build upon these findings in this paper through exploring the perceptions that determine whether and why citizen science is used in order to facilitate a shared understanding of its role and capacity to influence marine policy and management within a systems thinking framework.

Table 1
Models of citizen science in Western Australia and their outcomes, categorised by increasing public involvement.Source: Adapted from [40].

Outcomes for science	Outcomes for individuals	Outcomes for society	Implementation and implications	Examples
Contribute: asked by scientists to collect and contribute data and/or samples				
Potential for efficient data collection at large scale with high precision and accuracy; allows for coordination of large number of volunteers, spanning wide geographic area, the collection of large datasets, early detection	Some stewardship action and behavior changes; limited role for public participants	Limited stakeholder engagement and capacity; decision-making may be slow to result	Funding dependent and cannot continue without financial (often government) assistance; training and coordination/	Earthwatch programs; Reef check; ECOCEAN; DolphinWatch; Coastal Walkabout; True Blue Swimmer Supporter; Recreational Anglers Logbook Program
Collaborate: assist scientists in developing a study and collecting and analyzing data				
Potential for efficient data collection at large scale with high data precision and accuracy; may need to choose between data collection for scientific validity and data collection for education and empowerment	Sense of stewardship, increased capacity and skills and appreciation of data collection concerns	Highlights local conservation issues and provides detailed local information	Resource intensive – volunteers participate in various tasks; researchers responsible for volunteer recruitment and retention, data analysis, interpretation and dissemination	Earthwatch Teachlive program; Reef Life Survey; MarineWATERs
Co-create: develop a study and work with input from scientists to address a question of interest or an issue of concern				
Intermediate expectations of data precision and accuracy; intermediate capacity to inform large-scale monitoring schemes	Increased science process skills (refining questions and interpreting data)	Yields more decision-making power than other types of monitoring; High degree of decision-making relevance at biogeographical scale	High to establish, low to maintain; community must have commitment to goal setting, planning and implementation; For researchers, intensive support required to assist community in goal-setting, design, training and data analysis strategies	NRM programs; Sea Rangers; Eco Divers; Albany seagrass monitoring; Rat Island Recovery Program; Conservation Council WA's Climate Change Observatories; Gondwana Link Restoration
Colleague: independently conduct research that advances knowledge in a scientific discipline				
Amateurs become the 'experts' by carrying out work that otherwise might not transpire due to lack of resources, time, skills or inclinations in professional scientific community; Interactions between citizens and scientists are likely only when findings are written and submitted for peer review and submitted for peer review and publication.	Citizen scientists develop and extend their skills and knowledge in scientific concepts and processes; Focus of investigation is of high relevance to the individual.	Allows investigations of issues where there may not otherwise be a political priority.	Research is entirely self-funded by citizen scientists.	Conservation Council WA's community driven programs (including LEAD Esperance and Albany Dredging Environment Network (ADEN)) or Kimberley Community Whale Research Project.