

LIFE ON THE LINE

Using diffusion of innovation theory to understand the adoption, spread, and co-adoption of conservation and other environmental initiatives

A thesis submitted for the degree of Doctor of Philosophy, PhD,
Diploma of Imperial College (DIC) from the
Department of Life Sciences,
Imperial College London.
June 2023

Emily-Jane Lewis-Brown
Grantham Institute, Science Solutions for a Changing Planet DTP
Imperial College London, Life Sciences
Silwood Park, Room 1.4, Buckhurst Road
Berks, SL5 7PY
e.lewis-brown17@imperial.ac.uk
ORCID: 0000-0002-2504-5411

ABSTRACT

Preserving and restoring nature is critical, and conservation initiatives must be adopted and spread effectively at unprecedented rates. However, knowing how to scale-up conservation to meet this challenge remains elusive and understudied. The factors influencing adoption and spread of behaviours and technologies in other fields are well-researched and described through diffusion of innovation theory (hereafter, diffusion theory). Diffusion theory is used to increase the adoption and spread of behaviours and technologies in wide-ranging disciplines. Therefore, this thesis applies this long-standing and well-researched theoretical lens to advance scientific understanding of the diffusion of conservation initiatives.

Firstly, I examine what characteristics of Locally Managed Marine Areas (LMMAs) in Madagascar - a community-based conservation initiative - help and hinder their adoption, using choice experiments. I then use customer satisfaction research methods to measure the likely spread of these initiatives. Next, I test for correlations between the adoption of carbon management priorities, policies, practices, and emissions over time.

The results support the application of diffusion theory to LMMAs in Madagascar, with some adaptations, as adopters were motivated more by pro-social values than typically reported in diffusion literature. However, adopters reported dissatisfaction with their LMMAs due to negative impacts that may hinder the spread of these conservation initiatives. Finally, I found that adopters of voluntary carbon offsets, co-adopted more carbon management practices than did non-adopters of VCOs, contrasting with some literature, but consistent with diffusion theory literature which describes the effectiveness of co-adopting innovations in mutually re-enforcing clusters.

This study contributes new insights into the adoption, spread, co-adoption, and outcomes of conservation and other environmental initiatives that can be used to advance both conservation science and practice to help conservation initiatives reach scale and ensure they do no harm.

Statement of Originality

This work is all my own, and all else is appropriately referenced.

Copyright Declaration

The copyright of this thesis rests with the author. Unless otherwise indicated, its contents are licensed under a Creative Commons Attribution Non Commercial 4.0 International Licence (CC BY-NC). Under this licence, you may copy and redistribute the material in any medium or format. You may also create and distribute modified versions of the work. This is on the condition that: you credit the author and do not use it, or any derivative works, for a commercial purpose. When reusing or sharing this work, ensure you make the licence terms clear to others by naming the licence and linking to the licence text. Where a work has been adapted, you should indicate that the work has been changed and describe those changes. Please seek permission from the copyright holder for uses of this work that are not included in this licence or permitted under UK Copyright Law.

Acknowledgements

I am very grateful to the people and institutes below, without whom I could not and would not have undertaken or completed this PhD.

Funders: This study was funded by the Natural Environment Research Council [grant number NE/L002515/1], and Chapters 2 and 3 received funding from Margaret A. Cargill Philanthropies via the Alliance for Conservation Evidence and Sustainability.

Academic: Greatest thanks to my supervisors Robert Ewers and Morena Mills, for your calm yet ebullient advice. I've never laughed so much in team meetings. I'd like to offer my thanks to other collaborators, with special thanks to Katrina Davis for your great support and encouragement, and to all other collaborators in this work, in alphabetic order: Jean-Noel Andrianjaka, Sachin Yuvaraj Dinesh Babu, Hope Beatty, Michael Burton, Katrina Davis, Bryony Good, Fiona Goodwin, Neil Jenkins, Noah Lewis-Brown, Jordan Louviere, Rodial Makampa, Mike Mascia, Ando Rabearisoa, Arsene Jaona Ramahalefitra, Jeannot Ramiamanana, Noel Smits Van Waesberghe, and Vero. To the participants in interviews and focus groups, survey respondents and Conservation International office staff in Madagascar Antananarivo and Diego. My thesis was also improved through revisions

recommended by my examiners and reviewers of manuscripts that I published: thank you. I give special mention to two previous colleagues who taught me so much that inspired this PhD research. They are, Phil Brooke of Compassion in World Farming who helped me learn to spot when methods and metrics fail; and Ann Finlayson of WWF who first introduced me to diffusion of innovation theory two decades ago. I am also grateful to my academic and conservation colleagues who strive to improve standards in conservation science and practice.

Pastoral: I am grateful to a number of professionals for patching me up after an accident and other challenges during my PhD. I am grateful also to Professor Nikki Gournaris and Linnea Luuppala who kindly arranged an Interruption of Studies and part-time working that made my continuation on the doctoral program possible. Thank you.

Personal: I am grateful to the following, listed as most recent first: Professor Robert Ewers, Dr. Morena Mills, UN Patron of the Ocean Lewis Pugh, Steve McIvor, Dr. Tara Garnett, Prof. Tim Jackson, Dr. Sian Prior, Chris Howe, Dr. Jonathon Gordon, and Dr. Peter Evans, who believed in me over the years and gave me jobs that fulfilled my childhood dreams. I owe my greatest gratitude and respect of course to my family: my husband, children and animals, for your fun, kindness, and for looking after me and each other while I recuperated, researched and wrote. I also offer thanks to the relatives, friends and work-mates who supported my dream to go to university and follow my passion for conservation.

Input to the research in this thesis was gratefully received as below by chapter

1: Introduction. Comments gratefully received from Morena Mills and Robert Ewers.

2: The Importance of Future Generations and Conflict Management to Adopters of Conservation Initiatives

Jordan Louvier provided advice on Best-Worst Scaling and Michael Burton provided the bloc design. Securing research permits, research assistants and field access were aided by Ando Rabinara and Jeannot Ramiamanana. Fieldwork was managed by Hope Beatty, with interviews and focus groups undertaken and translated by Jean Noel Andrianjaka, Rodial Makampa, Arsene Jaona Ramahalefitra and Vero. Comments were gratefully received from Hope Beatty, Michael Burton, Katrina Davis, Professor Jeannot, Michael Mascia, Morena Mills, Ando Rabinara and anonymous reviewers of the manuscript for publication.

3: Measuring Adopter Satisfaction with Locally Managed Marine Areas

Jordan Louvier provided advice on Best-Worst Scaling and Michael Burton provided the bloc design. Securing research permits, research assistants and field access were aided by Ando Rabinara and Jeannot Ramiamanana. Fieldwork was managed by Hope Beatty, with interviews and focus groups undertaken and translated by Jean Noel Andrianjaka, Rodial Makampa, Arsene Jaona Ramahalefitra, and Vero. Assistance with data entry and cleaning was given by Noah Lewis-Brown. Comments were gratefully received from Hope Beatty, Katrina Davis, Robert Ewers, Professor Jeannot, Michael Mascia, Morena Mills, Ando Rabinara and anonymous reviewers of the manuscript for publication.

4: Comparison of carbon management and emissions of universities who did and did not adopt voluntary carbon offsets

Data were provided by Second Nature and gathered from HESA. The survey was distributed by Fiona Goodwin to EAUC members. Assistance in acquiring additional online data was given by Noah Lewis-Brown and Sachin Yuvaraj Dinesh Babu. Comments gratefully received from Robert Ewers, Neil Jennings, Morena Mills, and anonymous reviewers of the manuscript for publication.

5: Discussion: Turning the tide. Comments and edits were gratefully received from Morena Mills and Robert Ewers.

Table of Contents

ABSTRACT	2
COPYRIGHT DECLARATION	3
ACKNOWLEDGEMENTS	3
LIST OF TABLES	9
LIST OF FIGURES.....	10
1. INTRODUCTION.....	11
1.1 THE NEED TO KNOW HOW TO INCREASE ADOPTION OF CONSERVATION INITIATIVES ETHICALLY AND EFFECTIVELY.....	11
1.2 CONSERVATION INITIATIVES, THEIR SPREAD AND OUTCOMES.....	14
1.3 FROM IMPLEMENTATION, COMPLIANCE AND ENFORCEMENT, TO ENGAGEMENT, ADOPTION AND SATISFACTION: USING DIFFUSION OF INNOVATION THEORY AS A THEORETICAL FRAMEWORK	17
1.4 RESEARCH QUESTIONS	20
1.5 CASE STUDIES	22
<i>Locally Managed Marine Areas (LMMAs).....</i>	<i>22</i>
<i>Voluntary carbon offsets (VCOs)</i>	<i>23</i>
1.6 ORIGINALITY AND CONTRIBUTION OF THIS THESIS TO CONSERVATION SCIENCE AND PRACTICE.....	23
1.7 THESIS STRUCTURE	26
2. THE IMPORTANCE OF FUTURE GENERATIONS AND CONFLICT MANAGEMENT IN THE ADOPTION OF LOCALLY MANAGED MARINE AREAS	28
ABSTRACT	28
2.1 INTRODUCTION	28
2.2 METHODS.....	30
<i>Madagascar and the study sites</i>	<i>30</i>
<i>Locally Managed Marine Areas (LMMAs).....</i>	<i>31</i>
<i>Survey.....</i>	<i>33</i>
<i>Analysis.....</i>	<i>35</i>
<i>Survey and sample.....</i>	<i>36</i>
2.3 RESULTS	36
<i>Best-Worst Scaling (BWS)</i>	<i>36</i>
<i>Adoption-decision</i>	<i>40</i>
<i>Personal perspectives.....</i>	<i>41</i>
2.4 DISCUSSION.....	41
<i>Motivations for adoption of LMMAs</i>	<i>42</i>
<i>Removing barriers to adoption of LMMAs.....</i>	<i>43</i>
<i>Limitations and recommendations for future research.....</i>	<i>44</i>
2.5 CONCLUSION	45
3. MEASURING ADOPTER SATISFACTION WITH LOCALLY MANAGED MARINE AREAS	46
ABSTRACT	46
3.1 INTRODUCTION	47
<i>Survey instrument and surveys.....</i>	<i>49</i>
<i>Importance-Performance Analysis.....</i>	<i>50</i>
<i>Opinion analysis.....</i>	<i>51</i>
3.3 RESULTS	52
<i>Importance, Performance, and their relationship through IPA</i>	<i>52</i>
<i>Opinions of LMMA outcomes, abandonment and spread.....</i>	<i>54</i>
3.4 DISCUSSION.....	58
3.5 CONCLUSION	61

4. COMPARISON OF CARBON MANAGEMENT AND EMISSIONS OF UNIVERSITIES WHO DID AND DID NOT ADOPT VOLUNTARY CARBON OFFSETS.....	62
ABSTRACT	62
4.1 INTRODUCTION	63
4.2 METHODS	67
<i>Sample strategy.....</i>	<i>67</i>
<i>Survey.....</i>	<i>68</i>
<i>Analysis.....</i>	<i>69</i>
4.3 RESULTS	70
4.4 DISCUSSION.....	79
<i>Limitations and future research.....</i>	<i>82</i>
4. 5 CONCLUSIONS	82
5. TURNING THE TIDE: THESIS DISCUSSION	83
ABSTRACT	83
5.1 SUMMARY OF RESEARCH QUESTIONS AND FINDINGS.....	84
<i>Adoption of LMMAs</i>	<i>84</i>
<i>Satisfaction with and likely spread of LMMAs</i>	<i>85</i>
<i>Co-adoption of carbon management practices and consequent emissions reductions</i>	<i>86</i>
5.2 IMPLICATIONS FOR CONSERVATION SCIENCE AND PRACTICE.....	87
<i>Diffusion of conservation initiatives</i>	<i>88</i>
<i>Methods and metrics matter</i>	<i>89</i>
<i>Raising standards</i>	<i>91</i>
RECOMMENDATIONS FOR FUTURE RESEARCH	96
5.4 CONCLUDING REMARKS	98
6. APPENDICES	99
APPENDIX 1 CHAPTER 2 AND 3 SURVEY INSTRUMENT	99
APPENDIX 2 CHAPTER 2 SUPPLEMENTARY INFORMATION.....	111
APPENDIX 3 CHAPTER 3 SUPPLEMENTARY INFORMATION.....	117
APPENDIX 4 CHAPTER 4 SURVEY AND SUPPLEMENTARY INFORMATION	124
APPENDIX 5 CHAPTER 5 SUPPLEMENTARY INFORMATION – ACRONYM GLOSSARY.....	137
APPENDIX 6 PERMISSIONS	139
APPENDIX 7 WORK UNDERTAKEN ASSOCIATED WITH THIS PHD	139
7. BIBLIOGRAPHY.....	140

List of Tables

CHAPTER 1

TABLE 1.1 Summary of research gaps, questions, chapters, and case studies

CHAPTER 2

TABLE 2.1 Attributes used in the choice experiment and abbreviation codes

TABLE 2.2 Preference scale of attributes of LMMAs

TABLE 2.3 Conditional logit model results for attributes of LMMAs

CHAPTER 3

TABLE 3.1 IPA results and gap analysis of ten attributes of LMMAs

CHAPTER 4

TABLE 4.1 Characteristics of adopters and non-adopters of VCOs

TABLE 4.2 Carbon management practices of adopters and non-adopters

TABLE 4.3 Correlations between attributes and outcomes of all respondents

List of Figures

CHAPTER 1

FIGURE 1.1 Flow diagram of the diffusion of innovations

CHAPTER 2

FIGURE 2.1 Illustration of a Locally Managed Marine Area (LMMA)

FIGURE 2.2 Best and Worst frequency count data for each LMMA attribute

FIGURE 2.3 The preference scale of LMMA attributes

FIGURE 2.4 Levels of involvement in the adoption decision by groups

CHAPTER 3

FIGURE 3.1 Importance-Performance Analysis (IPA) scale-centred plot

FIGURE 3.2 Principle Component Analysis of LMMAs

FIGURE 3.3 Performance rating of LMMAs on all attributes measured

FIGURE 3.4 Performance of LMMAs on quality of life measured through: (a) Performance ratings (%) and (b) Net Promoter Score (NPS)

CHAPTER 4

FIGURE 4.1 University carbon management plans and practices

FIGURE 4.2 Cumulative adoption of carbon offsets by universities over time

FIGURE 4.3 Attributes of adopters and non-adopters of carbon offsets

FIGURE 4.4 Carbon emissions and carbon intensity of universities studied

FIGURE 4.5 Correlations between respondents' attributes and emissions

CHAPTER 5

FIGURE 5.1 Comprehensive Conservation Framework

1. INTRODUCTION

“It is important that we learn humility, which says there was someone else before me who paid for me. My responsibility is to prepare myself so that I can pay for someone else who is yet to come.” Maya Angelou, 2008

“If you are humble, if you make people realise that you are no threat to them, then people will embrace you and they will listen to you.” Nelson Mandela, 2000

In this thesis, I aim to contribute new science that can be used to increase and improve nature conservation. For this, I investigated what can help increase the adoption (Chapter 2), spread (Chapter 3), and outcomes (Chapter 4) of conservation initiatives. Finally (Chapter 5) I synthesised my research into a new comprehensive conservation framework that can be used to increase the uptake and performance of nature conservation and improve performance, with recommendations for future research.

First, in Chapter 1, I introduce my understanding of humanity’s arrival to the point where transformational change is needed to assure preservation of the Earth and humanity. I describe the need for research to increase the adoption, spread and outcomes of conservation initiatives, the research gaps and research questions I have addressed, the case studies I researched, and the contributions I have made to science.

1.1 The need to know how to increase adoption of conservation initiatives ethically and effectively

Human development relied on the Holocene’s relatively stable, habitable climatic conditions, with productive ecosystems and cheap fossil fuels, and human well-being improved for many, but this is now at risk (Robbins Schug et al., 2023). Richer nations and sectors of society created wealth and security through exploitation and pollution of nature of lower-income people (Bennett et al., 2023), and future generations (Batres et al., 2021), which must be acknowledged to avoid perpetuating injustices (Kashwan & Ribot, 2021). Over-exploitation of nature resulted in the loss of two-thirds of ecosystem services (Kareiva & Marvier, 2012) and almost half of Earth’s biodiversity (IPBES, 2019). Now, we farm over 79

billion animals each year, mostly one species: chicken (*Gallus gallus domesticus*) (Borchers & Pieler, 2010). Despite industrial and agricultural revolutions, poverty, hunger, and suffering are widespread (Pinstrup-Andersen & Pandya-Lorch, 1998), and inequity is escalating (Jackson, 2011; Robbins Schug et al., 2023). High-consuming sectors of society have the greatest impacts on nature and possess the greatest resilience to cope with environmental change (IPCC, 2023). The poor, women, certain racial and ethnic groups, and children who have damaged Earth least, are impacted by environmental change most, and may be less able to withstand the impacts (Nagel & Lies, 2022; Bennett et al., 2023). Such social inequity may influence the probability of societal collapse and reduce resilience to environmental shocks (Robbins Schug et al., 2023).

Recent studies underline the urgency with which humanity must change course and conserve the planet's systems upon which humanity depends, particularly the climate (IPCC, 2023) and biodiversity (IPBES, 2019). Six of nine identified planetary boundaries have been transgressed, and Earth has been pushed beyond safety for humanity (Richardson et al.). Yet the need for change has been known and reported since 1962, when Rachel Carson wrote:

"The road we have long been travelling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road — the one less travelled by — offers our last, our only chance to reach a destination that assures the preservation of the earth." (Carson, 1999, p. 240).

Since Carson's seminal work of 1962, governments, scientists and civil society have tried to galvanise changes to restore nature, and advance human well-being for over five decades (UNGA, 1972; UNEP, 1992; UNFCCC, 1992; UNGA, 2015; UNEP, 2022; UNGA, 2023b). These UN agreements, sit alongside numerous other international agreements and directives, and national laws to minimise negative impacts from human activities, such as killing wildlife, damaging habitats, and releasing pollution, including greenhouse gases (e.g. see IPBES, 2019). In 2015, the Sustainable Development Goals (SDGs) were established to combine conservation and human development (UNGA, 2015). Further, principles (e.g., the precautionary and polluter pays principles) (OECD, 1972; Pike, Khan, & Amyotte, 2020; Ibanitoru, 2021) and laws, policies and practices to minimise negative impacts on people and the planet have been established (e.g., environmental impact assessment laws and requirements to reduce negative impacts and risks to as low as reasonably practicable) (EU, 2004; Burgman, 2005; EU, 2011).

Despite science, international agreements, laws, policies, principles, practices, awareness, and over US\$20 billion of investments annually in conservation (2001-2008) (Waldron et al., 2013) rising to over US\$78 to US\$90 billion recently (OECD, 2020), we continue to fail to halt or reverse the damage to Earth's natural systems upon which humanity depends (O'Brien, 2012; IPBES, 2019; IPCC, 2023). Further, the threats from pollution and climate change are increasing (Leadley et al., 2014), with climate change posing possibly the greatest threat to the wellbeing of people and conservation of wildlife globally. Failure to conserve and restore nature (including wildlife, habitats, ecosystems and the climate) is attributed partly to a lack of protected areas and other conservation initiatives to restore nature (Laffoley et al., 2019; Leclerc et al., 2020; IPCC, 2023). Additionally, feedback mechanisms and thresholds in ecosystems can amplify impacts (Reid et al., 2009; Blythe et al., 2017; Keller et al., 2018). Therefore, the precautionary principle is needed in conservation planning, particularly with climate mitigation (Steffen et al., 2015) and an increase in the uptake of conservation initiatives is targeted (CBD, 2022; UNEP, 2022; UNGA, 2023a).

However, knowledge of how to increase uptake of conservation initiatives is limited (Admiraal et al., 2017; Mills et al., 2019; Romero de Diego et al., 2021), presenting a gap in the research (research gap 1). While the policy and legal context sets ambition, accountability and a timeframe which can influence the uptake of conservation initiatives are needed (Roccliffe et al., 2014b; Gladkikh et al., 2020), and actual adoption of conservation initiatives by individuals, communities and organisations is ultimately required. Conservation choices by individuals can be influenced by several factors, including their motivations (Farmer et al., 2011; Admiraal et al., 2017). Sustaining fisheries harvests, for example, is reported to have motivated adoption of marine conservation initiatives (Govan, 2009; Jupiter et al., 2014; Ruiz-Mallén et al., 2015). Values, beliefs and cultural norms can also influence whether individuals and organisations adopt conservation initiatives. However there is conflicting literature on whether self-enhancing values or benevolent values are more important in motivating conservation (Crompton & Kasser, 2010; Farmer et al., 2011; Admiraal et al., 2017). Some authors conclude different types of values motivate conservation (Nilsson et al., 2016; Bennett et al., 2018), while others claim these different types of values compete (Crompton et al., 2010; Agrawal, Chhatre, & Gerber, 2015; Rode, Gómez-Baggethun, & Krause, 2015). However, few studies measure the weightings given to different factors influencing adoption of innovations (Mannan & Haleem, 2017). Therefore, in Chapter 2 of this thesis, I address this research gap (research gap 1) by measuring the relative influence of

different factors that influence people's decisions of whether to adopt conservation initiatives.

1.2 Conservation initiatives, their spread and outcomes

Conservation initiatives

As the terms conservation and environment can be used in differing contexts and ways, I will now outline what is included as 'conservation initiatives' in this thesis. When considering nature conservation, IUCN, UNEP, WWF, UNFAO and UNESCO set the foundational concepts of conservation as: "maintenance of essential ecological processes and life-support systems; preservation of genetic diversity; and sustainable utilization of species and ecosystems" (IUCN-UNEP-WWF, 1980). Their "World Conservation Strategy" priority issues can be summarised as: "degradation and loss of farm lands, biodiversity, soils, watersheds, oceans; climate alterations and air pollution; lack of support for conservation, narrow sectoral approaches to conservation, and lack of integration with rural development" (IUCN-UNEP-WWF, 1980). IPBES (2019) re-iterates the dependence of biodiversity on ecosystems, including the climate and vice-a-versa. For example, small increases of 1°C can radically change sea ice to open ocean, altering ecosystems, including biodiversity, which in turn changes the climate (Reid et al., 2009). Therefore, initiatives to protect or restore Earth's wildlife, ecosystems, habitats and environmental conditions, including the climate, are included and referred to hereafter as "conservation initiatives" to be comprehensive yet succinct.

Philosophical debate exists as to whether conservation initiatives should be designed to benefit people or purley for the intrinsic value of nature (Kareiva et al., 2012; Sandbrook, 2015), while others place human wellbeing and sustainable development as central to conservation, as inherently valid and to motivate adoption of pro-conservation behaviours (IPBES, 2019). Further, conservation initiatives must respect human rights, justice, equity (Bennett et al., 2019; Sauls & López Illescas, 2023) and ethics (CBD, 2011), particularly respecting indigenous peoples as local rights-holders (Hoyle, 2011; UNFAO, 2016). Whether humans are part of nature is a separate debate (Ma et al., 2021). In this thesis, initiatives addressing threats to the natural environment, including biodiversity, habitats ecosystems and climate that are integrated with rural development, human rights and equity, are also termed "conservation initiatives" and a multi-sectoral approach is adopted.

Conservation initiatives have aided recovery of some megafauna (e.g., Lamichhane et al., 2017; Whitehead & Shin, 2022), waterways (Sharma, Joshi, & Bowes, 2021), and fish populations (Di Franco et al., 2016). However, some conservation initiatives have harmed some people and nature, and greater justice in conservation is sought (Luoma, 2023). Conservation initiatives have re-located communities and rights-holders have been removed from their lands and homes, and excluded from their livelihoods, food security and sovereignty (Lamichhane et al., 2017; Rambaree, 2020; Crosman et al., 2022). This may trap rights-holders in poverty and food insecurity, and deny development opportunities.

Conservation has led to conflict within and between communities; and rules have been secured and implemented by conservation organisations, sometimes with lethal force (Dickman et al., 2020), which may perpetuate, escalate or disguise other violence. Large marine protected areas (MPAs) have been established by industrialised nations in overseas territories, limiting fishing rights of less-industrialised nations (O'Leary et al., 2018; Rambaree, 2020). MPAs have also been implemented without consent from or consultation with local rights-holders, retaining a legacy of colonialism in conservation (Smallhorn-West et al., 2023). These inequities can be compounded by sharing benefits from conservation unfairly between community members, or failure to deliver benefits promised to local rights-holders for their economies and environments, or from negative social and ecological impacts (West, Igoe, & Brockington, 2006; Oldekop et al., 2016; Bennett et al., 2023). While scientific research can not solve these and other injustices alone, trans-disciplinary science involving stakeholders and public participation (Shanableh et al., 2022) can identify multiple interacting impacts, vulnerabilities, and solutions that increase adaptive capacities, minimise harm and maximise benefits (Bennett et al., 2016; Blythe et al., 2017; Whitney et al., 2017).

Spread of conservation initiatives can be affected by how their impacts are perceived

A known implication of harmful impacts and inequities from conservation, is that they result in poor perceptions of and reduced support for conservation initiatives, and erode trust in conservation organisations (Bennett & Dearden, 2014; Saif, Keane, & Staddon, 2022). In other fields of research, it is reported that sharing negative perceptions of initiatives hinders spread of the initiatives (Ramirez et al., 2014), and misses opportunities to increase spread

through sharing of positive perceptions (Dearing, 2009; Laitinen, 2018). Aware of the importance of customer satisfaction for growth and performance of companies, companies measure customer subjective satisfaction levels frequently (Morgan & Rego, 2006; Sun & Kim, 2013). However, the perspectives of people engaging with conservation initiatives and whether they are satisfied with the outcomes is poorly understood and under-researched (Agyare et al., 2015; Sainsbury et al., 2015), presenting a gap in the research (research gap 2). Where people's perspectives are measured in conservation research, it sometimes relies on interpreting perceived increases (e.g., in material wealth) as positive perceptions or positive outcomes (Ban et al., 2019; Smallhorn-West et al., 2019). Whereas other research fields use the Global Ratings of Change Scale to measure subjective perceptions of how change is experienced as 'better, same or worse' (Kamper, Maher, & Mackay, 2009). Additionally, metrics used for conservation evaluations are proposed *a priori* in manuals (Glew, Mascia, & Pakiding, 2012; Ahmadia et al., 2015; Mascia et al., 2017; Ban et al., 2019). While others emphasise the need to measure satisfaction on metrics of most importance to those being surveyed (Woodhouse et al., 2015), and to include diverse perspectives (Gurney et al., 2021). Therefore, in Chapter 3, I used customer satisfaction research methods to evaluate the satisfaction of people engaged in and affected by conservation initiatives, and the implications for the spread of these initiatives (addressing research gap 2).

Unpredictably irrational behaviours can affect conservation outcomes

In addition to considering how to increase adoption and spread of conservation initiatives, conservation initiatives must also be effective in delivering intended outcomes (Glew et al., 2012; Ahmadia et al., 2015; Gurney & Darling, 2017; Mascia et al., 2017; Stolton, 2021). However, engaging with conservation initiatives itself can erode the effectiveness of the initiative, as human behaviour is irrational (Ariely, 2009). For example, engaging in fisheries or energy conservation can release funds that can be spent on more intensive fishing or energy-using activities which reduce or outweigh intended conservation outcomes, and these perverse outcomes must be better understood and mitigated (Chitnis et al., 2013; Larrosa, Carrasco, & Milner-Gulland, 2016). Such rebound or backfire effect can also occur after engaging in pro-environmental behaviours, if people feel 'moral license' to engage less with other pro-environmental behaviours or even act un-environmentally (Gholamzadehmir, Sparks, & Farsides, 2019). Given the importance of limiting climate change to sustaining life

on Earth (IPBES, 2019; IPCC, 2023), it is critical to know whether initiatives to reduce carbon emissions suffer these unintended rebound effects. Research in this area is nascent, but suggests rebound effects are plausible but manageable. For example, residents who were informed that their hostel offset carbon emissions showered for longer than those not informed, although this rebound effect was mitigated by providing information to residents about rebound effects (Günther et al., 2020). Similarly, purchasing, developing, learning about, or imagining carbon offsets and negative emissions technologies is claimed to cause rebound effect, e.g., by giving ‘moral license’ to undertake carbon-emitting activities and deter adoption of activities to reduce carbon emissions, called ‘mitigation deterrence’ (Canzi, 2006; Anderson, 2012; McLaren, 2020). Conversely, others claim the opposite (Reynolds, 2014), and that claims of mitigation deterrence leads to confusion that may stall climate mitigation (Jebari et al., 2021). Therefore, opposing views are published about mitigation deterrence in carbon management, but data are lacking and the topic remains under-studied (Markusson, McLaren, & Tyfield, 2018) presenting a gap in the research (research gap 3).

The implications of not understanding mitigation deterrence in carbon reduction and removals can not be over stated. Limiting global warming to 1.5°C, requires rapid and deep cuts in carbon emissions as well as carbon removal from the atmosphere, and mitigation deterrence would escalate costs and impacts (IPCC, 2018; Batres et al., 2021). Mitigation deterrence in carbon management may also increase pressure to use riskier innovations, e.g., solar radiation management which is even more controversial (Reynolds, 2022). Mitigation deterrence and other causes of rebound effects can be reduced through policy instruments (Font Vivanco, Kemp, & van der Voet, 2016) or separate targets for carbon reductions and carbon removals (Batres et al., 2021). But without research to understand mitigation deterrence in carbon management, decisions to stop climate chaos may fail. Therefore, in Chapter 4 of this thesis I undertake empirical research into the adoption of voluntary carbon offsets (VCOs) in the context of other carbon management practices and emissions to address research gap 3 of this thesis. The advantage of this approach is that empirical research strengthens decision-making (Hulpke & Fronmueller, 2021).

1.3 From Implementation, Compliance and Enforcement, to Engagement, Adoption and Satisfaction: using diffusion of innovation theory as a theoretical framework

The three research gaps identified above in the current literature in understanding the adoption, spread and outcomes of conservation initiatives presented pressing problems that could benefit from new research methods and approaches. Therefore, my research used diffusion of innovation theory (hereafter diffusion theory) as a theoretical lens with which to examine how conservation initiatives might scale-up adequately and ethically, to set humanity on a transformational path to sustainability. I selected diffusion theory for three reasons. Firstly, because diffusion theory has been effectively applied to a wide range of disciplines to increase the up-take (adoption) of innovations (new ideas, behaviours or technologies), including in agriculture (Valente & Rogers, 1995; Rogers, 2003), education (Atkinson, 2007), health (Balas & Chapman, 2018), and IT (Moore, 1991). While its application to conservation initiatives (innovations) is relatively new, it is considered applicable and provides a comprehensive framework to examine the scaling-up of conservation initiatives (e.g., Mills et al., 2019; Romero de Diego et al., 2021). Secondly, diffusion theory has a solid research foundation with thousands of research papers published over the past 70 years into factors that influence temporal and spatial spread of a wide range of innovations through social landscapes over time (Rogers, 2003). Finally, diffusion theory research and its practical use are grounded in consumer and service industries (Dearing, 2008; Balas et al., 2018). One advantage of using diffusion theory is that it reframes conservation initiatives from being ‘implemented’ on people who must ‘comply’ through ‘enforcement’, to designing conservation innovations that ‘adopters’ want to adopt and spread through their social networks (Dearing & Cox, 2018). In diffusion theory, spread of innovations is dependent on adopters being satisfied enough to share positive experiences with near peers. This can help address human rights concerns about conservation, particularly protected areas where ‘implementation, enforcement and compliance’ remain the dominant narrative in conservation science and practice (WWF, 2022; Bergseth et al., 2023).

The schematic diagram in Figure 1.1 shows the key elements of diffusion theory and includes the adoption of single innovations or clusters of similar innovations, their spread and outcomes (Rogers, 2003; Dearing, 2008; Wisdom et al., 2014). Each chapter of this thesis addresses a research gap and research questions that were examined through different aspects of diffusion theory, as indicated in Figure 1. Rogers describes three sets of characteristics that influence adoption of innovations: those of the innovation, the adopters, and the context in which the adopters and innovation interact. Innovation characteristics are classically divided into five categories: relative advantage, complexity, trialability, observability, and

compatibility (Rogers, 2003; Dearing, 2008; Mascia et al., 2018), although other characteristics and categories have been developed (Pannell et al., 2006; Wisdom et al., 2014; Kuehne, 2017). In Chapter 2, I identify the key attributes of Locally Managed Marine Areas (LMMAs) and measure their relative influence on the decision to adopt LMMAs, involving a cross-section of members of adopters in the communities involved (research gap 1).

Adopters are subdivided into five general categories based on their characteristics including education, personality, values and risk-aversion (Rogers, 2003; Kuehne, 2017). The rate of adoption ranges over time between these categories, from the first to adopt to last as follows: starting with innovators, then early adopters, early majority, late majority, to laggards last (Smith & Findeis, 2013b). Each category of adopters may be more persuaded to adopt innovations with differing types of communications, for example, innovators may respond to narratives such as: “adopting early means they will stand out from the crowd”, whereas laggards may respond to: “everyone else adopted already and you stand out by not adopting” (Smith et al., 2013b; Dearing et al., 2018). Thirdly, the social, political and technological context in which potential adopters interact with innovations can help or hinder adoption (Wejnert, 2002; Rogers, 2003; Romero de Diego et al., 2021).

As with most innovations, adoption of conservation initiatives accumulates over time initially slowly, followed by a rapid increase, which then plateaus (depicted by a slow-fast-slow, or sigmoid, curve) (Mills et al., 2019). Outcomes from adoption are anticipated to be beneficial overall (Rogers, 2003), but negative outcomes are possible and can limit innovation spread (Dearing, 2009). Therefore, I measure adopters’ perceptions of outcomes and their levels of satisfaction with their conservation initiatives in Chapter 3 as a predictor of spread through positive peer-to-peer referrals (research gap 2).

Co-adoption of clusters of inter-related innovations where adoption of one innovation triggers adoption of another can also occur and deliver intended relative advantages more efficiently (Rogers, 2003; Carmichael et al., 2021). Co-adoption of clusters of innovations can occur sequentially with cumulative or synergistic results, and/or simultaneously as depicted in Figure 1. However, trade-offs may be necessary between conservation initiatives consciously (Smith et al., 2013a) or unconsciously and adoption of one conservation initiative could reduce adoption of others, for example through mitigation deterrence (Gholamzadehmir et al., 2019). Therefore, in Chapter 4, I test whether we find co-adoption of conservation initiatives, and how that influences the results of the intended outcomes (research gap 3).

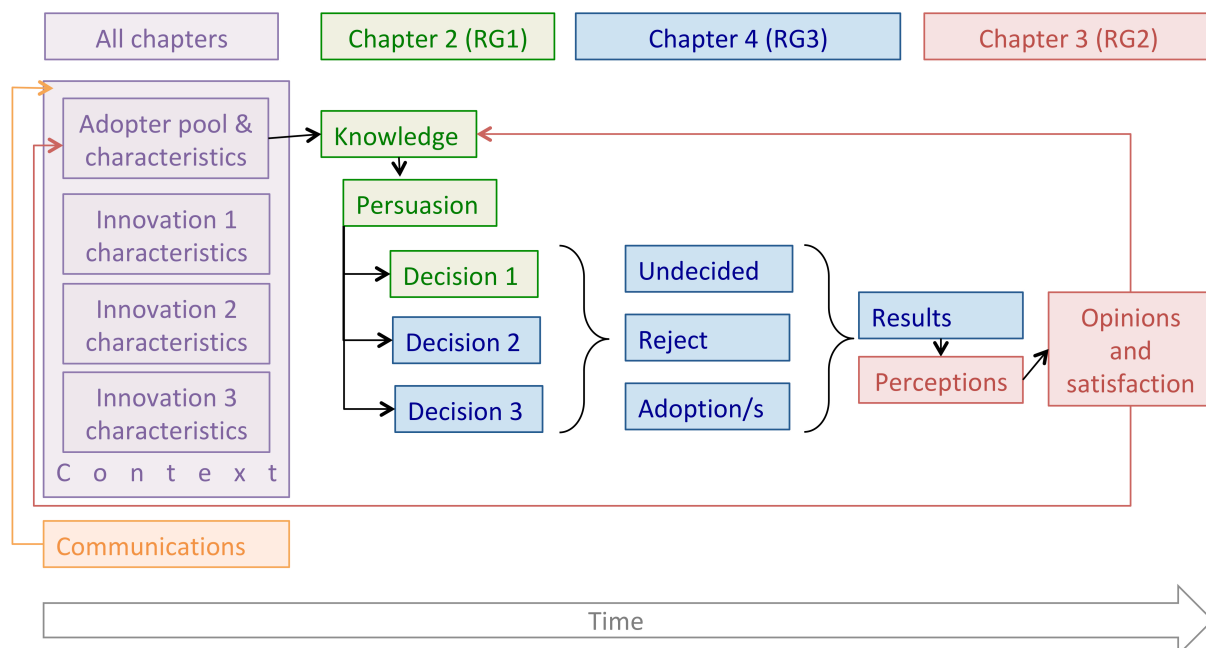


FIGURE 1.1 Simplified schematic representation of the diffusion (spread, adoption and co-adoption) of innovations over time, based on (Rogers, 2003; Dearing, 2008; Wisdom et al., 2014). Characteristics of innovations, adopters and their context (purple) and communications from existing adopters and elsewhere (orange) influence potential adopters who progress from first knowledge of an innovation, through persuasion to decisions (green), leading to adoption or non-adoption of one or more innovations and consequent results (blue). The results are perceived by adopters, leading to opinions and differing levels of satisfaction that may be communicated to the pool of potential new adopters (red).

1.4 Research questions

The purpose of this thesis is to produce scientific findings that can inform the design and management of conservation initiatives to preserve or restore the Earth's ecosystems, support the well-being of people, and minimise negative impacts on people and the planet. Specifically, I will contribute to the scientific understanding of factors influencing decisions to adopt conservation initiatives (research gap 1), satisfaction levels amongst adopters of these initiatives and implications for spread (research gap 2), and whether adoption of one initiative correlates with adoption of other initiatives and influences intended outcomes (research gap 3). Therefore, this thesis addressed the following research questions:

1. What influences the adoption of conservation initiatives?
2. Are adopters satisfied enough to recommend their conservation initiatives they are engaging with?

3. How does adoption of one initiative relate to adoption of another and its intended outcomes?

The first two questions addressed through research into the adoption (Chapter 2) and spread (Chapter 3) of Locally Managed Marine Areas (LMMAs), which are described below. The third question required a different case study where several discrete initiatives could be co-adopted in clusters or adoption of one initiative could deter adoption of another. Therefore I researched adoption of different carbon management initiatives including voluntary carbon offsets (VCOs) and the resulting outcomes in terms of carbon emissions (Chapter 4). A summary of research gaps and relevant research questions, chapters, case studies, and references to the relevant sections of diffusion theory, as described in Figure 1.1, is provided in Table 1.1 below.

TABLE 1.1 Summary of research gaps, questions, chapters, and case studies

Research Gap	Research Question	Chapter Case study	Figure 1
1. Limited knowledge of how to increase uptake of conservation initiatives	1. What influences the adoption of conservation initiatives?	Chapter 2 LMMAs	Adoption decision (green)
2. Lack of understanding and research into the perspectives of people engaging with conservation initiatives and whether they are satisfied with the outcomes	2. Are adopters satisfied enough to recommend their conservation initiatives they are engaging with?	Chapter 3 LMMAs	Spread of initiatives (red)
3. Lack of empirical research into the possibility of mitigation deterrence in carbon management	3. How does adoption of one initiative relate to adoption of another and its intended outcomes?	Chapter 4 VCOs	Results of adoption on co-adoption and outcomes (blue)

The aims and objectives of this research were as follows:

1. Understand which characteristics of conservation initiatives influence their adoption, using Locally Managed Marine Areas (LMMAs) as a case study:
 - a. Identify characteristics of LMMAs that help and hinder their adoption;
 - b. Rank characteristics of LMMAs using discrete choice experiments; and
 - c. Identify significant differences in the relative rankings of characteristics of LMMAs that influence adoption with conditional logit models.

2. Measure adopters' satisfaction with the conservation initiatives they adopted and evaluate how this might affect future adoption, using Locally Managed Marine Areas (LMMAs) as a case study:
 - a. Calculate satisfaction with LMMAs amongst adopters using Importance-Performance Analysis (IPA);
 - b. Estimate likely positive ratings by LMMA adopters using Net Promoter Scores (NPS) and qualitative data.
3. Understand whether the adoption of one climate mitigation measure impacts the adoption of others, using voluntary carbon offsets (VCOs) as a case study:
 - a. Compare adoption of carbon management measures and carbon emissions between adopters of VCOs and non-adopters and how these change over time;
 - b. Measure other possible explanatory variables for correlations between carbon management measures and emissions, and how these change over time.

Therefore, my PhD increases the scientific understanding of the diffusion of conservation initiatives and provides research that can be used to help address the mismatch between the challenges faced by people and the planet and humanity's responses. My cross-disciplinary evaluation of the findings offers new methods and insights to further advance conservation science that can be applied in conservation practice.

1.5 Case studies

Locally Managed Marine Areas (LMMAs)

Often promoted and supported by conservation NGOs, LMMAs are agreements by communities to manage their marine resources and wildlife for sustainable development and conservation (Roccliffe et al., 2014b). LMMAs are adoption as one initiative which may have several elements, such as banning destructive fishing methods, protecting certain species, and period closures to all harvesting (Roccliffe et al., 2014b). LMMAs provide a good case study to examine the adoption and spread of conservation initiatives as they have been adopted rapidly and spread widely across Pacific islands (Govan, 2009; Aswani, Albert, & Love, 2017; Jupiter et al., 2017), Madagascar (Mayol, 2013; Long et al., 2021), and are now being introduced in East Africa (Kawaka et al., 2017). Drivers for establishing LMMAs in the Pacific included restoring and sustaining fisheries and conserving wildlife for current and

future generations (Govan, 2009; Jupiter et al., 2014). However, factors influencing adoption and spread of LMMAs in Madagascar are not known. Therefore, research into the factors that influence adoption and spread of LMMAs in Madagascar is warranted. LMMAs are considered innovations in the context of diffusion of innovation theory due to their novelty in north-east Madagascar at the time of adoption. Diffusion theory originated from studying the adoption and spread of agricultural ideas and technologies (Rogers, 2003), and has been applied to the study of LMMAs elsewhere (Mascia et al., 2018; Mills et al., 2019).

Voluntary carbon offsets (VCOs)

VCOs are one tool in a suite of tools to mitigate climate change, and can be adopted alone, or co-adopted as part of a cluster of carbon mitigation measures. VCOs are certificates that confirm that one tonne of carbon dioxide (CO₂) emissions has been reduced (e.g., by replacing fossil fuels with renewable energy) or removed from the atmosphere (e.g., through afforestation) (Brouwer, Brander, & Van Beukering, 2008). Although VCOs can include nature-based projects, they are distinct from biodiversity offsets that compensate (to some extent) for environmental impacts on biodiversity (Rogers & Burton, 2017), or financial contributions towards sustainable development for people impacted by climate change, although VCOs can support biodiversity and sustainable development as co-benefits, carbon mitigation remains central to VCOs (Mitchell-Larson et al., 2020). VCOs make a good case study because their adoption, especially carbon removals offsets, is key to delivering net zero targets and net negative emissions required to increase likelihood of limiting global warming to below 1.5°C (UNFCCC, 1992; Muri, 2018; IPCC, 2023), but their adoption is claimed to reduce adoption of other carbon mitigation measures (Canzi, 2006; Anderson, 2012). Therefore, research is required urgently to examine whether adopting VCOs helps or hinders carbon management and emissions reductions.

1.6 Originality and contribution of this thesis to conservation science and practice

Theoretical framework used and extended

Through addressing several research gaps, my thesis makes important contributions to science, with implications for conservation practice. The theoretical lens I used to investigate the adoption, spread and co-adoption of conservation initiatives was diffusion of innovation theory. This theory describes the temporal and spatial diffusion of myriad innovations. I

found diffusion theory a compelling lens for developing science into the adoption, spread and co-adoption of conservation initiatives. However, I demonstrate that diffusion theory requires greater attention to pro-social values than described in current diffusion literature when applied to conservation initiatives.

Methods

Diffusion theory is applied to market-based innovations typically, therefore, my research views conservation adopters as akin to customers, rather than solely as people impacted by conservation outcomes. This fresh perspective is potentially powerful as it led to me chose methods usually confined to market research. I demonstrate that using subjective customer satisfaction research methods, rather than evaluation methods solely focused on objective impacts and outcomes, provides robust information about the opinions of the rights-holders in conservation whose opinions mattered, inherently, ethically, and for the diffusion of conservation initiatives. This resulted in new and valuable insights, with implications for conservation science, and practice. For example, adopters of conservation initiatives surveyed with customer satisfaction tools, reported the conservation initiatives brought changes to their lives that made matters worse, whereas impact evaluations elsewhere using different methods reported similar changes as ‘positive’.

The methods I selected from the literature were simple to use and effective in securing robust data. The resulting data can be easily analysed without the use of sophisticated packages or coding, and therefore are readily replicable and usable by NGOs and conservation initiative adopters themselves without need of coding skills or expensive softwares. I also provided templates in the most widely used software available, Excel, for researchers to have adequate analysis tools for future research that will provide robust and comparable results. The template provided can be used to compare results over time, between differing conservation initiatives, and between conservation initiatives and commercial innovations.

Research findings

The contributions to science from this thesis also arise from the quantitative and qualitative data gathering and analysis from rigorously designed surveys to answer research questions not previously addressed. My use of novel methods in conservation science provides new data sets that offer unique insights and perspectives to this research field. For example, I

provide measurements of the relative importance of differing factors that influenced the decision to adopt conservation initiatives, and identify how well adopters perceived conservation initiatives performed on the factors of greatest importance to them. I also reveal correlations between targets, policies, practices and outcomes of conservation initiatives, scientifically testing the popular theory of change used in conservation practice. The analysis herein provides compelling evidence that extends and in some cases contrasts with previous literature where uncertainty or assumptions prevailed. My research also provides a baseline for further research with the methods, concepts, and multi-disciplinary context provided here, and can be applied to and compared with other conservation initiatives and regions.

Implications in a multi-disciplinary context

In my discussions, I evaluate my research findings in the context of an unusually broad wealth of literature, which cross-pollinates conservation science with relevant concepts from differing disciplines such as the progressive realisation of the right to food security and nutrition. While academic research informs policy and practice, the reverse can also be true, and my work is informed by wide-reaching reviews of relevant recommendations, legal requirements, and regulations, such as the Environmental Impact Assessment Directive and polluter pays principle. This holistic approach provided results and insights that identify gaps for future research, particularly to discover how conflict can arise during conservation initiatives, and how to avoid and reconcile this unintended and unwanted outcome. I also highlight areas where conservation science and practice can develop to address some of the gaps discovered, such as how to apply the polluter pays principle and practice to reduce pollution to As Low As Reasonably Practicable in management of carbon emissions.

Solutions

In response to my findings, I propose a novel cross-disciplinary and comprehensive overarching theoretical framework for conservation. This framework provides a powerful structure to ensure that conservation science can be progressed and incorporated into conservation practice reliably with the most relevant survey questions. Incorporating the simple and replicable methods described here, with simple analyses using templates provided, it provides robust results. The data generated through the framework can be used to revise conservation initiatives as they develop, and collated with comparable data from other

initiatives for meta-analyses. The comprehensive conservation framework and associated protocols developed here, is itself a useful contribution to science.

1.7 Thesis structure

The following chapters of this thesis examine different elements of the diffusion of conservation initiatives, based on diffusion of innovation theory as shown in Figure 1. However, the chapters based on the same case studies are sequential (Chapters 2 and 3). To study co-adoption, a new case study was needed, where several similar initiatives could be adopted together or traded-off against one another (Chapter 4).

In Chapter 2, I investigate what helps and hinders adoption of a conservation initiative, Locally Managed Marine Areas (LMMAs) in north-eastern Madagascar. I derive a preference scale for LMMA attributes that adopters rank from best to worst and relate these to the local values and cultural norms that influenced the adoptions of the LMMAs studied.

In Chapter 3, I measure adopters' satisfaction with their LMMAs and assess the implications for likely spread of LMMAs in line with diffusion theory and customer satisfaction literature. I use customer satisfaction research methods, novel in conservation research but widely used in commerce to identify how to improve customer satisfaction and growth of companies, goods or services.

In Chapter 4 I investigate whether co-adoption of carbon management initiatives occurs, or whether adoption of voluntary carbon offsets (VCO) reduces adoption of other carbon management strategies (mitigation deterrence). I provide the first data-driven investigation into this potential problem.

In Chapter 5 I present a summary of my research findings and their implications for applying diffusion theory to understanding adoption, spread and co-adoption of conservation initiatives. Collating the commonalities and insights from each chapter, I explore methods and metrics for improving conservation science and practice and create a comprehensive

conservation framework. Use of this framework could standardise data gathering and conservation practices, which could advance future conservation research and practice.

Data, code, survey instruments, and statistical protocols in Excel used herein are published on Zenodo and links are provided in each chapter. Survey instruments used here and other supplementary information for each chapter are provided in appendices.

2. THE IMPORTANCE OF FUTURE GENERATIONS AND CONFLICT MANAGEMENT IN THE ADOPTION OF LOCALLY MANAGED MARINE AREAS

This chapter was published with the following reference:

Lewis-Brown, E., Beatty, H., Davis, K., Rabearisoa, A., Ramiaramanana, J., Mascia, M. B., & Mills, M. (2021). The importance of future generations and conflict management in conservation. *Conservation Science and Practice*, e488.

“First do no harm, then, try to prevent it” Hippocrates

Abstract

The need to scale-up conservation initiatives is widely accepted, but understanding how to catalyse the adoption of conservation initiatives remains elusive. To address this challenge, I used diffusion theory and Best-Worst Scaling experiments to rank the factors that influence the adoption of Locally Managed Marine Areas (LMMAs) by villages in north Madagascar. The most important driver for respondents to adopt LMMAs was the well-being of future generations, while the most important barrier was conflict within and between villages that could arise from the adoption of LMMAs. This emphasis on the benefits and costs of adoption is consistent with diffusion theory. However my results indicate that people’s intrinsic values (e.g., benevolence and peace) were more important to survey respondents in the adoption of LMMAs than is generally reported in the diffusion theory literature. Concerns about conflict from LMMAs and the distribution of livestock incentives warrant further consideration to support the adoption of this conservation initiative in the context of the Sustainable Development Goals. This study can guide future conservation research and practice to identify the “best” and “worst” attributes of LMMAs and other initiatives to increase the adoption of conservation.

2.1 Introduction

Conservation initiatives can help mitigate environmental degradation by protecting ecosystems and supporting sustainable development (Field, 2012). However, despite over US\$20 billion of investments annually in conservation (2001-2008) (Waldron et al., 2013), and international conservation targets (UNEP, 1992), conservation initiatives are not being adopted at the required rate (O’Brien, 2012). To address this misalignment, we need to better

understand what influences the adoption of effective conservation initiatives by governments, communities and individuals.

Research to date finds a variety of factors can influence people's conservation choices, such as their education (Tayouga, 2016) and capacity to engage in conservation (Bennett et al., 2018), or their motivations, including a desire to provide public goods (Farmer et al., 2011; Admiraal et al., 2017). Sustaining fisheries over the long-term has been an important motivation for adopting marine conservation initiatives (Govan, 2009; Jupiter et al., 2014; Ruiz-Mallén et al., 2015). The local policy environment can also help or hinder engagement in marine and terrestrial conservation initiatives (Roccliffe et al., 2014b; Gladkikh et al., 2020). Despite this literature base, there remains insufficient information about what drives people to adopt conservation projects (Admiraal et al., 2017) and an integrated analytical framework for conservation is only just emerging (Bennett et al., 2018). Therefore, I applied diffusion of innovation theory to examine the drivers and barriers to the adoption of conservation initiatives.

As described in Chapter 1, diffusion theory is based on seven decades of research to understand, predict and increase the adoption of innovations in different disciplines (Rogers, 2003; Atkinson, 2007; Dearing, 2009; Balas et al., 2018). In this chapter, I focussed my research on the characteristics of innovations that could influence adoption. Five key characteristics of innovations influence their adoption: relative advantage (e.g., status and income); compatibility (e.g., with values and needs); complexity of the innovation; trialability; and observability (Rogers, 2003; Wisdom et al., 2014). The importance of these characteristics can depend on their interactions with characteristics of the adopter and context (Pannell et al., 2006). For example, the relative advantage of adopting sustainable agricultural practices depends on the compatibility of the practice with adopters' beliefs and values (Pannell et al 2006) and social norms (Wisdom et al., 2014).

Values also drive people's motivations and influence behaviours (Schwartz, 1996). Most values fall within two basic axes; the first ranges from 'self-enhancing' (extrinsic) (e.g., personal success, status and wealth) to 'self-transcending' (intrinsic) values (e.g., equality, peace, and protecting the environment) and the second, bisecting axis, ranges from 'resistant to change', to 'open to change' (Schwartz, 1996). Environmental organisations often use extrinsic values (e.g., financial benefits or status) to increase adoption of conservation initiatives (Crompton et al., 2010), although several authors conclude that intrinsic rather than extrinsic values are key in conservation (Crompton et al., 2010; Farmer et al., 2011; Admiraal

et al., 2017). Further, extrinsic values, such as payments for conservation, have been found to ‘crowd-out’ intrinsic values (Crompton et al., 2010; Agrawal et al., 2015) and can reduce support for pro-environmental behaviours (Rode et al., 2015). In contrast, others (Nilsson et al., 2016; Bennett et al., 2018) find that both intrinsic and extrinsic values play a role in conservation. Therefore, empirical research is required to understand the influence of values, alongside other factors, in the adoption of conservation initiatives.

To understand what characteristics of conservation initiatives influence adoption, I studied Locally Managed Marine Areas (LMMAs), a community-based marine management tool that has spread relatively rapidly in Madagascar (Roccliffe et al., 2014b), with 178 LMMAs established since 1998 (MIHARI, 2020). I used a Best-Worst Scaling (BWS) choice experiment (Louviere, Flynn, & Marley, 2015) to rank the characteristics of LMMAs that were most influential in people’s decision to establish LMMAs in four villages in north east Madagascar. These results develop an understanding of what influences the adoption of these conservation initiatives and highlight how diffusion theory can be effectively applied to conservation. Conservation practitioners can use these results to inform the design of future conservation initiatives to improve the likelihood of adoption.

2.2 Methods

Madagascar and the study sites

Madagascar is one of the world’s poorest nations, with declining well-being fuelled by political unrest and climate shocks (Osborne & Hassine, 2016). Half of all children under five are chronically malnourished, with high levels of stunting and disease susceptibility (Bagcchi, 2020). The population is increasing rapidly, particularly along the coast where many are reliant upon the sea for food security and income (Le Manach et al., 2012). This country has a long history of combining community-based conservation with community development (Harvey et al., 2018). Establishment of LMMAs in this bio-diverse yet vulnerable region has been encouraged by the Malagasy government and NGOs (Zorzi & Rabearisoa, 2013). The four villages studied, were situated in the far north-east of Madagascar and mainly rely upon subsistence fishing with some livestock agriculture. They and are home to between 100 and 300 residents each, plus seasonal migrant fishers. Each village had a fisheries association that governed marine resources and established each village’s LMMA 10 years prior to the study. LMMA establishment in these villages was

supported by an NGO that provided training, facilitation, funding and alternative livelihoods through provision of livestock. The four villages studied and their LMMAs lay within the boundary of one large marine protected area (MPA) co-managed with the same NGO. The villages and NGO are not named for anonymity.

Locally Managed Marine Areas (LMMAs)

First developed in Pacific islands, LMMAs are based on local traditional customary tenure (Jupiter et al., 2014) which may have evolved to manage social relationships rather than to sustain fisheries (Foale et al., 2011). LMMAs in Madagascar are agreements within or between villages to sustainably manage shared traditional fishing grounds and include an associated management plan, management body, and defined marine area (Govan, 2009, MIHARI 2015). Pressure on marine resources led to the establishment of Madagascar's first LMMA in Velondriake, in the south-west, and LMMAs are now established nation-wide (Gardner et al., 2020). As with Velondriake, LMMA establishment is often supported with financial and logistical help from NGOs (Roccliffe et al., 2014b). LMMAs form around locally agreed rules to manage and restore coastal fisheries, habitats and wildlife, for example through restricting fishing gears and designating areas as temporary no-take zones for certain species (periodic closures) (Westerman & Benbow, 2013) and may include permanent no-take zones for all species (Figure 2.1). Periodic closures in LMMAs can improve fishery harvests and incomes (Benbow et al., 2014; Oliver et al., 2015; Gardner et al., 2018; Gilchrist et al., 2020). LMMAs can be managed by villages or government agencies can be involved with permits, legal recognition and enforcement.



FIGURE 2.1 A Locally Managed Marine Area (LMMA) is a community-based agreement to establish a management body and plan to manage a defined marine area, such as a village's whole traditional fishing ground. This may include rules that protect selected species and habitats and ban the use of certain gears, such as small-holed nets and poisons. Typically, LMMAs include marked areas where harvesting of any wildlife is prohibited for an agreed period (periodic closures).

In addition to restrictions on gear use and protection of habitats such as coral reefs and mangroves, LMMAs include periodic closures to all harvesting activities (Figure 2.1). These closures can be for periods of a few weeks to months (Oliver et al., 2015). Immediately after periodic closures are re-opened, harvests improve with increases in octopus sizes, fish abundance and incomes (Oliver et al., 2015). LMMA rules and periodic closures act in addition to national fisheries management rules and periods of no fishing during the windy season. For this study, LMMAs are considered an innovation (something new within this context) that is adopted when an LMMA is established.

The study

I secured agreement with an NGO to study LMMAs they had supported, and the NGO proposed six villages for the study along the north east coast of Madagascar's Diana Region. The NGO had supported each village to establish one LMMA with training, livestock (hens and goats), and financial support. Each LMMA studied was managed by the villages' fisheries associations. A professor at the University of Antananarivo secured permits for the

research and provided research assistants experienced in undertaking research survey interviews to conduct the field-based research in the local dialect.

Survey

The research and survey comprised four elements. Firstly, I used a literature review, discussions with an NGO staff in the United Kingdom and the experience of the research team to generate a list of 33 attributes of innovations that were considered to influence adoption (Appendix 2.5). The literature review spanned diffusion theory, including papers on health (Balas et al., 2018), agriculture (Pannell et al., 2006), education (Atkinson, 2007), animal welfare (Hansson & Lagerkvist, 2016), information technology (Moore, 1991) and conservation (Mascia et al., 2018). Literature on conservation outcomes, including socio-ecological impacts (Mascia et al., 2017) and conflict (Bennett et al., 2017b), were also reviewed to inform the development of the survey questions and attributes to test.

Secondly, I designed focus groups to be undertaken in the field to test the list of 33 attributes generated above and identify the most important attributes to research further. I developed the focus group protocol in line with recommendations for low literacy settings (Jakobsen, 2012).

Community leaders (village representative, council member, vice president or president), and non-leaders, fisher-folk, and non-fisher-folk were invited to attend focus groups. Four focus groups were held across two villages, with ten participants in each, with males and females grouped separately to encourage participants to speak freely. Research assistants presented the list of 33 attributes to participants one at a time and asked participants to say whether each attribute was important or not. A simple frequency count was used to identify the attributes considered most important to participants. Two attributes were changed through participant feedback, for example: “The benefit other people or the environment may have from the LMMA” was removed and replaced by focus group participants to: “The benefit to future generations” (Appendix 2.5).

The final list of 16 attributes used in the BWS choice experiment (Table 2.1) included the attributes identified by the focus groups as the most important, ensuring the five key characteristics described in diffusion theory literature were encompassed (compatibility, complexity, observability, relative advantage, and trialability) because I wanted to test the relevance of this theory (Dearing et al., 2018).

TABLE 2.1 Attributes used in the Best-Worst Scaling choice experiment and abbreviation codes

Attribute used in the BWS choice experiment	Code
The amount of money we could earn	Money
The food we could catch to eat	Food
Connections to people beyond the village	Connections
The control we would have over our marine resources	Control
The level of conflict in or beyond the village	Conflict
The monitoring and enforcement of the rules	Monitoring
How complicated or simple it seemed to establish an LMMA	Complexity
Someone in the village had seen or heard of LMMAs and their impacts	Observability
Whether LMMAs can be tested or changed to meet our needs	Trialability
The restriction of certain activities in an LMMA	Restrictions
New habits that might be needed	Habits
The health of the environment (non-target species)	Conservation
The benefit to future generations	Future generations
The pressure on the resources due to more people fishing	Resource pressure
The incentives for villages to establish and run an LMMA	Incentives
The funding and training provided by an NGO	Funding

Thirdly, I developed a survey instrument (Appendix 1) to gain information about the villagers and their opinions about the adoption of LMMAs. The survey was piloted with NGO staff in the field and the research assistants translated the key informant interview, focus group protocol and survey instrument to the locally appropriate phrasing and dialect of Malagasy. Ethics approval (2018-01438539-BEATTY-HB) was secured from Imperial College London before the focus groups and piloting of the survey.

The core of the survey was a Case 1 BWS choice experiment, which provided respondents with choices between distinct attributes from which they chose the best and worst, which was simpler than Case 2 or 3, where multiple levels or profiles of attributes are presented (Louviere et al., 2015). In this experiment, respondents were asked: “When your village was deciding whether or not to have an LMMA, which one of these four statements was thought by your village to be the best thing about an LMMA? And which one was thought by your village to be the worst thing about an LMMA?” I provided four attributes in each choice set and asked respondents to select the best and worst attribute from each set. Each attribute was

seen twice across eight choice sets in each survey, and there were eight survey versions, designed with Lighthouse Studio 9.5 (Sawtooth Software, 2017). I used multi-choice and open-box questions to assess respondents' characteristics, including their education, whether they were a village leader and their views about the LMMA. For example, I used Likert-style questions to understand respondents' level of involvement in, and agreement with, the decision to establish the LMMA.

Finally, from April to June 2018, Malagasy researchers undertook key informant interviews with an NGO representative working within the region and village chiefs to understand the context around LMMA establishment and secured permission to undertake surveys from the village chiefs. The researchers used purposive quota sampling in each village with *a priori* criteria (males, females, leaders, non-leaders, fishers, and non-fishers) to ensure a heterogeneous sample (Robinson, 2013). Snowball sampling was used to identify 30 respondents per village including respondents within each criterion, after Davis et al (2015) and Peay et al (2014). Consenting respondents were interviewed with the questionnaire survey and key informants and focus group participants were not included in the survey sample.

Analysis

Initial cleaning of the data removed respondents who were not present during the adoption decision. I also undertook a sensitivity analysis to determine the effects of incomplete responses in the choice experiment (Appendix 2.6) and eliminated responses with $\leq 60\%$ of best or worst responses completed.

Initially, I assessed the frequency with which each attribute was selected as best or worst to rank the attributes (Louviere et al., 2015). In contrast to Likert-scale questions, BWS experiments provide two sets of data, best and worst choices, indicating the drivers and barriers to adoption of LMMAs along the same perceptual preference scale (Louviere et al., 2015). The frequency with which an attribute is selected and the consistency with which respondents rate an attribute as either best or worst influences the attribute's ranking on the Best-Worst scale. To assess the significance of any differences in the rankings of attributes along the derived preference scale, I first analyzed best and worst responses separately and then combined, using conditional logit models (Hoffman & Duncan, 1988) in Stata 16. The results provide the statistical difference between each attribute and the attribute selected as the reference case. Across the sample, no respondent selected *conflict* as 'best' in the choice

experiment. Therefore, to facilitate model estimation, I included two best observations for this attribute to two randomly selected choices in the sample. I then assessed combined best and worst responses using a heteroscedastic conditional logit model (Hole, 2006), which allows for variance between the best and worst choice types. I tested whether best and worst responses could be combined through two log likelihood tests of the best and worst models compared to the combined conditional logit and heteroscedastic conditional logit models.

The attributes (Table 2.1) were compared with the set of different types of values that motivate behaviours, which are recognized across cultures (Schwartz, 1996). For example, attributes relating to conservation and conflict were considered to reflect intrinsic values of ‘universalism’; while control over resources and financial attributes indicated more extrinsic values of ‘influence and wealth’. Attributes relating to changing habits and connections to others within and beyond the village were considered to relate to respondents’ values of ‘openness to change’ as described by Schwartz (1996). Data and code can be accessed online: (<https://doi.org/10.5281/zenodo.4432076>).

Survey and sample

Local researchers undertook 25-30 surveys in each of four villages studied (n = 110), and each village had one LMMA. I report results for 88 respondents who met the criteria of being present during the decision-making process about establishing an LMMA and who completed >60% of both the best and worst responses in the BWS questions (Appendix 2.7). Two-thirds of respondents were male (68.2%) and approximately half (52.27%) considered themselves to be leaders in the community (Appendix 2.8).

2.3 Results

Best-Worst Scaling (BWS)

Attributes ranked frequently as best were not ranked frequently as worst, and vice-versa (Appendix 2.1), permitting the use of BWS frequency analysis to derive a preference scale (Louviere et al., 2015). *Conflict* and *resource pressure* were selected most frequently (89.8% and 65.3% respectively), and consistently ranked as worst when selected (100% and 93.9% respectively), resulting in highly negative rankings for these attributes. *Future generations* and *conservation* were selected respectively 60.0% and 36.9% of the times they occurred, and consistently as best (93.4 and 92.3% respectively) (Figure 2.2), resulting in strong

positive rankings. Conversely, *trialability* and *complexity* were infrequently selected when they occurred in the choice experiment (31.8% and 32.4% respectively), and were selected as best or worst in similar measure, resulting in rankings close to zero on the preference scale (Table 2.2 and 2.3, and Figures 2.2 and 2.3).

TABLE 2.2 Preference scale of attributes; derived from frequency data, weighted by the occurrence of each attribute across all surveys, such that 1.00 would indicate an attribute was chosen on every occurrence (completion rate >60%, n = 88). Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment.

Attribute	Best	Attribute	Worst	Attribute	Best-Worst
Future generations	0.56	Conservation	0.03	Future generations	0.523
Funding	0.43	Future generations	0.04	Conservation	0.313
Control	0.39	Incentives	0.05	Funding	0.301
Food	0.35	Habits	0.07	Control	0.295
Conservation	0.34	Enforcement	0.08	Food	0.267
Money	0.32	Food	0.08	Enforcement	0.233
Enforcement	0.31	Control	0.10	Incentives	0.227
Incentives	0.27	Money	0.10	Money	0.222
Habits	0.23	Funding	0.13	Habits	0.153
Trialability	0.18	Trialability	0.14	Trialability	0.034
Restrictions	0.17	Complexity	0.20	Complexity	-0.074
Connections	0.13	Observability	0.24	Observability	-0.114
Complexity	0.13	Connections	0.40	Restrictions	-0.244
Observability	0.13	Restrictions	0.41	Connections	-0.273
Resource pressure	0.04	Resource pressure	0.61	Resource pressure	-0.574
Conflict	0.01	Conflict	0.89	Conflict	-0.875

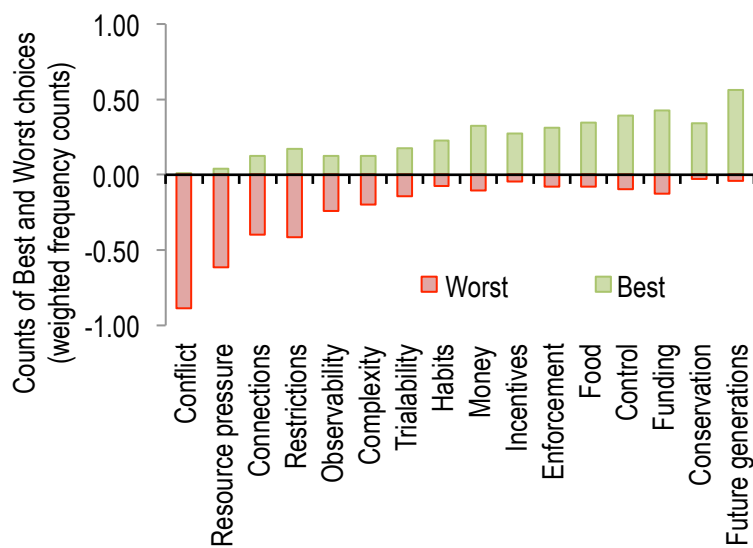


FIGURE 2.2 Best and Worst frequency count data for each attribute of LMMAs included in the Best-Worst Scaling choice experiment. Data are weighted for the occurrence of each attribute ($n = 176$), where 1.0 would indicate 100% selection as Best (green) and -1.0 would indicate 100% selection as Worst (red). Surveys completed to >60% only are included ($n = 88$).

Log likelihood ratio tests of (1) the conditional logit models of best, worst, and combined choices; and (2) the heteroscedastic conditional logit models of combined best and worst choices rejected the combined models.” Therefore, I report the results of the conditional logit model for best choices here with the most centrally ranked attribute, trialability, as the reference case (Table 2.3) as this provides a clear scale of preference of LMMA attributes.

The conditional logit model of best responses ranks the *benefits to future generations* as the best attribute of LMMAs, followed by *funding*, then *resource control*, *conservation*, *food*, *money* and *enforcement*, with significant positive rankings in relation to the reference case, *trialability* ($p < 0.01$). *Conflict* was ranked significantly worse than any other attribute ($p < 0.01$), followed by the *pressure on the resource* ($p < 0.01$). The remaining six attributes were ranked with no significant difference from the central reference attribute. Figure 2.3 illustrates the positions of the attributes on the preference scale relative to *trialability*, and the rankings are provided in detail in Appendix 2.6. Consistent with previous research (Davis, Burton, & Kragt, 2016), the ranking between the simple frequency count analysis and conditional logit model is similar.

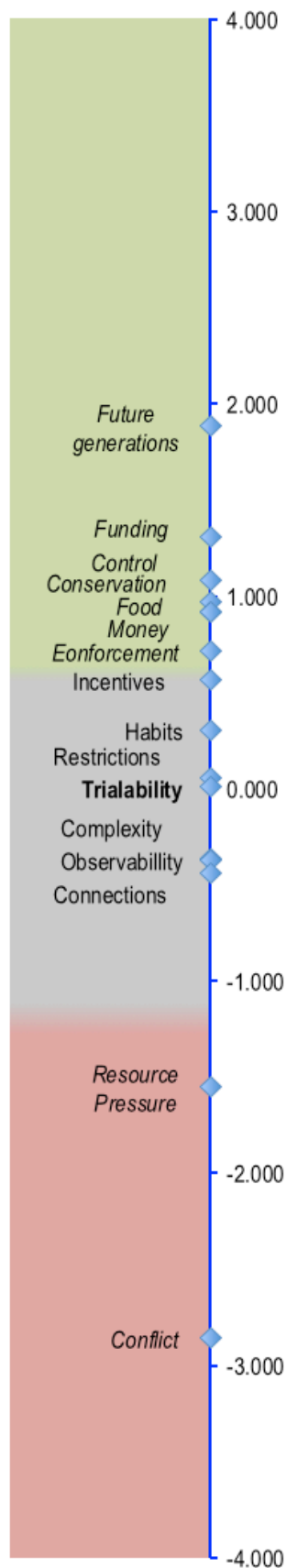


FIGURE 2.3 The preference scale of LMMA attributes, derived from the rankings (coefficients) of each attribute relative to the most centrally ranked attribute, Trialability (in bold), using a conditional logit (CLogit) model of attributes selected as Best. Italics and red shading indicates attributes with a significantly more negative coefficient relative to Trialability. Grey shading indicates attributes with no significant difference in their ranking in relation to Trialability. Green shading indicates attributes with a significantly more positive coefficient relative to Trialability ($p < 0.01$). Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment. Conflict was the strongest barrier to adoption of LMMAs and Future generations was the strongest driver of adoption of LMMAs in this study.

TABLE 2.3 Conditional logit model results for attributes selected as Best with Trialability as the reference case (completion rate > 60%, n = 88). Italicisation indicates attributes with a significant difference ($p < 0.01$) to Trialability (in bold). Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment.

BEST Attribute	Trialability as reference (completion rate >60%, n = 88)			
	Coeff- icient	p value	95% interval	Confidence
Future generations	1.878	0.000	1.391	2.366
Funding	1.305	0.000	0.814	1.796
Control	1.078	0.000	0.583	1.573
Conservation	0.967	0.000	0.464	1.470
Food	0.913	0.000	0.428	1.397
Money	0.908	0.000	0.403	1.413
Enforcement	0.711	0.006	0.199	1.222
Incentives	0.559	0.028	0.059	1.059
Habits	0.299	0.249	-0.209	0.807
Restrictions	0.047	0.864	-0.493	0.588
Trialability	0.000			
Complexity	-0.376	0.217	-0.971	0.220
Observability	-0.376	0.205	-0.957	0.205
Connections	-0.448	0.135	-1.036	0.140
Resource pressure	-1.557	0.000	-2.403	-0.712
Conflict	-2.861	0.000	-4.309	-1.413

Adoption-decision

As indicated by their response to Likert-style questions, most respondents felt very involved or somewhat involved in the adoption-decision (71.76%). However, leaders felt more involved in the adoption decision than non-leaders, on a scale of one (I was unaware of the decision) to five (I was very involved in the decision). Males and females in leadership roles scored their involvement level as four or five out of five more often (males, 85.71% and females, 90.91%) than did male or female non-leaders (males 47.83% and females 68.75%) (Figure 2.4). Overall agreement with the decision to adopt an LMMA was high (91.95%) and most respondents (91.43%) reported that a particular individual or NGO influenced this decision.

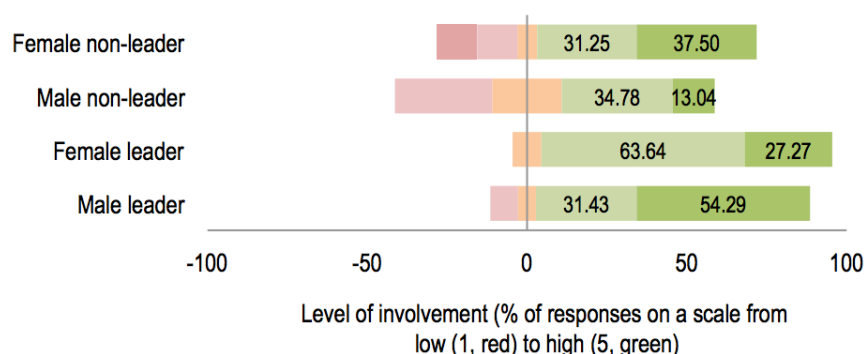


FIGURE 2.4 Involvement in the adoption decision by different groups in the sample ($n = 85$) on a scale from “I was not aware of the decision (1, dark red) to “I was very involved in the decision” (5, dark green). Most respondents (71.76%) felt involved in the decision to a level of 4 or 5 out of 5 (green). However, leaders felt more involved (85.71% and 90.91%) than non-leaders (47.83% and 68.75%).

Personal perspectives

When asked open-ended questions about the decision to establish an LMMA, many respondents said that livestock incentives (chickens and goats) were important in the decision and mentioned that they would like more goats to be provided in the future. Livestock was provided by the NGO to villages establishing LMMAs. However, several people, including fishers, reported disquiet about the way the livestock were distributed and asked that everyone in the village receive livestock incentives, not just fishers. The distribution of livestock incentives was reported as one source of conflict in villages. Participants also reported issues associated with villagers agreeing with and respecting the fishing rules, and negative impacts on village traditions caused by LMMA adoption. Pressure on the resource, which ranked as the second worst aspect of LMMAs in the conditional logit model (Table 2.3), may have reflected concerns expressed during interviews that the fishing resources had been deteriorating before the LMMA was established, which motivated them to protect the resource.

2.4 Discussion

I found the strongest positive driver for establishing Locally Managed Marine Areas (LMMAs) in the study sample was the belief that LMMAs would bring benefits to future

generations. Other positive influences included financial factors, control over resources, conservation and food availability. The strongest opinions overall however consistently related to a negative attribute associated with adoption of LMMAs: the level of conflict within or between the villages.

Motivations for adoption of LMMAs

Our findings are broadly consistent with previous research into the motivations of individuals and communities to engage in conservation, and the importance of relative advantages and disadvantages in the decision to adopt within diffusion theory (Rogers, 2003; Pannell et al., 2006; Wisdom et al., 2014; Dearing et al., 2018). However, these results emphasize the importance of intrinsic values in influencing the decision to adopt LMMAs.

The significance of avoiding conflict, of future generations, and conservation to adopters in this study indicates that self-transcendent (intrinsic) values of benevolence (i.e. preservation and enhancement of family, friends and community) and universalism (i.e. tolerance and protection of all people and for nature) (Schwartz, 1996) were of primary importance to respondents. Adopting temporary closures, primarily for the benefit of future generations seems particularly benevolent as fisheries and other harvests for food and income can be constrained during periodic closures (Hall, 2002). Keller (2009) reports that increasing future generations (the offspring of oneself and others) and providing natural resources for them is the essence of a meaningful and moral life in rural Madagascar. Bequeathing benefits to future generations was also a key motivation for establishing LMMAs in Pacific islands (Govan, 2009; Jupiter et al., 2014). Intrinsic values, including place attachment and providing a public good (Farmer et al., 2011) and having a meaningful life and moral attitudes towards others (Admiraal et al., 2017; Bennett et al., 2018), are key drivers in influencing adoption of conservation initiatives more broadly.

In contrast, the motivations for adoption discussed within diffusion theory, for example, financial rewards, risk reduction, and status (Rogers, 2003; Pannell et al., 2006; Kuehne, 2017), are underpinned by self-enhancing (extrinsic) values (Schwartz, 1996; Crompton et al., 2010; Bennett et al., 2018). Self-enhancing values are also found to be significant in this study, through the importance attributed to financial factors, resource control, and food, but of significantly less importance than two of the factors reflecting self-transcending (intrinsic) values of “benevolence” (Schwartz, 1996; Crompton et al., 2010; Bennett et al., 2018). Motivations for autonomy and control over local resources were also found to be important in

the adoption of the LMMAs studied, as found with adoption of LMMAs in the Pacific (Jupiter et al., 2014) and in community-based conservation in Latin America (Ruiz-Mallén et al., 2015).

There is less consistency, however, amongst the literature about the relative importance of financial benefits and incentives in the adoption of conservation initiatives. These have been found to be important in Payments for Ecosystem Services (Ruiz-Mallén et al., 2015) and conservation agriculture (Pannell et al., 2006), but were shown to be the least important factor influencing the adoption of conservation easements (Farmer et al., 2011). Therefore, I find that motivations that are consistent with intrinsic values played a greater role in the adoption of this conservation initiative than is typically described in diffusion theory (Rogers, 2003; Pannell et al., 2006; Wisdom et al., 2014; Kuehne, 2017).

Removing barriers to adoption of LMMAs

My study highlights the need to address the conflict that can be generated by conservation, not only because it was perceived as the most negative characteristic of LMMAs and could therefore reduce adoption of conservation initiatives, but also for ethical reasons (Bennett et al., 2017b). The cause of conflict in the villages studied was not always clear, but the distribution of livestock incentives was cited as one cause of conflict during LMMA establishment. Accounting for local perceptions of ‘fairness’ and local power dynamics that may lead to elite capture when distributing incentives are known to be important in influencing attitudes towards conservation initiatives (Randrianarison, Ramiaramanana, & Wätzold, 2017).

In line with a ‘do no harm’ approach, the United Nations (UN) encourages the use of social protection measures to protect food security during initiatives that affect food availability (CFS, 2012), and providing livestock for villages with fisheries closures in LMMAs can be considered as fulfilling this responsibility. While social protection measures (such as providing livestock) are important in conservation, the risk of causing conflict in each socio-cultural context needs to be considered (HLPE, 2012). The potential for conservation to cause conflict can often be predicted *a priori* (Matulis & Moyer, 2017; Ban et al., 2019), and the onus is on practitioners to minimise and manage conflict, with particular attention to protecting vulnerable small-scale fishers (UNFAO, 2015). This can be achieved, for example, by providing stakeholders with access to conflict management (Ostrom, 2009). UN Food and Agricultural Organisation recommend that in support of the Sustainable Development Goals

(SDGs), community-based conservation “pay particular attention to issues of gender equality, participation, transparency and accountability in decision-making and the progressive realization of the right to adequate food for all” (UNFAO, 2017).

In addition to livestock incentives being cited as a cause of conflict in this study, incentives can also prime extrinsic values and crowd-out intrinsic motivations for undertaking conservation (Crompton et al., 2010; Agrawal et al., 2015; Rode et al., 2015; Randrianarison et al., 2017). Given that intrinsic values were important to the adoption of LMMAs in this study, further research could usefully examine whether livestock can be provided in ways that prime intrinsic values and are perceived locally as equitable, for example with emphasis on protecting vulnerable community members and food security (UNFAO, 2015, 2017).

Limitations and recommendations for future research

Our study was limited to a relatively small sample size of 88 respondents across four villages in Madagascar, however, an advantage of BWS is that preference estimation is robust to small sample sizes (Lancsar et al., 2013). As with Davis et al (2015) and Peay et al (2014), I used quota and snowball sampling (Robinson, 2013) due to field constraints. This limited my interpretation of results to the sample group rather than generalizing to the whole population. Additionally, data collection was undertaken by Malagasy research assistants to minimize the influence of the presence of foreign researchers on respondents, however, respondents may have associated the researchers with environmental NGOs and responded accordingly. Fortunately, BWS has been shown to reduce biases such as acquiescence bias, and errors due to cultural or language obstacles commonly found in other survey methods (Lee, 2008).

Future research could investigate whether the patterns found here are relevant for LMMAs across Madagascar and other cultural settings internationally, and delve deeper into understanding responses associated with future generations and conflict. Although I identified that ‘benefits to future generations’ influences adoption decisions, this study does not differentiate which benefits for future generations were most important. The causes of conflict in the adoption of conservation initiatives, mechanisms to mitigate conflict, and the most effective management of livestock or other social protection measures, warrant further research. It would also be interesting to investigate whether people considering conservation initiatives linked to their livelihoods, such as in farming and fisheries, respond differently to financial motivations and incentives compared to those considering conservation initiatives that are unrelated to their livelihoods.

2.5 Conclusion

In conclusion, this research found that the most important driver for respondents when adopting LMMAs was the well-being of future generations, which relates to intrinsic values. Direct benefits to adopters that relate to extrinsic values, such as food and financial security were of less importance in the decision to adopt. The strongest barrier was conflict that arose within and between villages, at least in part relating to elite capture of livestock provided to support villages adopting LMMAs. This might be addressed through the delivery of UNFAO and High Level Panel of Experts recommendations for conservation to avoid conflict, support food security, and protect vulnerable communities.

I found that while diffusion theory can be applied to conservation initiatives it should be refined to better fit conservation initiatives as people's intrinsic values and motivations may be particularly important in applying diffusion theory to this context.

Methodologically, a benefit of the approach in this study is that a simple BWS count analysis can effectively approximate preference scales without reliance on more computationally complex estimation methods. Conservation practitioners can use BWS to easily identify the factors that are most important to potential adopters and design conservation initiatives accordingly to increase adoption

3. MEASURING ADOPTER SATISFACTION WITH LOCALLY MANAGED MARINE AREAS

This chapter has been submitted for publication as the following:

Lewis-Brown, E., Beatty, H., Davis, K., Rabearisoa, A., Ramiamanana, J., Mascia, M. B., Ewers, R.M., & Mills, M. (2023). Who Cares What People Think? Importance-Performance Analysis Shows Where Improvements Can Be Made Which May Help The Spread of Locally Managed Marine Areas. *Conservation Biology*. In review

"You can't find meaning at the end of a telescope." Brian Cox, 2023

Abstract

To protect and restore ecosystems at the speed and scale required to meet current environmental challenges, a greater understanding of how conservation initiatives spread from existing to new adopters is required. According to diffusion theory, positive adopter-to-peer communication is a powerful driver of innovation spread, while negative communications hinder innovation spread. Aware of this, businesses regularly survey customer satisfaction and respond accordingly to maximize company growth. Therefore, I used two consumer research measures commonly used by businesses, Importance-Performance Analysis which measures performance on metrics that are most important to customers, and Net Promoter Score which measures likely spread through positive referrals. I studied satisfaction amongst adopters of Locally Managed Marine Areas (LMMAs) in north-eastern Madagascar. Through this novel approach, I identified several attributes of LMMAs that adopters rated as important but as having performed poorly (funding and livestock provided by an NGO, conflict and connections with others). Attributes rated as important and performing well by adopters included restrictions on fishing in LMMAs. I also identified that non-leaders were less satisfied with aspects of their LMMAs than were village leaders. These findings can be used to improve the design and management of LMMAs, inform *a priori* impact assessments to minimize negative impacts from conservation initiatives and increase the spread of conservation initiatives. More broadly, this study presents a novel outlook for increasing adoption of conservation initiatives, by framing adopters of conservation

initiatives as akin to customers whose perceptions of conservation initiatives matter, both inherently, and because they influence future spread of conservation initiatives.

3.1 Introduction

Our coasts and oceans provide food, fuel, and fibre for billions of people, and support social and cultural well-being (Alongi, 2002; Marshall et al., 2019). These rich and diverse environments are under unprecedented pressure (particularly from destructive fishing and climate change), and require greater adoption and spread of effective conservation initiatives within a decade (IPBES, 2019; Laffoley et al., 2019; UNEP, 2019). New agreements to protect inshore waters and the high seas demonstrate the global concern for the state of the oceans and the need for greater adoption and spread of conservation initiatives (e.g., CBD, 2022; UNEP, 2022; UNGA, 2023a). However, understanding what helps or hinders conservation initiatives spread within or between communities remains limited (Mascia et al., 2018; Romero de Diego et al., 2021) and further research is needed urgently.

Processes and factors involved in the adoption and spread of innovations are described in diffusion theory (Rogers, 1983; Rogers, 2003). This informs the purposive diffusion of technologies and behaviours in a range of fields (Dearing et al., 2018) and can help catalyse conservation at larger scales (Mascia et al., 2018). Adoption flows from knowledge (for example through information from existing adopters, governments, or charities) through persuasion, to decisions to reject or adopt innovations, which lead to outcomes (Figure 1.1). Outcomes are often assumed to be positive due to pro-innovation bias (Rogers, 2003), but negative outcomes are possible and can result in adopters forming negative perceptions and consequent opinions (Rosenberg, 2001). If communicated, these opinions can influence potential new adopters and either increase or limit the spread of innovations (Dearing et al., 2018). Influence is not uniformly distributed among individuals in a social network (Mbaru & Barnes, 2017), and is strongest between near-peers, especially with negative opinions (Ramirez et al., 2014; Dearing et al., 2018). Avoiding negative opinions and communications is, therefore, the most important outcome for the spread of innovations (Dearing, 2009), and for ethical reasons (Woodhouse et al., 2015). Aware of this, businesses monitor customer satisfaction and opinions, as they correlate with consumer behaviour, company success and growth (Azzopardi & Nash, 2013; Blasberg et al., 2008; Sun & Kim, 2013).

Research evaluating conservation initiatives has focused on measuring ecological and some social outcomes (Edgar et al., 2014; Oldekop et al., 2016; Gardner, Latham, & Roccliffe, 2017; Jupiter et al., 2017), but satisfaction amongst those engaged in conservation remains poorly understood. Conservation initiatives, for example, marine protected areas (MPAs), routinely report outcomes such as increased fish abundance and biomass within MPAs (Garcia-Rubies, Hereu, & Zabala, 2013; Gilchrist et al., 2020) and surrounding seas (Kough et al., 2019). These outcomes can increase local people's fishery catches and wealth (Long, 2017; Robertson et al., 2020). While these objective metrics may contribute to understanding changes in various aspects of human well-being, people's subjective opinions of their satisfaction, relationships, and quality of life are also important for people affected, and for the spread of conservation initiatives (Loveridge et al., 2020; Mbaru et al., 2021). Monitoring and evaluation should include metrics that matter most to those impacted (Woodhouse, Lange, & Milner-Gulland, 2016), and through understanding the meaning of conservation initiatives to their adopters, we can tailor them better for spread through positive referrals.

Negative outcomes and impacts of MPAs are also reported, including conflict and displacement of local communities, raising ethical concerns (de Lange et al., 2016; Oldekop et al., 2016; Bennett et al., 2017a) and potentially reducing the success and spread of conservation initiatives. To minimize negative impacts on resource-users, conservation is shifting from top-down towards community-based initiatives (Spalding et al., 2016) and co-managed conservation (Oldekop et al., 2016). Additionally, intergovernmental, non-governmental and academic authors recommend voluntary measures to predict and minimize negative impacts of conservation on local communities for ethical reasons (Greiber, 2009, CIHR, 2010, Bennett et al., 2017a), including respect for indigenous peoples as rights-holders (Hoyle, 2011; UNFAO, 2016). However, voluntary measures are considered by some NGOs to be "not appropriate in situations where high rates of participation and compliance are required, where there is limited flexibility regarding actions and timings, or where serious social or environmental risks are involved" (RSPB, 2015). By contrast to the voluntary nature of these recommendations, legal instruments require industrial developers in many countries to predict, minimize, and compensate for negative impacts on people and their environment, with monitoring prior-, during- and post-development (Wathern, 1992; EU, 2011; Saeed et al., 2012). Similarly, research institutes require ex-ante impact assessments and ethical evaluations and monitoring, with compensation for negative impacts on those undertaking or affected by research (Brittain et al., 2020).

While evaluations at all stages of a project are intrinsically linked, this study focuses on the subjective satisfaction levels and opinions of people who previously adopted and remain engaged with conservation initiatives. For this, I studied adopters' satisfaction with Locally Managed Marine Areas (LMMAs) in four villages in north-east Madagascar. In doing so, I recognize adopters of LMMAs as the rights-holders, resource-users and custodians of their environment, and conceptualize them as akin to customers whose opinions matter inherently, and for the success and spread of conservation initiatives.

I used Importance-Performance Analysis (IPA) (Martilla & James, 1977), which identifies and prioritizes which factors of a product or service need targeting to improve adopter satisfaction (Sever, 2015). IPA is adaptable to a range of settings (Azzopardi & Nash, 2013) and is used widely in health care, education, and tourism (Abalo, Varela, & Manzano, 2007; Sever, 2015). However, IPA has been used just once in conservation evaluation, in a study of adopters' satisfaction with community management areas in Ghana (Agyare, 2015). I also calculated the Net Promoter Score (NPS), which measures customer satisfaction and predicts the growth or spread of a product, service or company (Reichheld, 2003; Laitinen, 2018; Borsci, Buckle, & Walne, 2020) and appears novel in conservation evaluation literature. NPS also identifies groups, or individuals, within communities who are dissatisfied, as addressing their concerns is key to turning adopters into promoters (Blasberg et al., 2008). I provide recommendations for how it might be possible to measure and improve adopter experiences and perceptions of a conservation initiative that may have relevance more broadly.

3.2 Methods The study site for this research was four villages in north-east Madagascar that had each established one LMMA, as described in detail in Chapter 2 above.

Survey instrument and surveys

This research uses the second half of the survey instrument used in Chapter 2 (Appendix 1) to test respondents' attitudes to and satisfaction with LMMA outcomes across a list of attributes. Attributes known to influence the adoption of innovations (Rogers, 2003; Farmer et al., 2011; Cetas & Yasue, 2017) and those typically used to evaluate marine conservation outcomes (Bennett et al., 2014; Ahmadi et al., 2015; Mascia et al., 2017; Ban et al., 2019) were included. An initial list of 35 attributes was reduced and re-worded to be locally relevant through four focus groups held in villages close to the survey sites in Madagascar. The survey had three sets of questions: 1. Best-Worst Scaling choice experiment to rank the

importance of LMMA attributes; 2. scale-based questions to rate the performance of LMMA attributes; and 3. questions about adopters' age, income, role in LMMA (leader / non-leader), livelihood, education, and opinions of LMMAs (Appendix 1).

Local researchers gained consent from respondents and surveyed 110 residents from four villages in the Malagasy dialect of Antakarana in May-June of 2018. Respondents were identified purposively to include individuals representing a range of opinions (those self-reporting as males, females, village leaders and non-leaders (Appendix 3.11). This was achieved through snowball sampling (Robinson, 2013) as used elsewhere with best-worst scaling (Davis et al., 2015) and IPA (Agyare et al., 2015). Survey responses were subject to unavoidable memory errors (Kamper et al., 2009), as the LMMAs were established 10 years before the survey. All respondents lived in the villages surveyed and most (98 %) were involved in the decision to establish their village's LMMA. Respondents who were not present during the establishment of the LMMA were excluded from analysis, as were those who failed to complete >60 % of both best and worst responses in the choice experiment. These restrictions left 88 usable surveys. Data were translated into English, and open-box questions were coded by keywords and themes.

Importance-Performance Analysis

IPA surveys typically invite respondents to rate the importance of a number of the attributes of an innovation or service on a 5, 7 or 10-point scale (Azzopardi & Nash, 2013; Lai & Hitchcock, 2015). Respondents then rate the performance of the innovation or service according to the same list of attributes. The average (mean) importance and performance scores are plotted on an IPA matrix plot with four quadrants (Azzopardi et al., 2013; Lai et al., 2015). The quadrants are categorized to indicate where action should be prioritized to optimize the balance between respondent satisfaction and resource investment. Quadrant A indicates attributes where performance is greater than importance "over-performance" i.e., savings could be made. Quadrant B indicates attributes where the innovation or service performance is similar to importance. Quadrant C indicates attributes where an innovation could be performing better, but attributes in quadrant D are the priorities for improvement.

The threshold lines between quadrants of the IPA plot can be set in different ways: 1. average (mean) of the results for data-centred plots; 2. central points of rating scales for scale-centred plots 3. performance targets, e.g., targets for outcomes pre-determined by the organization commissioning the research (Tonge & Moore, 2007).

To measure importance, I asked respondents to rank each attribute rather than rate them, a recommended refinement that provides a better measure of importance (Abalo et al., 2007). Respondents ranked attributes of LMMAs using a Case 1 Best-Worst Scaling (BWS) choice experiment (Finn & Louvier, 1992). Each survey presented eight choice sets, each with four LMMA attributes, from which respondents indicated the best and worst attributes. A total of 16 attributes were assessed, and respondents saw each attribute twice. Eight survey versions were used to balance attribute co-appearance. Scores of one were allocated to each attribute when selected as either ‘best’ or ‘worst’, and zero if they were not selected. First, I calculated importance as best minus worst, then as best plus worst. The two methods provide similar results, but I report best plus worst to simplify the IPA plot.

To measure performance, each respondent was presented with 18 scale-based questions, anchored with descriptive adjectives (Harpe, 2015). Options ranged from ‘much better’ to ‘much worse’, after the Global Rating of Change Scales (GRCS) (Kamper et al., 2009). The scale included five approximately evenly spaced categories (coded in the analysis from -2 to +2) around a neutral centre of ‘neither better nor worse’ (0) (Harpe, 2015). The central scores, therefore, indicated that if there was change, it was neither better nor worse, rather than no change occurred. As is standard in IPA and Global Ratings of Change Scales analyses, I used mean scores to measure perceptions (Fischer et al., 1999; Kamper et al., 2009; Azzopardi et al., 2013).

I plotted results for 10 attributes with both importance and performance data on a scale-centred IPA plot and extended the IPA matrix to represent rating of ‘much worse’ as negative values, adding zones E and F. Following standard IPA nomenclature, I made the following categorizations: E, improve second; F, improve first (Figure 3.1). Finally, I weighted importance scores to match the performance ratings, and undertook a gap analysis of the difference between the importance and performance scores for each attribute, to gauge overall satisfaction and predict consumer behaviour (Azzopardi & Nash, 2013).

Opinion analysis

I conducted a principle component analysis (PCA) that identifies attributes with similar response patterns (Ryan & Sterling, 2001). I limited the PCA to the ten attributes used in the IPA for consistency and to accommodate the small sample size (Reise, Waller, & Comrey, 2000). To understand the full spread of opinions captured in the survey, I analysed all 18 performance questions with descriptive analyses (Appendix1, questions 24 to 41).

To complement previous analyses which identify specific attributes for improvement to increase overall satisfaction, I also calculated the NPS, which indicates satisfaction amongst different sections of the customer community, so that their opinions can be addressed to increase the likelihood of spread (Blasberg et al., 2008). As with previous studies, I deviated from the standard NPS question (Morgan & Rego, 2006), and used the performance question: “Has the overall quality of life changed in the village?” reflecting literature recommending subjective quality of life should be surveyed (Woodhouse et al., 2016). I used a 5-point scale to identify clusters of adopters who may be promoters, passive, or detractors. I scored responses of 5 as promoters, 4 as passive and 3 or below as detractors, and calculated the NPS as the number of promoters minus the number of detractors (Laitinen, 2018). Finally, I undertook a content analysis of open-box questions (Appendix 3.8). Responses were coded and categorized into themes with minimal alteration of terms, to remain as faithful as possible to respondents’ sentiments (Graneheim, Lindgren, & Lundman, 2017).

3.3 Results

The results indicated more dissatisfaction than satisfaction with the LMMAs studied using IPA gap analysis (-0.58) and NPS (-9.31). Despite this, most respondents (98%, $n = 86$) wished to keep their LMMAs.

Importance, Performance, and their relationship through IPA

The average importance scores for each attribute were plotted against performance on a scale-centred IPA plot (Figure 3.1), which shows two attributes were perceived as important and performing well (restrictions on fishing, and control over the resource). However, four attributes were perceived to have worsened since the LMMAs were established, including the most important: ‘conflict within and between villages’. Conflict was selected almost every time it appeared in choice tables (always as worst), indicating its importance to respondents, and received a negative performance score (mean -0.90). This result places conflict in zone F (dark red) of the IPA plot (Figure 3.1) and is prioritized first for improvement. Respondents also perceived ‘funding and training’ provided to villages adopting LMMAs as important but performing poorly, with 53% of respondents rating this attribute negatively ($n = 59$).

Conversely, ‘restrictions of certain activities in an LMMA’ (e.g., temporary closures and gear restrictions) was the only attribute plotted in the ‘good work’ zone B (darker green), as this was the third most important and best performing attribute of LMMAs. The Gap

Analysis (importance minus performance) found respondents rated attributes higher on importance than performance overall (-0.58), indicating dissatisfaction with their LMMA (Table 3.1).

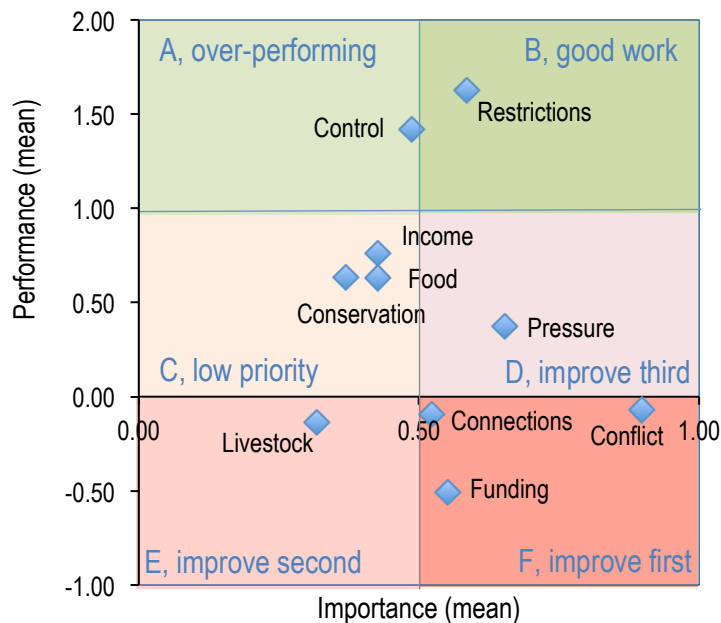


FIGURE 3.1 Importance-Performance Analysis (IPA) scale-centred matrix plot, with average importance scores plotted against average performance scores for 10 attributes of LMMAs ($n = 88$). The matrix is extended to include negative performance values for attributes that became worse since the LMMA was established, measured through scale-based questions with response options from “much better” (+2) to “much worse” (-2 truncated to -1 to fit observations). Importance (x-axis) is measured through a choice experiment (best plus worst).

TABLE 3.1 IPA results and gap analysis of the importance and performance of ten attributes of LMMAs.

Attribute used in the BWS choice experiment	Abbreviation	Importance	Performance (standard deviation)	Gap Analysis
The restriction of certain activities in an LMMA	Restrictions	1.17	1.63 (0.74)	0.46
The control we would have over our marine resources	Control	0.98	1.42 (0.96)	0.44
The amount of money we could earn	Income	0.85	0.76 (0.83)	-0.09
The health of the environment (non-target species)	Conservation	0.74	0.64 (0.94)	-0.1
The food we could catch to eat	Food	0.85	0.63 (0.81)	-0.22
The incentives for villages to establish and run an LMMA	Livestock	0.64	-0.14 (1.39)	-0.77
The pressure on the resources due to more people fishing	Pressure	1.31	0.37 (0.95)	-0.93
Connections to people beyond the village	Connections	1.05	-0.09 (1.39)	-1.14
The funding and training provided by an NGO	Funding	1.1	-0.51 (1.55)	-1.61
The level of conflict in or beyond the village	Conflict	1.8	-0.07 (1.26)	-1.86
Overall mean and gap analysis			0.464	-0.58

*Importance data are weighted to the same scale as performance, and the gap analysis is calculated as the performance score minus the importance score. With gap analysis, results, close to zero indicate similar performance and importance scores, which is considered optimal in IPA, and a negative result indicates attributes rated with lower performance than importance, which indicates focal areas for improvements.

Opinions of LMMA outcomes, abandonment and spread

Principle Component Analysis (PCA) found four clusters of attributes with similar performance ratings patterns (Figure 3.2 and Appendix 3.9). The primary component (C1, nature conservation, pressure on the resource, and food) was coded ‘natural resources’. The second component (C2, livestock and funding provided to villages establishing LMMAs) was coded ‘NGO support’. The third component (C3, fishing restrictions, incomes and control over decisions) was coded ‘self-determination’, and C4 (conflict and connections with other people) was coded ‘relationships’. Attributes in C2 (NGO support) and C4 (relationships) required greatest improvement and received negative mean performance ratings, whereas C1

(natural resources) and C3 (independence) received more positive ratings (Figure 3.2 and Appendix 3.9).

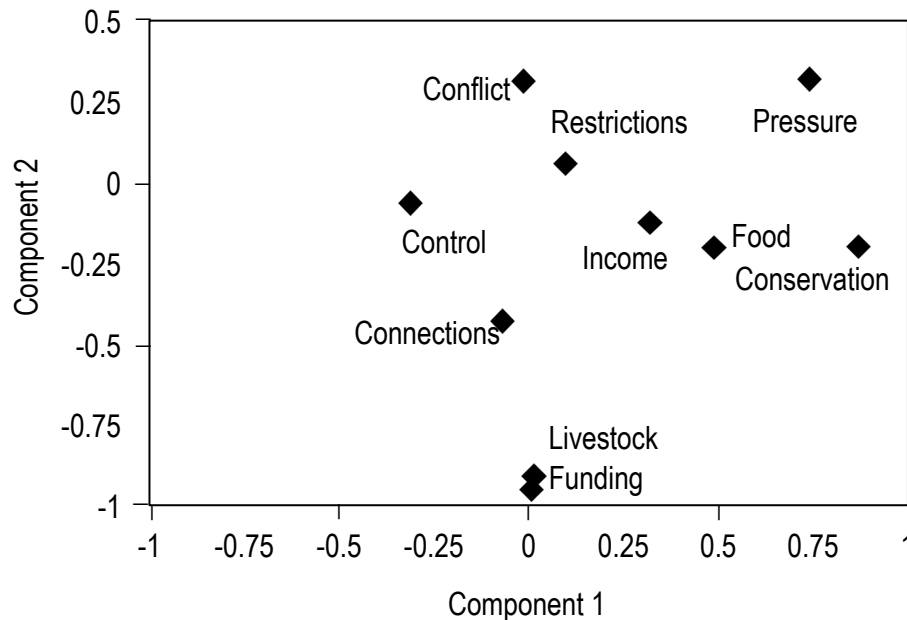


FIGURE 3.2 Principle Component Analysis of Locally Managed Marine Areas (LMMAs) performance ratings by respondents on scale-based questions from “much better (+2) to “much worse (-2) for ten attributes ($n = 86$). C1 (comprised of livestock and funding) explained 28.84% of variance and C2 (comprised of pressure, conservation and food) explained 20.66% of variance. Two further components were discovered: C3 (comprised of control, restrictions and incomes) explained 14.79% of variance, and C4 (comprised of conflict and connections) explained 11.61% of variance.

In total, respondents rated performance of LMMAs on 18 attributes: 13 of which were rated positively and five negatively based on mean rating scores on the scale from -2 (“much worse”) to +2 (“much better”) (Figure 3.3), and the mean of means was positive (0.51). The most negatively performing attribute was ‘village traditions and customs’ since establishing the LMMA, with 65% of respondents rating traditions as much weaker since establishing LMMAs (mode -2, median -2, mean -1.07, $n = 83$). This was corroborated in open box questions, for example: *“I don't know why there is this disrespect of our traditions.”* Likewise, funding was rated negatively, along with livestock, connections to others, and conflict. The remaining 13 attributes were rated positively on average, particularly the restrictions on fishing and control over resources. When ratings from leader and non-leader respondents were compared, large areas of consensus appeared. However, leaders ($n = 46$)

rated LMMA performance significantly more positively than did non-leaders ($n = 40$) on two attributes: funding (Fisher's Exact test used as one cell was $n = <5$, $p = 0.002$, $n = 86$) and traditions (Fisher's Exact test, $p = 0.008$, $n = 83$) (Appendix 3.5).

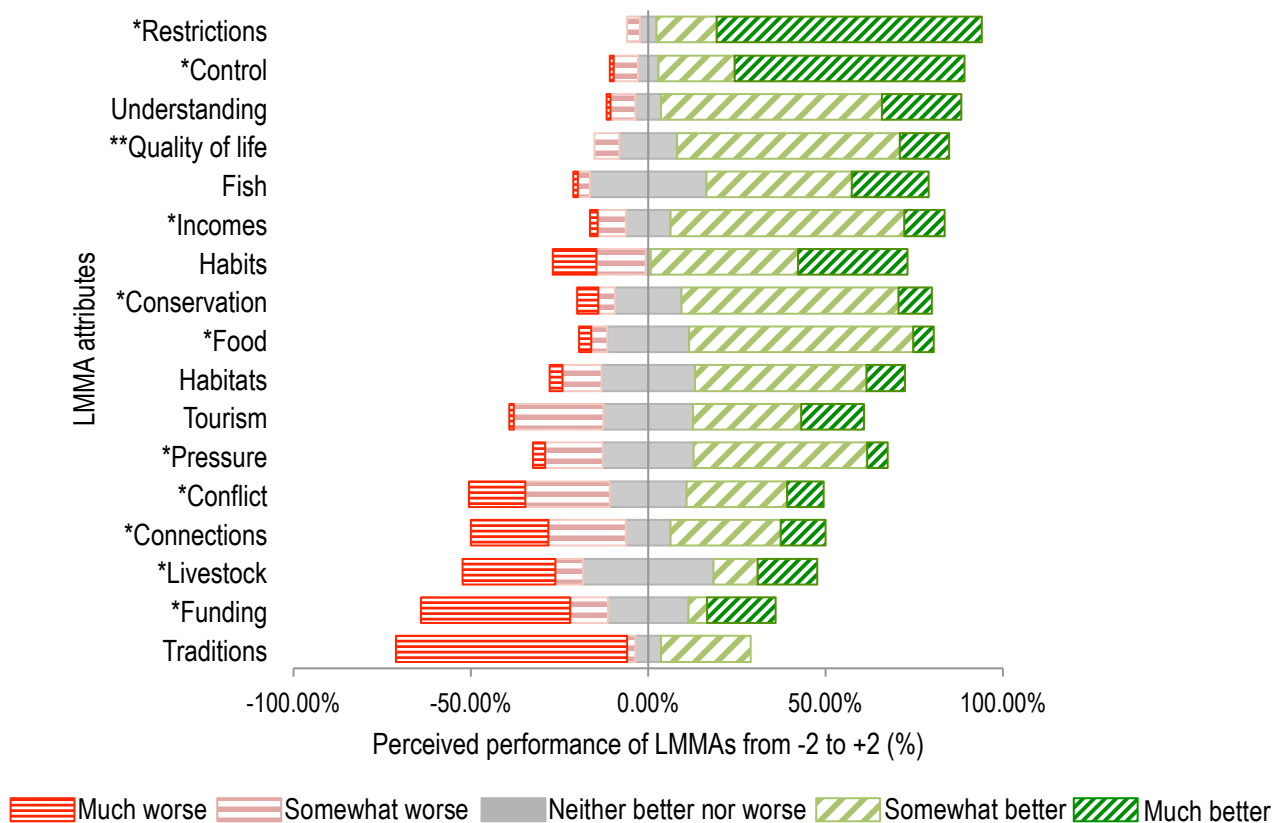
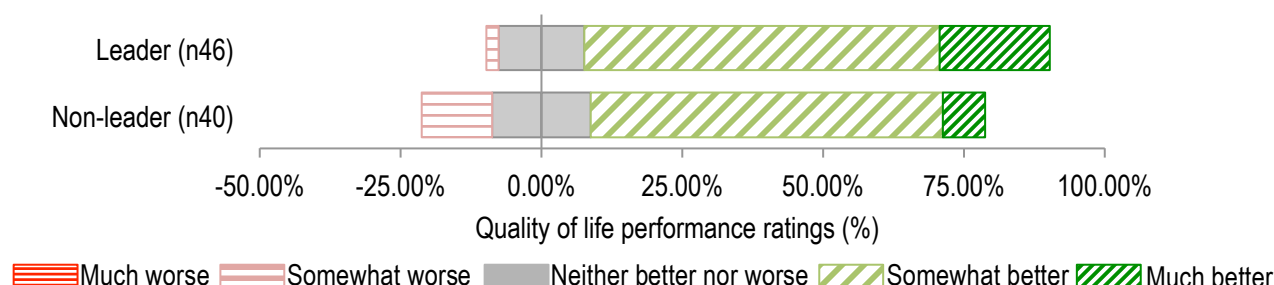


FIGURE 3.3 Performance rating of Locally Managed Marine Areas (LMMAs), showing the percentage of responses for each question per category. The five categories from left to right indicate five performance ratings from 'Much worse' to 'Much better' ($n = 88$). *denotes attributes used in the IPA and ** denotes attribute used for the NPS.

Considering adopters' perceptions of changes to their quality of life since establishing LMMAs, the mean performance rating was positive (mean = 0.84) (Appendix 3.4), with no significant difference between village leaders ($n = 46$, mean = 1.0) and non-leaders ($n = 40$, mean = 0.65) (Fisher's Exact test, $p = 0.5$) (Figure 3.4a, and Appendix 3.5, 6). However, the NPS (Figure 3.4b) results were negative (NPS -9.31, $n = 88$), as this metric discards 'somewhat better' responses as 'passive' (62.79 % of responses) and calculates the percentage of promoters (13.95 %) minus detractors (23.26 %). The NPS differed between village leaders, who were primarily promoters (NPS +2, $n = 46$), and non-leaders, who were

primarily detractors (NPS -22, $n = 40$). Similarly, the NPS differed between villages (Appendix 3.7), and village 2 was the strongest detractor (NPS -39, $n = 23$).

(a)



(b)

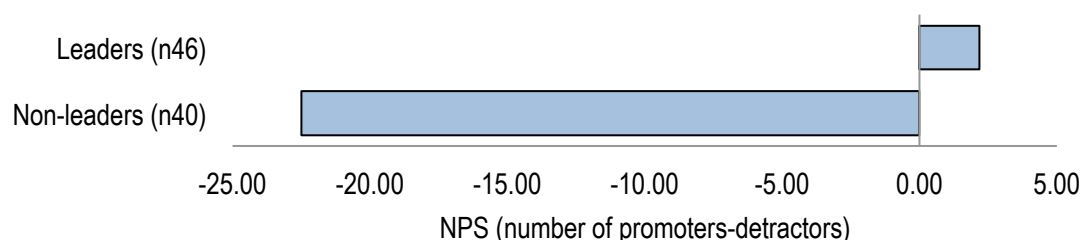


FIGURE 3.4 Performance of Locally Managed Marine Areas (LMMAs) on quality of life data presented as (a) Performance ratings (%) on a 5-point Likert-style scale from “Much worse” through “Neither better nor worse” to “Much better”. No respondents rated their quality of life as becoming “Much worse” since the LMMA was adopted, so the categories shown range from “Somewhat worse” to “Much Better”. (b) Net Promoter Score (NPS) (promoters minus detractors) ($n = 86$).

When asked whether respondents would like to keep their LMMA, almost all respondents (98%) reported they wished to keep their LMMA. When asked to explain why, four main reasons were mentioned (Appendix 3.8): ‘to protect the sea and resources’ (41 %); ‘increase catches’ (15 %); ‘for current benefits’ (16 %) and ‘for future generations’ (10 %). For example, one respondent commented: *“With no LMMA the people are poor, but with the LMMA, the people are no longer in poverty”* and *“You can see lots of benefits and it develops your way of living.”* However, 18 % of respondents expressed discontent with the LMMA management, with 9 respondents (including leaders and fishers) citing unequal distribution of livestock incentives as problematic; stating that everyone in the village should benefit, not just fishers. Two respondents (from village 2) did not wish to keep their LMMA and explained that: *“When they share something, some of us don’t benefit”* and *“I do not want the continuation of the LMMA, it has created lots of conflicts.”* Some respondents

volunteered that they wished for other villages to join their LMMA, and one wished for other villages to establish LMMAs. Several respondents mentioned LMMAs had spread between villages through exchange visits and peer communication, for example, a respondent (in village 2) commented: “*We have seen the success of [another village with an LMMA], so that convinced us.*”

When asked to compare MPAs to LMMAs, most of those who commented preferred LMMAs to MPAs (95 %). Respondents commented that they preferred LMMAs because LMMAs were local and protected their resources, also respondents felt informed, a sense of ownership, and control over rules. The near by MPA was viewed negatively because it was not helping local people and respondents expressed mistrust of the MPA.

3.4 Discussion

We measured satisfaction with LMMA outcomes amongst adopters in north-east Madagascar using established satisfaction research methods from consumer research, IPA (Martilla et al., 1977) and NPS (Reichheld, 2003). Most outcomes need improving to increase satisfaction amongst adopters, including the impacts on traditions, conflict and connections; and the impacts of the funding and livestock provided by the NGO partner. These are not necessarily independent as the cause of conflict was linked to the distribution of benefits as well as weakening of traditions and customs. Interestingly, although the respondents expressed discontent with the LMMA, they also expressed the wish to keep it. This research can be used to increase satisfaction with and likely spread of LMMAs and other conservation initiatives, and help identify negative impacts of conservation on communities for ethical conduct (CBD, 2011).

High levels of satisfaction were reported in the IPA for two LMMA attributes: ‘restrictions on fishing’ and ‘control over resources’. Positive perceptions of fishery restrictions were surprising as fisher-folk are considered resistant to fishery restrictions (Sanchirico et al., 2006; Suuronen, Jounela, & Tschernij, 2010). However, looking across the results, ‘restrictions on fishing’ clustered with ‘control over the resource’ in the component ‘self-determination’. Also, control over LMMA rules and fishing, were cited by respondents as reasons for preferring LMMAs to the local MPA. By contrast, MPAs weaken local governance and tenure (Sowman & Sunde, 2018), forming one of the reasons LMMAs are preferred instead (Cinner & Huchery, 2014; Newell et al., 2019). Positive outcomes from

marine reserves correlate positively with support for conservation initiatives and conservation outcomes (Bennett, 2016). These positive perceptions were common to leaders and non-leaders, a phenomenon that has been observed elsewhere (Oliver et al., 2015; Long, 2017). These positive perceptions provide a strong basis for LMMAs to spread through positive peer referrals (Rogers, 2003; Dearing & Cox, 2018).

However, negative perceptions are particularly detrimental to the spread of innovations (Ramirez et al., 2014), and the overall IPA gap analysis result was negative. This indicates overall dissatisfaction with the LMMA attributes tested (Martilla et al., 1977), consistent with conservation research using IPA elsewhere (Agyare, 2015). By comparison studies in tourism find 40% to 100% of IPAs return positive results (Azzopardi & Nash, 2013). The NPS also returned a negative result and, although comparisons within conservation are not possible due to lack of similar studies, negative NPSs in industry indicate dissatisfaction amongst adopters that may constrain spread of an innovation or company (Morgan et al., 2004; Blasberg, Vishwanath, & Allen, 2008). In contrast to the IPA and NPS approach, mean LMMA performance values were positive. It is worth noting that the majority of conservation evaluations typically report means (Gurney et al., 2014; Ahmadi et al., 2015; Mascia et al., 2017). This contrast in results is likely because IPA and NPS set higher bars to achieve positive scores than mean averages, particularly NPS which discards scores of “somewhat better” (Blasberg et al., 2008) which comprised the majority of survey responses in this study.

Four attributes of LMMAs were identified in the IPA as important but had made matters worse since establishing the LMMA and therefore require improvement. This included the funding and livestock provided to villages establishing LMMAs, which clustered on a component ‘NGO support’. Traditionally, increases in financial and material wealth are reported as ‘positive’ outcomes of marine reserves (Andam et al., 2010; Oldekop et al., 2016; Ban et al., 2019). This contrast in results may relate to perspectives, as I did not interpret an increase in these attributes as inherently positive, I asked respondents their perceptions of changes in their lives due to these attributes, on the better-same-worse scale, as recommended (Kamper et al., 2009; Glew et al., 2012;), which is different to asking whether there was a change in material wealth. Some respondents attributed negative ratings to inequitable distribution of these benefits, known to foster conflict and undermine cooperation (Gurney et al., 2021).

Reporting of conflict is not unusual in evaluations of LMMAs or other conservation areas (Gardner et al., 2020; Long et al., 2021) evaluations, and raises ethical concerns and jeopardizes support for and spread of these conservation initiatives (Bennett et al., 2014; Bennett et al., 2017a). Respondents reported that conflict was more severe during the early stages of adopting and negotiating LMMA rules, and eased over time. However, IPA, NPS, and mean performance ratings are limited to capturing only overall trends to one point in time, and not different rates and arcs of change over time between attributes. Given the importance of conflict to respondents, further research into the causes and resolution mechanisms is recommended (Ostrom, 2009). Also, placement of thresholds between zones in the IPA plot can affect how attributes are prioritized for improvement (Chen, 2014). I used a scale-centred plot as it was most relevant for this research, however, some may select target-driven thresholds (Tonge et al., 2007), for example, do no harm and no net loss targets (Arlidge et al., 2018; Bull et al., 2018).

The weakening of village traditions and customs reported by LMMA adopters contrasts with literature on LMMAs in Fiji where LMMAs are considered to strengthen traditions (Clarke & Jupiter, 2010; Weeks & Jupiter, 2013; Jupiter et al., 2014; Aburto et al., 2015). The reasons for respondents feeling their traditions had become weaker and “disrespected” was not clear but translocation of initiatives between cultures requires locally relevant refinements and context specific understandings of cultural values (Infield et al., 2018). Additionally, dissatisfaction was expressed significantly more by respondents of lower social standing (those who identified as non-leaders), as elsewhere (Setiawan et al., 2012), which warrants further research to ensure LMMAs are equitably managed (Leadley et al., 2014) and to avoid detractors constraining LMMA spread (Blasberg et al., 2008).

The prevalence of negative impacts perceived from adopting the LMMAs studied strengthens calls for future conservation initiatives to do no harm (Greiber, 2009), and could suggest the need for mandatory *a priori* impact assessments in line with many industries and academia (Wathern, 1992; Saeed et al., 2012; Brittain et al., 2020). Conservation initiatives meet many of the criteria used when screening for projects that require EIAs. For example, conservation initiatives are designed to impact nature (Ahmadi et al., 2015) often through purposively changing human behaviours (Dobson et al., 2019), with the potential to significantly impact people, their livelihoods, resource-use, resource-rights and culture by design and default (Lewison et al., 2019). Conservation initiatives are also often targeted towards the most vulnerable environments and endangered species (Groves et al., 2002), in

the most remote regions where impacts on nature and people may be most significant (O'Leary et al., 2018).

3.5 Conclusion

I conclude that improving attributes that adopters perceive as important but performing poorly, and addressing concerns of the most dissatisfied adopters, may help LMMAs spread. Additionally, this will help address concerns raised about conservation initiatives having negative impacts on communities. Further research could usefully examine whether improving satisfaction amongst adopters of other conservation initiatives increases spread and reduces the need for inputs by conservation organizations. Given IPA and NPS are increasingly accepted standards in commerce their use in conservation evaluations is worth further consideration. This study and approach can also be used to inform future pre-adoption impact assessments to minimize and mitigate negative impacts on metrics that matter most to adopters and help conservation perform more positively for people and the planet.

4. COMPARISON OF CARBON MANAGEMENT AND EMISSIONS OF UNIVERSITIES WHO DID AND DID NOT ADOPT VOLUNTARY CARBON OFFSETS

This chapter has been published as the following:

Emily Lewis-Brown, Neil Jennings, Morena Mills & Robert Ewers (2023) Comparison of carbon management and emissions of universities that did and did not adopt voluntary carbon offsets, *Climate Policy*, DOI: [10.1080/14693062.2023.2268070](https://doi.org/10.1080/14693062.2023.2268070)

“Seek first to understand” Steven Covey

Abstract

My thesis thus far has examined the adoption and spread of conservation initiatives, studying LMMAs in Madagascar. However, there is concern that adoption of one conservation initiative can reduce adoption of another, leading to reductions in the effectiveness of conservation efforts. This could happen for example through moral licensing, but little research exists to examine this phenomenon for initiatives to address a great threat to nature conservation: climate change. This is an important research gap because several authors claim that addressing climate change through purchasing voluntary carbon offsets (VCOs) reduces efforts amongst adopters to reduce their carbon emissions at source, leading to greater carbon emissions than had no adoption of VCOs occurred. Conversely, other authors and diffusion of innovation theory predicts that initiatives are co-adopted in mutually reinforcing clusters, to greater effect. However, there is scant empirical data to inform this debate and inform policies and actions to mitigate climate change. Meanwhile, the need to reduce greenhouse gas emissions, remove carbon from the atmosphere, and stabilise natural carbon sinks is accepted and has led to the development of many carbon management measures, increasingly including voluntary carbon offsets (VCOs). Research is needed to establish whether adopting VCOs reduces adoption of other carbon mitigation measures and whether carbon emissions reductions are affected.

Therefore, I compared the carbon management characteristics (priorities, policies, practices and emissions) of universities that did and did not adopt VCOs. I found adopters measured carbon emissions for longer and held targets to reach net zero earlier than non-

adopters. Adopters of VCOs also undertook more carbon management practices in both 2010 and 2020 than non-adopters. I also found that both adopters and non-adopters significantly increased their carbon management practices over the decade studied, but with no difference between groups. Gross CO₂ emissions were reduced significantly over time by adopters of VCOs but not by non-adopters, whereas carbon intensity and percentage annual emissions reductions did not relate to adoption status. Consequently, this study showed no indication of mitigation deterrence amongst the universities studied. Rather, greater emissions reductions correlated with earlier net zero target dates and a higher number of policies and carbon management practices.

However, this study was constrained to universities that were affiliated with a national environmental network, so research beyond these organisations, and with individuals, would be useful. The survey was voluntary, exposing the study to potential self-selection bias so the findings may not be generalised beyond the study group. Finally, I found the location-based carbon accounting method currently required of universities may underestimate emissions reductions, particularly for adopters of VCOs. Reporting market-based carbon accounts may overcome this.

4.1 Introduction

Greenhouse gas emissions and black carbon pollution pose an existential threat to nature and humanity through climate change (IPBES, 2019; IPCC, 2023). Global carbon neutrality by 2050 followed by net negative emissions through rapid reductions of greenhouse gas emissions, removal of carbon from the atmosphere, and stabilisation of natural carbon pumps and sinks are required to increase the possibility of limiting global warming to below 1.5°C (Reid et al., 2009; Field, 2012; Mach, 2014; Hansen et al., 2017; IPCC, 2018; Mascia et al., 2018; IPCC, 2023). Voluntary carbon offsets (VCOs), which reduce carbon emissions or remove atmospheric carbon, have emerged as part of a combination of approaches to help address climate change (Kauppi et al., 2001). However, several authors claim adoption of VCOs, for example by universities, governments, individuals or businesses, deters adoption of other carbon mitigation actions (Canzi, 2006; Anderson, 2012), while others claim the opposite (Reynolds, 2014), leading to confusion which may itself stall climate mitigation (Jebari et al., 2021).

Voluntary carbon offsets (VCOs) are certificates relating to one metric tonne of carbon dioxide (1MTCO₂) emissions that are either reduced, for example through forest protection or renewable energy generation; or removed from the atmosphere, for example through afforestation (Broekhoff et al., 2019). Projects creating VCOs can be certified, for example through Gold Standard (Gold-Standard, 2019), to ensure high environmental and ethical standards of VCOs. I define the term VCO as including carbon credits (Woo et al., 2021) but not Renewable Energy Certificates (see Appendix 4.1 for more detail). Guidance on buying high-quality, ethical VCOs within a mitigation hierarchy that prioritises emissions reductions before offsets is provided by VCO certification bodies and retailers including Climate Neutral Now (UNFCCC, 2022), government bodies such as UK's Carbon Trust (Ceppi, 2006), and sector-specific bodies such as Second Nature and the Environmental Association of Universities and Colleges (EAUC) for academic institutions (Adair, 2016; Mitchell-Larson et al., 2020).

VCO retailers, accreditation bodies and associated literature consistently specify that VCOs sit at the bottom of the carbon mitigation hierarchy that starts with measure, then reduce, then offset (Adair, 2016; Gold-Standard, 2019; CNN, 2022). Elsewhere, VCOs are recommended only as a transition technology; to achieve net negative emissions; or be reserved for hard-to-avoid emissions (Malay et al., 2014; Allen et al., 2020; Mitchell-Larson et al., 2020). This is consistent with long-standing regulations on environmental protection and restoration, and prevention and remediation of wastes and pollution. For example, EU directives regulating environmental impacts on people, the environment, including climate, include a mitigation hierarchy: avoid, reduce, remedy (e.g., through restoration or offsets), then compensate impacted communities (EU, 2011; Wathern, 1992).

Further, UK policies require that waste and pollution be reduced to as low as reasonably practicable (ALARP) (Burgman, 2005; Pike et al., 2020) using the best practicable environmental options (BPEO) (Lewis, 1988). More widely, the long-standing 'polluter pays principle' requires polluters to reduce and remedy their wastes and pollution, and pay compensation for damages, bearing the costs themselves (EU, 2004; de Sadeleer, 2015). Therefore, current conditions can be considered to require carbon emissions to be addressed first by avoiding and reducing carbon emissions to as low as reasonably practicable, then remedying and compensating for damages.

Despite this policy and legal context, concern exists that adopting VCOs may degrade action to reduce carbon emissions by polluters and hinder emissions reductions, possibly via moral hazard (Canzi, 2006; Anderson, 2012; Günther et al., 2020). Moral hazard is an insurance industry concept, with wide-ranging interpretations and uses, but generally describes the hidden effect on individuals whereby insurance removes incentives to reduce associated risks to the individual (Rowell & Connelly, 2012). The concept spread beyond insurance, economics and individuals, to organisational behaviours and carbon management (Jebari et al., 2021) and was appropriated as a populist pejorative term (Rowell & Connelly, 2012). However the term “moral hazard” is considered a “misnomer” in the context of VCOs, as the decision to pollute and offset reside with the same agent (Wagner & Zizzamia, 2022). Applying moral hazard to VCO adoption assumes VCOs are substituted for other carbon mitigation measures rather than being additional. However, climate mitigation literature indicates that adoption of clusters of carbon reduction and removal technologies and solutions will be required (Pacala & Socolow, 2004; Ceppi, 2006; IPCC, 2018).

Claims of mitigation deterrence (e.g., via moral hazard) from adopting VCOs have been made without supporting data (e.g., Canzi, 2006; Anderson, 2012; Koberstein & Applegate, 2021). However, some have suggested that claims of mitigation deterrence may themselves reduce climate mitigation action (Jebari et al., 2021). Others claim that adopting technologies to remove CO₂ from the atmosphere, which could overlap with VCOs, may increase adoption of other mitigation efforts (Reynolds, 2014). This is consistent with diffusion theory – which suggests that adoption of one innovation (technology, idea or behaviour perceived as new by adopters) may trigger co-adoption of a cluster of associated innovations, increasing adoption outcomes (Rogers, 2003 p249). Associated innovations are understood by adopters as mutually-supportive and inter-dependent (Carmichael et al., 2021). Therefore, VCOs provide an ideal case study to examine whether these initiatives are adopted instead of other initiatives to mitigate climate change, or co-adopted in clusters with climate mitigation initiatives.

The seemingly opposing views may not be mutually exclusive, and other psychological or sociological processes may influence behaviour. Moral licensing for example seems plausible, whereby adoption of one pro-environmental behaviour decreases the likelihood of subsequent pro-environmental behaviours (Gholamzadehmir et al., 2019). Experiments found that individuals learning about carbon offsets reduced support for carbon mitigation measures

in one study (Campbell-Arvai et al., 2017), and caused rebound behaviours in another, but that the rebound effect was corrected by information about the possibility of rebound effects (Günther et al., 2020). This self-correction is unsurprising given that individuals have strong preferences to remain consistent with their self-image, goals, and prior behaviours (Locke & Latham, 2019). However, individuals' 'preference for consistency' is not universally equal which leads to variability in outcomes (Guadagno et al., 2001; Brown, Asher, & Cialdini, 2005). Consistency over time is highly valued in organisations to help brand recognition (Beverland, Wilner, & Micheli, 2015), and many use targets and theories of change to set, monitor and evaluate intended outcomes (e.g., Hestres, 2015; Arensman, van Waegeningh, & van Wessel, 2018; Salazar, Mills, & Verissimo, 2019). However, research into the effects of organisations adopting VCOs on other carbon management strategies is currently lacking.

With opposing claims and theories, variability in behavioural responses, and a paucity of empirical research, the question of whether adoption of VCOs causes mitigation deterrence remains understudied (Markusson et al., 2018). Therefore, this research examines three questions: do adopters and non-adopters of VCOs differ in their: 1. characteristics (carbon management priorities, policies and practices), 2. carbon management practices and changes over time; and 3. carbon footprints and changes over time.

Universities make a useful study population as they are influential leaders in climate action (Barron et al., 2021) and have large carbon footprints (Mitchell-Larson et al., 2020), with impacts beyond their organisations. Additionally, many universities have carbon management and reduction strategies and net zero targets (Chadwick, 2016; Idundun, Hursthouse, & McLellan, 2021) a date by which they aim to balance carbon emissions with equivalent carbon removals or off-setting (Thomson et al., 2021) and make their carbon emissions data publicly available (HESA, 2021; Second-Nature, 2021). Some universities have adopted carbon offsets, providing guidance on the process (Allen et al., 2020) while others have rejected carbon offset adoption (Anderson, 2012) providing data for both adopters and non-adopters required for this study. I emphasise this study population may not reflect wider society or other organisations, as customer-oriented organisations, that are obliged to publicly report their data may act differently to industrial-based companies (Kotchen & Moon, 2012). Therefore, I limit interpretation of the results to the study population and recommend that research into other populations is undertaken.

4.2 Methods

The first step was to develop a survey instrument that would answer the three research questions above. To do this, I identified factors that I hypothesised may relate to the adoption of VCOs that could be measured and analysed to answer the research questions herein (Figure 4.1, with more detail in S2.7). The factors in Figure 4.1 were selected from literature on carbon management in universities (Malay et al., 2014; Tang & Luo, 2014; Chadwick, 2016; Allen et al., 2020; UNEP, 2020; Idundun et al., 2021); carbon management reporting platforms (HESA, STARS and Second Nature), and discussions with existing environmental managers in UK and USA universities.

Characteristics of innovations, potential adopters, and the context in which they interact can affect adoption of innovations (Rogers, 2003; Simin & Janković, 2014; Kuehne, 2017; Balas et al., 2018; Dearing et al., 2018; Romero de Diego et al., 2021). Therefore, to answer the research questions in turn, I tested whether universities' characteristics (including institution size, carbon management priorities, number of environmental policies and net zero target dates), related to the number of carbon management practices adopted, carbon emissions, and changes over time. I tested for differences in these attributes listed between adopters and non-adopters of VCOs. I also tested for relationships between the characteristics, practices and outcomes regardless of adoption status.

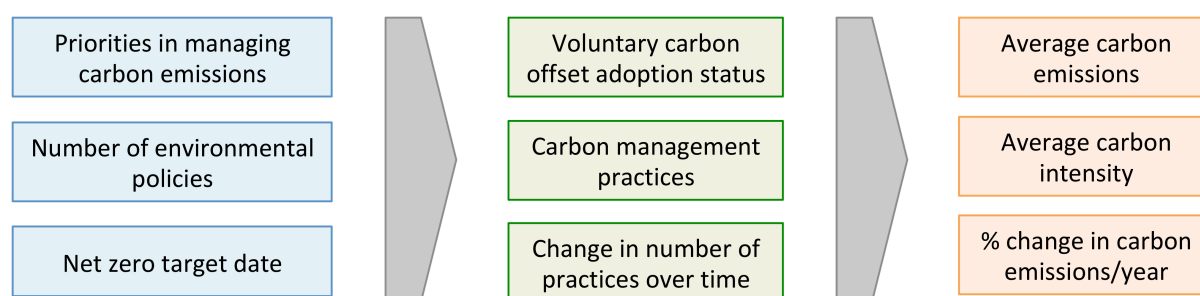


FIGURE 4.1 An illustration of the main factors hypothesised in this study that may relate to the adoption of VCOs in universities. This includes universities' characteristics (pale blue), carbon management practices adopted (green), and carbon emissions (red).

Sample strategy

The sample strategy was limited *a priori* to universities in the UK and North America that are subscribed to sustainable education platforms such as EAUC in the UK and Second Nature in the USA. This minimised variability in the sample, as factors such as cultural norms, pro-

environmental attitudes, and internal capacity to consider environmental issues can influence adoption decisions (Rogers, 2003). I also limited the study temporally, to data from 2009 to 2020, to capture the most reliable carbon emissions data. This period pre-dated policies by funders that require carbon emissions from grant-related travel to be offset (e.g., Wellcome, 2022). This policy will turn the adoption decision of organisations in receipt of Wellcome funding from voluntary to compulsory, which follows a different adoption process (Rogers, 2003, p. 29).

Ethics approval was granted by Imperial College London (SETREC 21IC6610) and sampling was undertaken during summer of 2022 through a voluntary e-survey sent to environmental or estate managers. EAUC distributed the survey to UK university members, comprising 60% of UK universities. I emailed over 500 USA universities on the Second Nature and STARS databases (covering 10% and 20% of USA degree-awarding universities respectively). I posted the survey on USA “green schools” Listserv and the Association for the Advancement of Sustainability in Higher Education (AASHE) advertised the survey to its members. I reached a small number of Canadian universities incidentally. Of the universities who responded, one representative from each university consented to and completed one survey.

Survey

The survey was tested amongst the study population for consistent interpretation and to balance the effort of completing the survey with the adequacy of data gathered. Definitions were provided on page one of the survey to clarify distinctions between VCO that were counted in the survey and compulsory purchases of Certified Emissions Reductions (CERs), Renewable Energy Certificates (RECs) and green energy tariffs, which did not count as VCOs. Respondents completed a series of multiple-choice and matrix questions, where response options were automatically randomised. Open-box options provided opportunities for respondents to provide greater details about their decision-making choices. The survey measured three sets of variables:

1. universities’ characteristics, including adoption status; carbon management priorities, environmental policies and net zero targets;
2. carbon management practices in 2010 and 2020, such as purchasing renewable energy, and policies to reduce carbon from food or travel; and
3. gross carbon emissions from 2009 to 2019 (excluding carbon offsets).

Carbon data provided in the survey were augmented and quality-checked against UK Higher Education Statistics Agency (HESA) and Second Nature databases (HESA, 2021; Second-Nature, 2021). In line with the United Nations Framework Convention on Climate Change (UNFCCC), universities report carbon in three ‘scopes’: scope 1 (direct emissions from owned or controlled sources), scope 2 (indirect emissions from the generation of purchased electricity, steam, heating and cooling) and scope 3 emissions (all other indirect emissions, e.g., from business travel and food) (Appendix 4.11) (Ranganathan et al., 2015). This research is limited to scope 1 and 2 emissions, as scope 3 emissions were not reported adequately. Universities use location-based carbon accounting method which does not account for renewable electricity generated onsite sold to the grid, or purchase of renewable electricity, whereas deductions for these are permitted with the market-based carbon accounting (Sotos, 2015). Universities report only gross carbon emissions, excluding carbon offsets.

Analysis

Data from 106 universities were received and quality checked, and ten were removed from the sample due to incompleteness or failure to meet criteria set *a priori*, such as affiliation with a sustainability organisation. Data and code can be accessed online (<https://doi.org/10.5281/zenodo.7023154>). The final sample analysed ($n = 96$) included adopters ($n = 34$) and non-adopters ($n = 62$) of VCOs. Responses were split across the UK ($n = 36$), USA ($n = 58$) and Canada ($n = 2$). To test whether data from differing nations for adopters and non-adopters could be amalgamated, I tested for associations between adoption status and national context and found no significant association (Chi-square 0.595, $p = 0.440$, $n = 96$). Therefore, further analysis was completed using adopters and non-adopters as a binary predictor variable, regardless of nation. To check for bias in the survey population, I compared the proportion of VCO adopters (those adopting VCOs) amongst USA survey respondents (34%) with the Second Nature database for USA universities invited to respond (14%). This indicates self-selection bias, possibly due to the voluntary nature of the survey (Robinson, 2013), therefore I limited interpretation of the analysis to the sample and avoided generalisations.

Descriptive analyses provided overall themes and patterns that compared adopters with non-adopters. I explored normality of distribution and homogeneity of variance in the data and applied non-parametric tests accordingly in SPSS v25. I used Chi-square and Fisher’s

Exact test to test for associations between categorical nominal variables, including adoption status and carbon management priorities. I used Welch tests to compare the number of policies, number of practices and the carbon emissions between adopters and non-adopters.

I used repeated measures ANOVA to test firstly whether the number of carbon management practices, and secondly, carbon emissions, changed between 2010 and 2020. I also tested whether differences over time differed between adopters and similarly matched non-adopters (based on location, size and carbon emissions), with post-hoc G*Power analyses to test confidence levels in the results. I used regressions to test the rates of changes in carbon emissions, and adoption of carbon offsets over time. I used Spearman's Rho to analyse correlations between how early net zero target dates were (number of years ahead of mandatory 2050 dates for net zero), number of policies and practices, and carbon outcomes, to assess interactions between variables (Motawa & Oladokun, 2015). Finally, I coded qualitative data from open-box questions for content analysis, to understand the direction of correlations and gain a deeper understanding of responses.

4.3 Results

Overall, adopters of VCOs had earlier net zero target dates and undertook more carbon management practices, than non-adopters. Equivalent or greater emissions reductions were achieved by VCO adopters than non-adopters on the metrics tested. Greater emissions reductions correlated with earlier net-zero target dates and number of carbon management policies and carbon management practices.

Carbon offsets were adopted by the universities studied at an increasing rate over time (Figure 4.2), particularly in the UK (Appendix 4.2). Adopters (n = 34) were classified as those who had purchased offsets (n = 16), those who had agreed and planned to purchase offsets (n = 9) and those who had funded or agreed to fund equivalent activities to offset carbon emissions (n = 9) (Appendix 4.3). The reasons given for adopting VCOs included: addressing emissions that cannot be avoided yet e.g., travel (32%), and to achieve their net zero targets (21%). None said they had adopted VCOs to set earlier net zero target dates. VCOs were also adopted to show leadership; and to support overseas development (such as through cook-stoves), justice and social benefits to others.

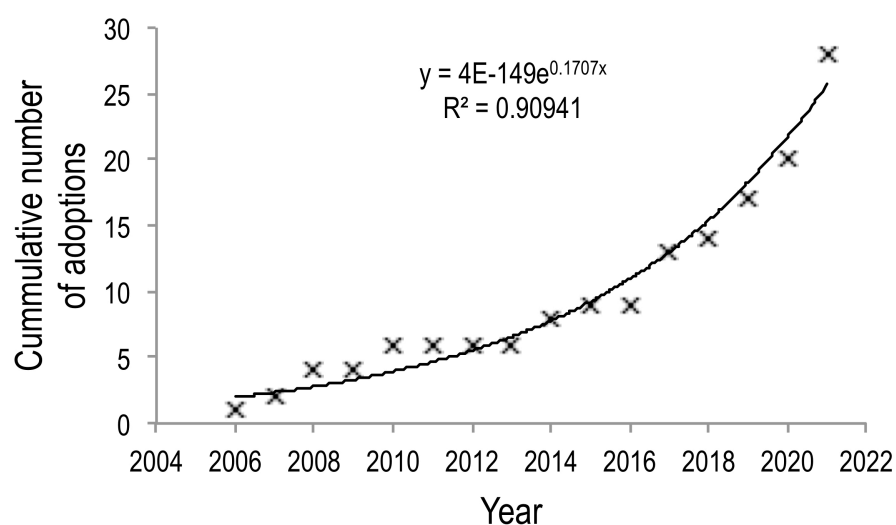


FIGURE 4.2 Cumulative number of universities who adopted voluntary carbon offsets over time, with exponential regression line shown (linear regression, $y = 1.3926x - 2794.5$, $R^2 = 0.84331$) ($n = 28$). Non-adopters ($n = 62$) were classified as those who were undecided ($n = 53$), those who identified as non-adopters in open-box questions ($n = 5$) and those who rejected carbon offsets ($n = 4$) (Appendix 4.3). Some universities who had not decided whether to adopt VCOs reported that funding was a limiting factor, while others reported their current focus was on reducing emissions and purchasing RECs which are not classified here as carbon offsets. Reasons given for rejecting VCOs were: cost; to focus on reductions; and one held a “scientific belief that they do not deliver all that is promised and are a distraction”.

Addressing the first research question, carbon management characteristics and emissions of universities studied were similar between adopters and non-adopters on seven of ten variables tested (Figure 4.3 and Table 4.1). Additionally, analysis of the survey results (Appendix 4.1, question 7, and S2.7) showed priorities in tackling carbon emissions were not significantly different between groups (Fisher’s Exact test, $p = 0.412$). Most respondents prioritized reducing emissions (71%), while none prioritized offsetting emissions alone, although some prioritized both (29%) (Appendix 4.4). When asked to explain carbon management priorities, 19% of those who replied ($n = 85$) mentioned reducing emissions saves money, or funds were not available to purchase VCOs. Both adopters and non-adopters expressed concern about the efficacy of VCOs, but even some non-adopters rated both offsets and emission reductions as priorities, stating VCOs are useful for emissions where reductions were not possible, for example, from travel.

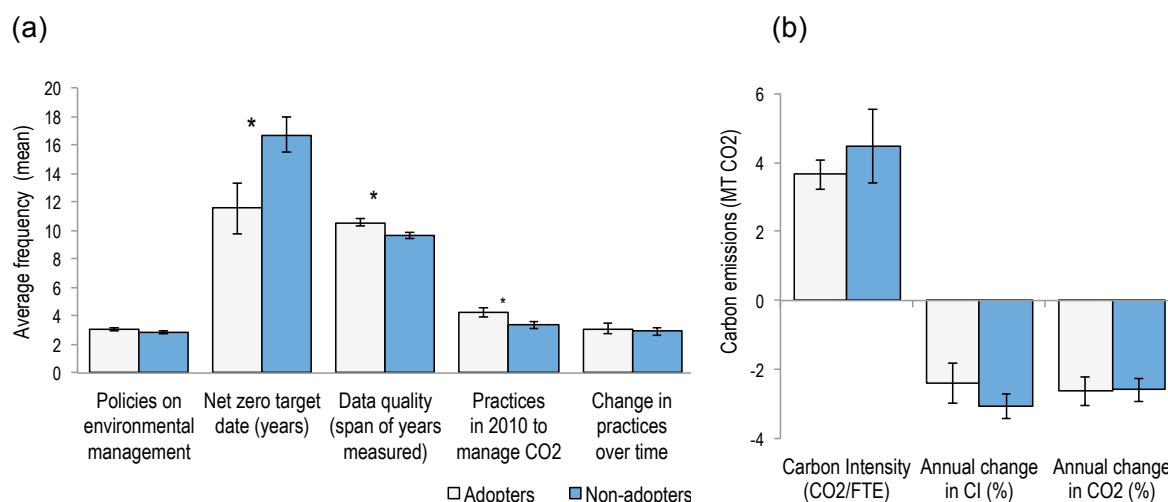


FIGURE 4.3 Attributes of adopters (light grey) and non-adopters (dark blue) of voluntary carbon offsets. Only four of ten attributes tested using Welch tests show significant differences between adopters and non-adopters at the 95% level (*). Figure 4.3a) shows the mean frequency results for each attribute and 3b) shows mean carbon emissions in metric tonnes of CO₂-equivalent (MT CO₂) and mean carbon Intensity (MTCO₂/full-time equivalent student) and how these change over time. The full set of results for all attributes tested is shown in Table 4.1 below.

The number of policies to manage carbon emissions, including accreditation, dedicated staffing, and carbon reduction plans (Appendix 4.5), was not significantly different between adopters and non-adopters of VCO (Welch statistic 0.792, df_1 , $p = 0.376$), nor did it relate to institution size (number of full-time equivalent students) (Welch statistic 48.264, df_1 , $p = 0.338$). However, the detail of one of the policies did differ significantly between groups. Target dates for achieving net zero for scope 1 and 2 emissions were significantly earlier for adopters than non-adopters (Welch statistic 52.352, $df = 1$, $p = 0.022$) (Appendix 4.6). Two adopters had reached net zero by 2018, and another aimed for “absolute zero” (zero carbon emissions, rather than compensating for emissions with offsets) for scope 1 and 2 emissions by 2048. Net zero targets for scope 3 emissions were reported by some adopters and non-adopters (61% and 64% respectively). Only three respondents reported policies to achieve net negative emissions (carbon removal or offsetting of more than emitted), one VCO adopter and two non-adopters – one of which rejected VCO adoption. The strongest difference between groups was that adopters reported gross scope 1 and 2 carbon data for a longer time than did non-adopters (Welch statistic 7.103, df_1 , $p = 0.009$).

TABLE 4.1 Characteristics, practices and outcomes of adopters (n = 34) and non-adopters (n = 62) of voluntary carbon offsets for attributes encompassing respondents' (a) characteristics and practices to mitigate carbon emissions, and (b) outcomes in terms of carbon emissions. Significant Welch test results are indicated by * for $p < 0.05$, and ** for $p < 0.01$.

	Adopters (n = 34)		Non-adopters (n = 62)		Equality of Means (Welch test)			
	mean	st. error	Mean	st. error	Statistic	df1	df2	Pqq
(a)								
Policies on environmental management	3.029	0.116	2.869	0.111	0.792	1	83.315	0.376
* Net zero target date	11.552	1.814	16.706	1.203	5.606	1	52.352	0.022
Size (thousand students)	19.440	2.903	16.327	1.380	0.938	1	48.264	0.338
** Data quality (years)	10.559	0.240	9.661	0.237	7.103	1	85.041	0.009
* Practices in 2010 to manage CO ₂	4.265	0.339	3.371	0.250	4.509	1	67.890	0.037
* Practices in 2020 to manage CO ₂	7.382	0.378	6.290	0.265	5.608	1	64.889	0.021
Change in practices over time	3.118	0.355	2.919	0.273	0.196	1	70.326	0.660
(b)								
Carbon emissions (mean gross annual MTCO ₂)	74.70	16.96	64.92	13.30	0.196	1	71.467	0.659
Carbon Intensity (mean MTCO ₂ /FTE)	3.651	0.440	4.476	1.068	0.510	1	79.243	0.477
Annual change in CI (%)	-2.407	0.583	-3.067	0.362	0.927	1	58.612	0.340
Annual change in CO₂ (%)	-2.623	0.417	-2.584	0.340	0.005	1	73.865	0.942

Addressing the second research question, the number of practices to manage carbon emissions and climate change, including purchasing or generating renewable electricity, and reducing carbon-intensive foods available onsite (Appendix 4.7), was significantly greater for VCO adopters than non-adopters, in both 2010 and 2020 (Welch test 4.509, $p = 0.037$ and 5.608, $p = 0.021$ respectively, $n = 96$). The number of practices increased between 2010 and 2020 significantly for both groups (Wilcoxon Ranked test -8.068, $p = < 0.001$), and the increase was not significantly different between groups (Welch test 0.196, $p = 0.660$, $n = 96$) (Table 4.2, Appendix 4.8). Analysis of respondents with an adoption date between 2010 and 2020 ($n = 10$), compared with a group of matched non-adopters ($n = 10$), also found

significant increases in practices for both groups over time, using repeated measures ANOVA (Wilk's Lambda 0.476, $p = <0.001$; within-subjects effects 52.90, $p = <0.001$). The G*Power (Faul, 2007) was adequate for this within-subject test (96% chance of correctly rejecting the null hypothesis). Between-subjects effects for adopters and non-adopters were not significant (Type III sums of Squares 14.40, $p = 0.062$), indicating no mitigation deterrence post-adoption of VCOs, although confidence was lower in this result due to sample size.

Considering individual practices separately, I found adopters of VCOs had the greatest adoption of energy efficiency (94%), followed by energy-saving practices (91%) in 2010, rising to close to 100% in 2020. These two practices were also the most prevalent practices for non-adopters, but less so, with greater room for growth over the decade with $<80\%$ adoption in 2010, and $>95\%$ in 2020 for both practices. Purchase of RECs and generation of renewable electricity was far greater amongst VCO adopters than non-adopters, and rose in both groups over the decade, particularly amongst non-adopters. The largest increase in practices by adopters involved reducing emissions from food (Table 4.2, Appendix 4.7). These different practices affect scope 1, 2 and 3 carbon emissions reported by universities differently. Therefore, I categorised practices into three groups (Table 4.2):

- A, those affecting scope 1&2 emissions that are counted in location-based accounting;
- B, those affecting scope 1&2 emissions but not counted in location-based accounting;
- C, those affecting scope 3 emissions and not counted in carbon emissions reports.

Appendix 4.7 shows that adopters increased group B carbon management practices, which reduce emissions that are not counted, more than did non-adopters. Whereas non-adopters increased group A carbon management practices that reduce emissions which are counted, more than did adopters. However, the differences are not significant with this sample size and variability (Welch test 3.203, $p = 0.079$; 0.057, $p = 0.812$; 1.916, $p = 0.170$ respectively).

TABLE 4.2 Practices to manage carbon emissions and climate change undertaken by adopters and non-adopters of VCO in 2010 and 2020 (%) classified into 3 carbon emission groups: A, those affecting scope 1&2 emissions which are counted in location-based accounting; B, those affecting scope 1&2 emissions but are not counted; and C, those affecting scope 3 emissions and are not counted (n/a indicates carbon management strategies which can not be accounted for with current data). *RECs are Renewable Energy Certificates

	Percentage undertaking each practice (%)		Change actions undertaken (%)		Group
	Adopters	Non-adopters	Adopters	Non-adopters	
Generate renewables- 2010	52.94%	25.81%			
Generate renewables- 2020	94.12%	79.03%	41.18%	53.23%	n/a
Energy efficiency - 2010	94.12%	79.03%			
Energy efficiency - 2020	97.06%	96.77%	2.94%	17.74%	A
Space efficiency - 2010	35.29%	35.48%			
Space efficiency - 2020	70.59%	64.52%	35.29%	29.03%	A
Energy-saving - 2010	91.18%	77.42%			
Energy-saving - 2020	97.06%	96.77%	5.88%	19.35%	A
Purchase renewables - 2010	32.35%	22.58%			
Purchase renewables - 2020	73.53%	62.90%	41.18%	40.32%	B
Purchase RECs* - 2010	41.18%	14.52%			
Purchase RECs* - 2020	67.65%	37.10%	26.47%	22.58%	B
Travel - 2010	14.71%	19.35%			
Travel - 2020	47.06%	35.48%	32.35%	16.13%	C
Food - 2010	11.76%	4.84%			
Food - 2020	55.88%	43.55%	44.12%	38.71%	C
Supply-chains - 2010	5.88%	4.84%			
Supply-chains - 2020	41.18%	29.03%	35.29%	24.19%	C

Addressing the third research question, gross carbon emissions and carbon intensity (scope 1 and 2 without accounting for carbon offsetting) averaged over the decade studied were not significantly different between adopters and non-adopters (Welch test, 0.196, $p = 0.659$ and 0.510, $p = 0.477$ respectively) (Table 4.1). Also, there were no significant differences between adopters and non-adopters in annual percentage change in gross CO₂ emissions (Welch statistic 0.005, $p = 0.942$); or carbon intensity (Welch statistic 0.927, $p = 0.340$) averaged over the decade.

However, regression analysis showed that adopters reduced gross CO₂ emissions significantly over time (Spearman's Rho, -0.745, $p = 0.008$), while non-adopters did not (Spearman's Rho, -0.591, $p = 0.056$) (Figure 4.4, Appendix 4.13). Both groups reduced carbon intensity (CO₂ emissions per full-time equivalent student) as a percentage each year of the year before significantly over time (Spearman's Rho, -0.797, $p = 0.002$ and -0.645, $p = 0.032$ respectively). However, as universities report gross location-based emissions, reductions in emissions may be even greater if measured using market-based accounting, especially for adopters of VCOs, based on their greater co-adoption of carbon management practices described above (Table 4.2).

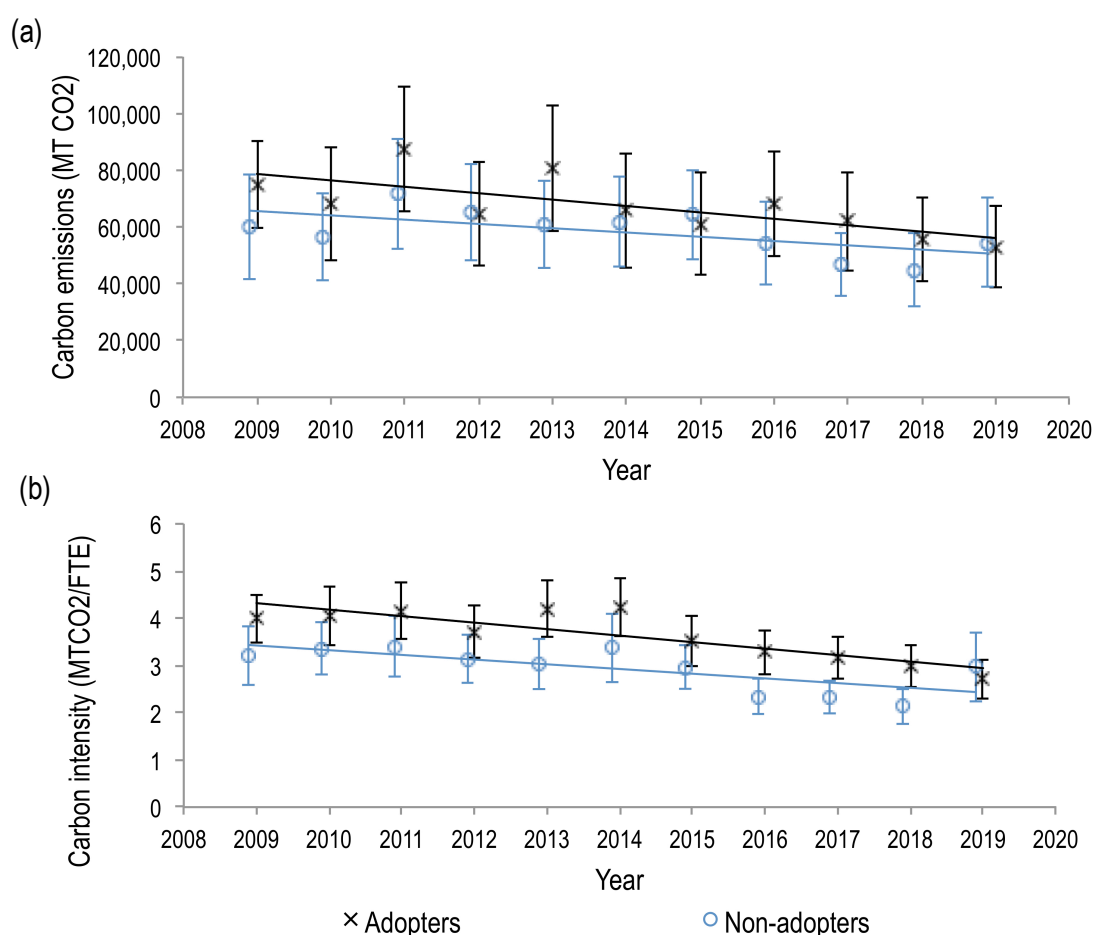


FIGURE 4.4 Mean annual carbon emissions and carbon intensity from 2009 to 2019 for adopters ($n = 34$) and non-adopters ($n = 62$) of voluntary carbon offsets. Figure 4.4a) illustrates carbon emissions in metric tonnes (MT) of gross scope 1 and 2 CO₂-equivalent (CO₂), which adopters reduced significantly over time (Spearman's Rho, -0.745, $p = 0.008$) while non-adopters did not (Spearman's Rho, -0.591, $p = 0.056$). Figure 4.4b) carbon intensity (CI) illustrates MTCO₂ per full-time equivalent student (FTE). Both adopters and non-adopters reduced carbon intensity significantly over time (Spearman's Rho, -0.797, $p = 0.002$ and -0.645, $p = 0.032$ respectively).

I found country-level differences in the characteristics of the universities studied in the UK and USA and their carbon emissions (Appendix 4.14). For example, UK universities held more policies and reported data for longer than did USA respondents (Welch tests 21.680, $p < 0.001$; and 94.003, $p < 0.001$ respectively). UK and USA respondents did not undertake a significantly different number of practices to manage their carbon in 2010. However, UK respondents showed a greater increase in the number of practices over the decade and undertook more practices to manage carbon emissions in 2020 than USA respondents (Welch tests 0.004, $p = 0.952$; 22.362, $p < 0.001$; and 23.120, $p < 0.001$ respectively). The mean carbon emissions of UK respondents were significantly lower than their USA counterparts, and UK respondents achieved a greater annual percentage decrease in carbon intensity and gross CO₂ over the decade measured (Welch tests 17.075, $p < 0.001$; 14.898, $p < 0.001$; and 8.870, $p = 0.004$ respectively). Carbon emissions are influenced by carbon intensity of electricity supplied via the grid, which varies spatially and temporally, and generally declined over the decade studied (de Chalendar, Taggart, & Benson, 2019; Risner & Sutherland, 2021) (Appendix 4.10). The proportion of adopters to non-adopters did not differ significantly between nations (Chi-square value 0.797, $p = 0.372$, $n=94$), neither did net zero target dates, or university size (Welch test 2.842, $p = 0.96$; and 1.932, $p = 0.168$ respectively).

Although adoption status was not significantly related to reductions on most carbon emissions metrics tested, other variables were, including net zero target date and number of carbon management practices in 2020 (Figure 4.1, Table 4.3). Across the whole sample ($n = 96$), the greatest number of significant Spearman's Rho correlations arose from the number of policies held by universities. The number of policies correlated positively with the number of practices taken in 2010 (Spearman's Rho coefficient (coef.) 0.224, $p = 0.029$) and in 2020 (coef. 0.463, $p < 0.001$) (Figure 4.5), and the increase over time (coef. 0.254, $p = 0.013$) (Table 4.3, Figure 4.5). The number of policies also positively correlated with number of years carbon emissions were reported (coef. 0.270, $p = 0.008$). Number of policies correlated with lower average carbon intensity (coef. -0.337, $p = 0.001$), and greater reductions in both CO₂ emissions and carbon intensity over time (Figure 4.5) (coef. -0.275, $p = 0.007$, and coef. -0.344, $p = 0.001$ respectively).

Earlier net zero target dates correlated with lower mean gross CO₂ emissions (Table 4.3) but not mean carbon intensity (coef. -0.260, $p = 0.020$, and coef. -0.219, $p = 0.051$ respectively). Earlier net zero target dates also correlated significantly with greater annual percentage reductions in CO₂ emissions (coef. -0.252 $p = 0.024$) (Table 4.3, Figure 4.5b).

Although cause and effect are not experimentally tested, open-box question responses indicated directionality, for example, an adopter with a net zero target date of 2030 explained: *“We see it as the responsibility of wealthy institutions and countries to make material reductions in CO₂ emissions. It is unsustainable for us to “buy our way” to reduction. Further, we believe that our students have come to understand the difference and expect us to meet a higher standard.”*

TABLE 4.3 Correlations between different attributes of both adopters and non-adopter respondents combined (n = 96) indicating that the number of policies and practices are correlated significantly with each other and with carbon emissions outcomes using Spearman’s Rho correlation in SPSS (2-tailed). Blue shading indicates significant positive correlations; orange indicates significant negative correlations; and white indicates non-significant results at 95% level.

Spearman's Rho Correlation Coefficients	Net zero date earliness (S1&2)	Data span	Practices 2010	Practices 2020	Practices (change)	Mean CO ₂	Size (mean FTE)	Mean carbon inten- sity (CI)	% change in CO ₂ per yr	% change in CI per yr
Policies (sum)	0.028	.270**	.224*	.463**	.254*	-0.177	0.023	-.337**	-.275**	-.344**
Net zero date earliness (S1&2)		0.095	0.055	.230*	0.143	-.260*	-0.114	-0.219	-.252*	-0.185
Data (span)			0.054	0.193	0.156	-0.162	0.047	-.245*	-.278**	-0.185
Practices 2010				.465**		0.017	0.073	-0.024	-0.165	-0.116
Practices 2020						-0.102	0.104	-.243*	-.354**	-.380**
Practices (change)						-0.184	-0.015	-.255*	-.214*	-.262**
Mean CO ₂							.763**		.306**	.230*
Size (mean FTE)								0.152	0.094	-0.003
Mean carbon intensity (CI)									.325**	.403**
% change in CO ₂ per yr										.768**

**Correlation is significant at the 0.01 level. *Correlation is significant at the 0.05 level.

Greater numbers of practices to manage carbon emissions in 2020 correlated with greater reductions in carbon emissions on all metrics, as did increases in practices between 2010 and 2020 (Figure 4.5). Although causation is not proven by the correlations found here alone, universities with earlier net zero policies or greater than average number of environmental policies, also undertook more carbon management practices and achieved significantly

greater emissions reductions than average across the study sample. In the UK, these emission reductions were also greater than that achieved by the national grid (Appendix 4.10).

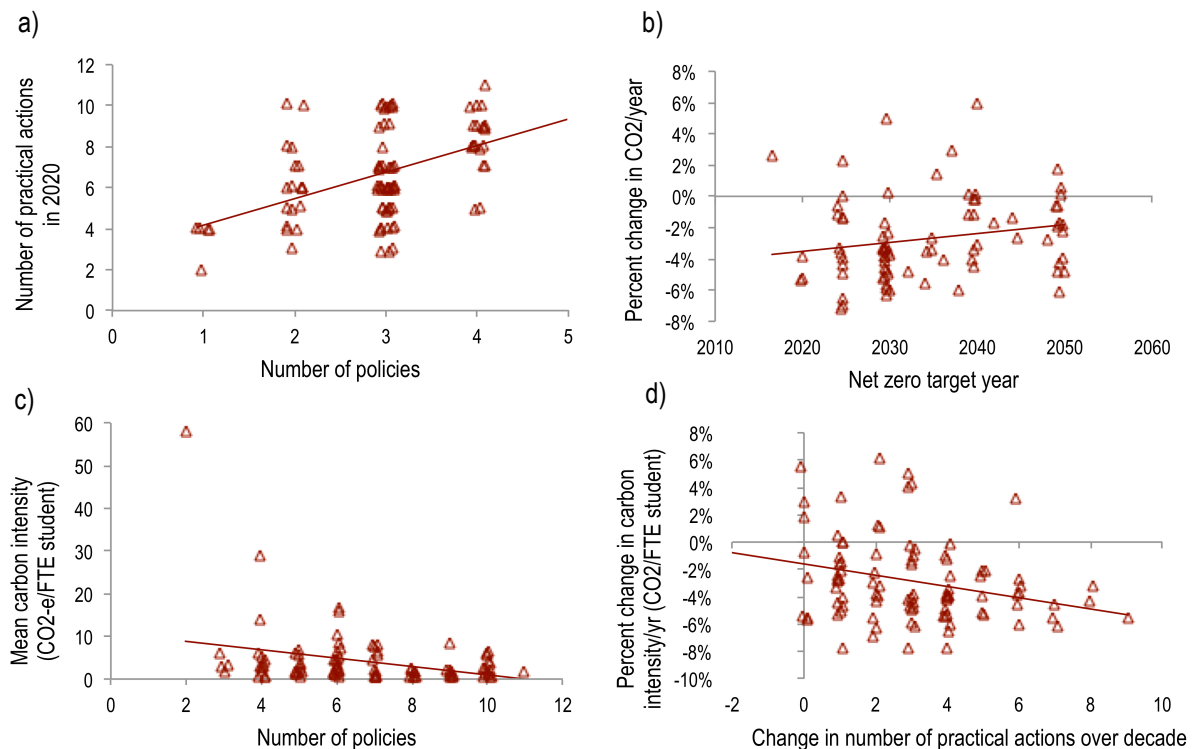


FIGURE 4.5 Correlations between attributes of the universities sampled and their carbon emissions for all survey respondents ($n = 96$) to illustrate a selection of significant Spearman's Rho correlations (Table 4.3), including between (a) number of environmental policies held by universities (not including a policy to offset carbon emissions) and number of practical actions taken in 2020 ($p = <0.001$); (b) net zero target date and % change in CO₂/year ($p = 0.024$); (c) number of policies in 2020 and mean carbon intensity ($p = 0.001$); and (d) changes in the number of practical actions and % change in carbon intensity/year ($p = 0.010$).

4.4 Discussion

Voluntary carbon offsets have been developed to help reduce emissions and remove carbon from the atmosphere, for example through renewable energy provision and afforestation. However, multiple differing views exist about the impacts of adopting VCOs on adoption of other mitigation measures, and consequently on carbon emissions (e.g., Anderson, 2012; Reynolds, 2014; Markusson et al., 2018; Jebari et al., 2021). Given net negative emissions are necessary to minimise climate change and net zero targets are widespread, some carbon removal with durable storage is required (Jebari et al., 2021; IPCC, 2023), which could

involve carbon removal-based VCOs. Additionally, polluters should pay clean-up costs and compensate for damages from carbon emissions under the polluter pays principle (Jebari et al., 2021; IPCC, 2023). Yet, possible ‘mitigation deterrence’ from adopting VCOs remains concerning and understudied (Markusson, McLaren, & Tyfield, 2018).

I compared carbon management priorities, policies, practices and emissions of universities that did and didn’t adopt VCOs. The finding here that both adopters and non-adopters prioritised emissions reductions rather than offsets is consistent with mitigation hierarchies in laws, literature, and advice from governments, funders, VCO accreditors and retailers (Tilton, 2016; Snyder, 2020). Further, researchers have proposed that VCO should sit within a mitigation hierarchy that includes carbon emissions reductions to as low as reasonably practical (ALARP) using the best practicable environmental options (BPEO), with ethical considerations and support of the UN Sustainable Development Goals (Mitchell-Larson et al., 2020). ALARP and BPEO are long-standing environmental protection and pollution management practices (Lewis, 1988; Burgman, 2005; Pike et al., 2020), consistent with environmental pollution and risk management (EU, 2004). However, protocols and guidance for reducing carbon emissions to ALARP using BPEO are lacking and warrant further research, as decarbonisation should be prioritized over offsetting (Barron et al., 2021).

I found adopters of VCOs reported carbon data for longer, had earlier net zero target dates, and undertook more practical actions to manage carbon emissions in both 2010 and 2020 than did non-adopters. The increase in practical actions over the decade studied was similar for both groups. Mean carbon emissions, carbon intensity, and emissions reductions over time were similar between adopters and non-adopters, in fact, greater for VCO adopters on one metric. These results, therefore, do not support claims that adoption of VCOs causes mitigation deterrence (Canzi, 2006; Anderson, 2012; Koberstein et al., 2021). Rather, co-adoption of carbon management technologies including VCOs was found, as VCO adopters undertook significantly more carbon management actions consistent with literature describing adoption of mutually re-enforcing technology clusters (Rogers, 2003, p. 249; Reynolds, 2014; Carmichael et al., 2021).

One explanatory factor may be that adopters described adoption of VCOs in terms relating to pro-social and pro-environmental behaviours, which may protect against moral licensing in some cases (Steg & Vlek, 2009; Wittek & Bekkers, 2015) which may protect against moral licensing in some cases (Gholamzadehmehr et al., 2019). Additionally, VCOs create financial costs to adopters that internalise the externalities of carbon emissions to some extent (Kuhn

& Uler, 2019), which is the opposite of moral hazard where costs and risks are placed onto others. The implication, therefore, is that, amongst the study sample, the adoption of VCOs follows the polluter pays principle (Munir, 2013), which is consistent with academic recommendations (Snyder, 2020; Ibanitoru, 2021) and environmental law, where polluters have a duty to reduce pollution and pay for clean-up costs and damages (EU, 2004; de Sadeleer, 2015). Conversely, the concept of moral hazard by definition of placing risks and costs onto others (Rowell & Connelly, 2012) can be extended to releasing carbon pollution and not paying for this pollution to be removed or compensating those impacted.

Universities currently report location-based carbon accounts, rather than market-based accounts (Sotos, 2015), which can influence perceived carbon emissions reductions and misinform decision-makers (Thomson et al., 2021). I found certain carbon management activities that are not counted in location-based accounting were undertaken more by VCO adopters than non-adopters. Thus, there may be systematic under-reporting of emissions reductions, particularly amongst VCO adopters, that may be captured with market-based reporting. This is reminiscent of agricultural life-cycle analysis, water foot-printing, and feed conversion efficiency methods where changing methods and metrics can reverse the direction of the results (Gerbens-Leenes, Mekonnen, & Hoekstra, 2011; Wilkinson, 2011; Yang, 2017).

The results in this study show that greater numbers of policies and earlier net zero targets, correlate with higher numbers of carbon management practices and significantly greater emissions reductions. While this does not prove causation, the results are consistent with theories of change underpinning many advocacy and campaign strategies (Hestres, 2015; Arensman et al., 2018; Salazar et al., 2019). Literature also indicates that policies and targets increase adoption of practices with intended outcomes (Rogers, 2003; Locke et al., 2019). I emphasise however, that the results herein relate to the study population of universities, i.e. organisations with formal processes for setting targets, monitoring and evaluating, which act differently to industrial-oriented companies that are less consumer-facing and do not publicly report environmental performance (Kotchen et al., 2012). Therefore, these results cannot be generalised to individuals or other types of organisations.

Limitations and future research

The study population here has been constrained to universities that are affiliated with a national environmental network, and carbon data prior to the Wellcome Trust's policy requiring universities in receipt of their funding to offset associated carbon emissions. Additionally, the e-survey was voluntary, which is central to ethical good practice but plausibly opens it to self-selection bias (Robinson, 2013). Consequently, I have not generalised the results beyond the survey sample and further research including longitudinal studies and research into other sectors and individuals is warranted. Finally, further research into the views of non-adopters who actively rejected VCOs would be useful, for example to help understand how they plan to meet net zero targets, including net-negative emissions targets.

4. 5 Conclusions

Amongst universities studied, I found adopters of VCOs measured their carbon emissions sooner and had earlier net-zero target dates than non-adopters. I also found greater co-adoption of carbon management practices amongst VCO adopters, consistent with diffusion theory that predicts co-adoption of mutually reinforcing clusters of initiatives. I found variables such as the policies and practices of universities correlated with carbon emission reductions, and adopters reduced their carbon emissions over time to a similar degree to non-adopters. Therefore, these results combined suggest that mitigation deterrence, moral hazard, and moral licensing were not found among the universities I studied that adopted VCOs. Rather, I found co-adoption of carbon management initiatives that delivered intended outcomes, inline with diffusion theory.

However, I conclude that key principles and practices in pollution management are lacking in carbon management and work is needed to apply the polluter pays principle to carbon management, and develop protocols to reduce carbon pollution to as low as reasonably practicable (ALARP) using best practicable environmental options (BPEO), in line with other environmental pollution management and reduce the risks of mitigation deterrence beyond the university sector.

5. TURNING THE TIDE: THESIS DISCUSSION

“When the missionaries arrived, the Africans had the land and the missionaries had the Bible. They taught us how to pray with our eyes closed. When we opened them, they [missionaries] had the land and we [Africans] had the Bible.” Jomo Kenyatta & Desmond Tutu.

Abstract

Several social and environmental problems face humanity, which can act cumulatively and synergistically, creating existential threats to people and the planet. Addressing these problems is stifled by a lack of understanding of how to design and mobilise sufficient effective solutions. Therefore, I used diffusion theory to investigate adoption and spread of Locally Managed Marine Areas (LMMAs) as one type of solution. I also examined co-adoption of carbon management policies and practices among universities that did and did not adopt voluntary carbon offsets (VCOs). Both LMMAs and VCOs are considered here to be ‘conservation initiatives’ as respectively they help conserve coastal environments, and the climate with benefits for nature, although both serve additional purposes.

The results of my research in Chapter 2 showed that intrinsic values of benevolence towards future generations motivated adoption of the LMMAs studied, while concern about conflict was a barrier to adoption. In Chapter 3, I discovered low satisfaction with LMMAs and identified areas for improvement to increase adopters’ satisfaction and likely spread of this conservation initiative through positive referrals. In Chapter 4, I demonstrated that adopters of carbon offsets co-adopted more carbon management practices than did non-adopters. Again, gaps were identified in the methods currently used to manage and report carbon emissions, and solutions proposed.

In this discussion chapter, I summarise the problems addressed, the research gaps identified, and the findings of the three research projects undertaken to address these problems and gaps. I then discuss the implications of my research for the application of diffusion theory to conservation. Bringing these findings together, I provide a framework and recommendations for future advancements in conservation research how this can be used in to improve performance and therefore adoption, spread and co-adoption of effective conservation initiatives ethically.

5.1 Summary of research questions and findings

Adoption of LMMAs

Targets for greater adoption of effective conservation and sustainable development initiatives are increasing (e.g., CBD, 2022; UNEP, 2022; UNGA, 2023a). However, conservation literature differs in its conclusions about what motivates adoption of conservation initiatives, particularly whether financial incentives help or hinder adoption of conservation agriculture (Pannell et al., 2006; Farmer et al., 2011). Empirical research identifying what can help and hinder the adoption of conservation initiatives is limited (Admiraal et al., 2017). Therefore, the first research question addressed was: “What influences the adoption of conservation initiatives?” The case study I used was the adoption of Locally Managed Marine Areas (LMMAs) in north-eastern Madagascar (Chapter 2).

My analysis found that anticipated benefits to future generations was the strongest positive influence on LMMA adoption, followed by funding, as found elsewhere (O’Garra, 2009) plus control over their own resources. Nature conservation was not the key driver for LMMA adoption in this study. The results herein also support other research that indicates intrinsic values are important to adopters of conservation (Farmer et al., 2011; Admiraal et al., 2017), more so than reported in diffusion theory. Therefore, priming intrinsic values may enhance the adoption and spread of these conservation initiatives. A negative influence on the adoption of LMMAs was concern about conflict that arose within and between villages during the adoption-decision. Conflict is not unusual in conservation (Bennett, 2014; Robertson et al., 2020), consequently, codes of conduct for conservation, and social protection policies have been recommended (CFS, 2012; Bennett et al., 2017; Knox, 2018; UNGA, 2018). Newing and Perram (2019) remind conservation organisations of their responsibility as secondary duty-bearers to do no harm, in line with other industries.

This research contributes several key conclusions to conservation science. My results support previous studies suggest that benefits to future generations motivates adoption of LMMAs (Govan, 2009; O’Garra, 2009; Jupiter, et al., 2014). Also that conflict from conservation initiatives is a concern that needs to be addressed (for ethical reasons as well as to support the adoption of conservation initiatives) (Bennett et al., 2017; Ban et al., 2019). And finally, my results are consistent with diffusion theory in that relative advantage played a

large role in the adoption-decision (Rogers, 1983; Mbaru & Barnes, 2017; Dearing & Cox, 2018; Mascia & Mills, 2018). However, I offer new insights into how diffusion theory may need to adapt to the adoption of conservation initiatives. I find that the decision whether to adopt the LMMAs studied was more motivated by values of benevolence and harmony, with relative advantages to others rather than to the adopter, which supports literature describing intrinsic values as key drivers of motivating pro-environmental behaviours, such as engaging with conservation initiatives (Crompton & Kasser, 2010; Farmer et al., 2011; Schultz et al., 2016; Cetas & Yasue, 2017).

Satisfaction with and likely spread of LMMAs

Diffusion theory describes the spread of innovations as being increased by adopters sharing positive opinions with their peers about their experiences (Admiraal et al., 2017). Aware of this, businesses measure customer satisfaction using standardised methods and respond to maximise growth (Rogers, 2003; Dearing, 2009). However, customer satisfaction is rarely measured in conservation evaluations (Sun et al., 2013; Sever, 2015). Therefore, the second research question I addressed was: “What did adopters think of their conservation initiatives?” using Locally Managed Marine Areas (LMMAs) in north-eastern Madagascar (Chapter 3) as a case study.

The results identified two attributes with high adopter satisfaction, and four particularly unsatisfactory attributes, with an overall negative result across all attributes measured. This result is consistent with the only other study found to use this method in a conservation evaluation (Agyare et al., 2015), but compares unfavourably to Importance-Performance Analysis (IPA) studies in other industries (Azzopardi et al., 2013). The Net Promoter Score (NPS) also returned negative results, which, together with a negative IPA result indicate likely limits on LMMA spread (Blasberg et al., 2008; Azzopardi et al., 2013; Sun et al., 2013; Ramirez et al., 2014; Dearing et al., 2018). Furthermore, while the IPA and NPS delivered negative results, whereas simple averages of the data, a method generally used in conservation project evaluations (Glew et al., 2012; Gurney et al., 2014; Ahmadia et al., 2015; Mascia et al., 2017) returned positive results. NPS sets a higher bar for returning positive results as it only codes ratings of ‘much better’ as positive. NPS discards ‘somewhat better’ ratings as ‘neutral’ and all other ratings are coded as negative ‘detractors’. Therefore, where simple averages are used, there may be systematic over-estimates of adopters’ satisfaction with LMMAs and mask opportunities to improve likely spread. Use of customer

satisfaction research methods is therefore recommended for future conservation evaluations that would benefit from spread through positive peer-to-peer referrals, and could be considered as a measure of ethical performance.

This research contributes the following insights to conservation science. First, adopters were unsatisfied with their conservation initiatives on most attributes tested, which may limit spread through peer-to-peer referrals. Second, measuring, responding to and avoiding negative perceptions of impacts on adopters on attributes that matter to them will increase likely spread of LMMAs, and can help address ethical concerns around the implementation of conservation initiatives (Greiber, 2009; de Lange, Woodhouse, & Milner-Gulland, 2016; Bennett et al., 2017a; Newing et al., 2019). I demonstrated that customer satisfaction methods can be used in conservation evaluations and can generate important insights into people's perceptions of conservation initiatives.

From this research, I recommend impact assessments be required for conservation initiatives prior to them being replicated elsewhere, with possible negative impacts identified and communicated to potential adopters and those impacted, with agreed monitoring, mitigation, remediation and compensation, in line with other disciplines (EU, 2004, 2011; Saeed et al., 2012; Brittain et al., 2020).

Co-adoption of carbon management practices and consequent emissions reductions

There is high confidence that rapid reductions in carbon emissions and durably stored carbon removals are required to limit global warming (IPCC, 2023). However, some carbon mitigation measures are controversial, including adoption of voluntary carbon offsets (VCOs). Some claim that VCO adoption deters adopters from adopting other carbon mitigation measures, eroding emissions reduction efforts (Canzi et al., 2006; Anderson, 2012). However, these claims are not based on research. Therefore, the third research question I addressed was: "Does the adoption of one conservation initiative relate to the adoption of another?" For this study, I examined carbon management strategies among universities that do and do not adopt voluntary carbon offsets (VCOs) (Chapter 4).

My analysis showed adopters of VCOs held more ambitious net zero targets and undertook more carbon management practices than did non-adopters, and both metrics correlate with reductions in carbon emissions. However, I also found that adopters and non-adopters of VCO reduced their reported carbon emissions over time by similar amounts. Although I could not test for causality, my results suggest mitigation deterrence was not

found, in fact, co-adoption was found, in line with diffusion theory (Rogers, 2003; Carmichael et al., 2021). Rather than finding VCOs cause moral hazard, it is possible purchasing VCOs reverses moral hazard by internalising externalities, and enacts the polluter pays principle where polluters pay for pollution prevention, reduction, remediation or compensation for damages (OECD, 1972; de Sadeleer, 2015; Ibanitoru, 2021).

Additionally, this study also found carbon emissions reductions may be under-reported, particularly for adopters of VCO who co-adopted more actions to reduce carbon emissions that are not included in current reporting methods. To address this and improve future research and carbon management, I recommend universities use market-based carbon reporting, as described elsewhere, as well as location-based reporting (Ceppi, 2006). I also recommend the development of policies to reduce emissions to As Low As Reasonably Practicable (ALARP), in line with requirements in other disciplines (Burgman, 2005; Pike et al., 2020).

This study contributed empirical data to the previously data-poor debate about possible rebound effects when managing carbon emissions. Access to market-based emissions data would allow additional analysis of changes in market-based carbon emissions over time in future research. Also, if the recommendation to add market-based emissions reporting is followed, much more detailed and useful emissions data will be available for future research. But perhaps more usefully, this study considers carbon dioxide (CO₂) emissions as waste pollution for climate mitigation, after (Buck, 2020; Kadkhodayan & Alizadeh, 2022). Through this rationale, I identify pollution control principles (polluter pays principle and the precautionary principle) and policies and practices (ALARP and EIA policies and practices) that can, therefore, be applied to help conserve the climate.

5.2 Implications for conservation science and practice

In this thematic discussion, firstly, I discuss my research in relation to diffusion theory, followed by a discussion of the implications of my findings for conservation science and practice. I collate my research findings and the policies, practices and theories discussed herein, into a comprehensive conservation framework that forms the basis of my recommendations for future conservation research and practice.

Diffusion of conservation initiatives

Considering the results of the three data chapters collectively, my results were largely consistent with diffusion theory (Rogers, 2003; Dearing & Cox, 2018;), however some differences were evident. Following Figure 1.1, knowledge of the LMMAs studied in Chapter 2 was brought to villages through communications with peers and knowledge exchange visits to villages with LMMAs. As found elsewhere, LMMAs were supported by conservation charities through the persuasion phase (Roccliffe et al., 2014), and in the villages studied, the charity also provided technical support and livestock incentives to villages establishing LMMAs. The adoption-decision was not significantly influenced by the adopter characteristics examined in Chapter 2 (sex and leadership roles), although other characteristics not tested here may have been significant. Certain innovation characteristics tested in Chapter 2 were significant, in line with diffusion theory. The adoption-decision was driven primarily by anticipated relative advantages, as described in diffusion theory, but this usually relates to advantages to adopters such as improvements in their health, status or finances (Rogers, 2003; Kuehne, 2017; Dearing & Cox, 2018). Whereas adoption of the LMMAs I studied was founded primarily on anticipated benefits to future generations; and benefits to adopters', finances, control over resources and livelihoods were secondary. This indicates greater emphasis on pro-social, intrinsic, values during the adoption-decision of the LMMAs studied than in current diffusion literature. It also demonstrates the value of context-specific market research at the design stage and adaptation or re-invention of initiatives to increase likely adoption (Wejnert, 2002; Rogers, 2003; Weeks et al., 2013). Of the five innovation characteristics described in diffusion theory to influence adoption (Rogers, 2003), three were not significant to the adopters of the LMMAs studied: trialability, observability and complexity in this case study.

Following Figure 1.1 further, Chapter 3 found that LMMA adoption led to outcomes, perceptions, and opinions, consistent with diffusion theory. However, the negative opinions reported by adopters likely limits spread of LMMAs through positive referrals. This limitation may perpetuate reliance upon outside actors to diffuse this conservation initiative. Despite experiencing negative impacts, adopters wished to keep their LMMAs, re-enforcing their adoption decision. Finally, in Chapter 4, when researching carbon management in universities and the impacts of adopting voluntary carbon offsets, I found co-adoption of mutually re-enforcing innovation clusters, in line with diffusion theory (Rogers, 2003;

Dearing, 2009; Carmichael et al., 2021;). I also found adopters' characteristics (for example earlier net zero targets) related significantly to adoption of carbon offsets and other carbon management practices, in line with diffusion theory (Rogers, 2003; Wisdom et al., 2014; Dearing & Cox, 2018). Flowing from this, greater adoption of carbon management practices correlated with greater levels of intended outcomes (reduced carbon emissions), supporting inherent assumptions in diffusion theory and theories of change that adoption of policies and practices brings relatively advantageous intended outcomes (Wisdom et al., 2014; Kuehne, 2017; Pannell & Zilberman, 2020).

Therefore, my results were largely consistent with diffusion theory and no alterations to Figure 1 are required, although greater attention to pro-social values is recommended. This research examines decision-making by whole organisations (villages) or on behalf of whole organisations (universities), and diffusion theory postulates organisational decision-making may differ from that of individuals (Rogers, 2003, p. 348; Wisdom et al., 2014). Therefore, further research into the co-adoption and diffusion of conservation initiatives amongst individuals is warranted.

Methods and metrics matter

The three research studies herein show the importance of ensuring that scientists engage with the appropriate methodology and metrics when trying to understand the impacts of conservation initiatives. In particular, two issues arose that may benefit from further consideration: what was being measured; and how results were interpreted.

Chapter 2 showed the main driver for LMMA adoption was something not included in my initial list of 35 potential impacts of conservation initiatives derived from conservation evaluation literature and practice (Glew et al., 2012; Gurney et al., 2017; Mascia et al., 2017; WWF, 2022). Rather, the primary driver for adoption in my research arose from focus groups in the field: benefits to future generations. Although this attribute has been associated with adoption of LMMAs (Govan, 2009; O'Garra, 2009), it is not measured in standardised conservation evaluation manuals and therefore may be systematically overlooked. Inclusion of metrics that matter most to those being surveyed is important (Woodhouse et al., 2016). To ensure metrics that matter most to adopters are used, methods such as focus groups can be used to derive and test the attributes surveyed (Newing et al., 2011, p. 59; Malakar, Mishra, & Patwardhan, 2018). Which metrics are used to evaluate the impacts of conservation

initiatives on future generations also requires discussion with adopters, and will likely require projections to be made based on recent trend data and likely scenarios.

In Chapter 3, adopters perceived negative outcomes on attributes relating to funding and livestock given to villages establishing LMMAs, whereas increases in material wealth are reported as positive elsewhere (Ban et al., 2019; Jupiter et al., 2014). The difference is likely methodological as I measured adopters' subjective perceptions of whether changes were better, same or worse, rather than objective measures of increases or decreases. Also, I interpreted 'worse' as negative, even though there was an increase in livestock and funding in the villages. Whereas other surveys ask whether incomes or wealth increased and interpret increases as positive and decreases as negative (Sup. Inf. Table 3, Ban et al., 2019). Whereas, the adopters I surveyed reported perceiving the funding and livestock given to them negatively due to unfair distribution of these resources. Interpreting 'respondents perceiving increases on socio-ecological metrics' as 'respondents perceiving positive impacts' is found elsewhere in conservation literature (Smallhorn-West et al., 2019), but can confuse an objective measure for a subjective opinion. Measuring respondents' subjective perspectives is standard in customer satisfaction research and could improve future conservation evaluations.

Similarly, results from the VCO study in Chapter 4 differed from publications claiming that adopting VCOs reduces adoption of other climate-conserving initiatives (Canzi, 2006; Anderson, 2012; Greenberg & Fang, 2015). Those predictions were based on the opinions of experts rather than research. While expert opinion makes valid contributions to decision-making, multiple evidence bases, including scientific research data are required (Tengo et al., 2014; Collins, Coughlin, & Randall, 2019; Hulpke et al., 2021). Secondly, this chapter identified that the method required of universities when reporting carbon emissions (location-based carbon accounting) hindered comparative analysis of carbon emissions reductions between VCO adopters and non-adopters, that may have been measurable with data from a different method (market-based carbon accounting). For example, location-based reporting uses the average emissions intensity of power grids from which energy is purchased. Whereas, market-based method calculates emissions from specific electricity tariffs from which energy is purchased, which may have a lower carbon footprint if it is a renewable energy tariff (Morgan et al., 2006). If one study group adopts renewable electricity tariffs more than a comparator group, this difference will only be apparent with market-based reporting methods. Therefore, reporting market-based emissions in addition to location-based data could improve future research.

Raising standards

Negative impacts from conservation initiatives are reported in post hoc conservation evaluations and academic literature (Bennett et al., 2014; Oldekop et al., 2016). As well as reducing adoption and spread of conservation initiatives (Dearing & Cox, 2018), negative impacts from conservation also raise ethical concerns. However, I have not been able to find scientific literature evaluating best practices in predicting and minimising impacts of conservation initiatives on people or ecosystems *a priori*. Only, predicting and minimising negative impacts from conservation on biodiversity is addressed, where mitigation hierarchies and no net loss approaches are proposed (Arlidge et al., 2018). As no net loss trades negative impacts against positive ones it may not apply when addressing impacts on humans, rather, academics propose conservation adopt ‘no loss’ or ‘do no harm’ to people (Greiber, 2009; Newing & Perram, 2019) in line with medicine (Hughes, 2007). However, adequate research and processes to ensure conservation initiatives do no harm are lacking, and concern remains about negative impacts on people’s livelihoods (UNFAO, 2017) and human rights UNHCR (Knox, 2018), and protection for people from conservation is recommended (UNFAO, 2015, 2017).

In response, United Nations agencies, IUCN, NGOs, and academics have generated manuals, guides, toolkits, standards, strategies, frameworks and policies to improve the design and management of conservation initiatives, minimise negative and maximise positive outcomes of conservation. However, even recent conservation science and practice literature focuses on post-hoc evaluations rather than *a priori* assessments, and approach conservation through the lens of ‘implementation, enforcement, compliance’ rather than ‘engagement, adoption and satisfaction’ (WWF, 2022; Bergseth et al., 2023). This may retain the legacy of colonialism in conservation described by Smallhorn-West et al. (2023) in both science and practice. One standard agreed across many NGOs that may be best suited to addressing impacts *a priori* is the Open Standards for the Practice of Conservation Version 4.0 because it includes an equal focus on the planning and evaluation phases of conservation initiatives (CMP, 2020). However, the standards, policies and guidelines are voluntary. NGOs consider voluntary measures insufficient to mitigate negative impacts and “not appropriate in situations where high rates of participation and compliance are required, where there is limited flexibility regarding actions and timings, or where serious social or environmental risks are involved” (RSPB, 2015). RSPB continues: “Best-practice design features include the need for clearly defined and measurable targets against which performance can be

assessed, alongside robust and transparent monitoring and reporting requirements” with “a credible threat of sanctions” of those causing negative impacts.

Another limitation is that many conservation initiative evaluations have been conducted, supported or funded by, or in collaboration with the NGOs whose initiatives were evaluated (Weeks et al., 2013; Jupiter et al., 2014; Roccliffe & Harris, 2014a; Ahmadia et al., 2015; Arton et al., 2020; Lewis-Brown et al., 2023). This demonstrates impressive work by NGOs to measure conservation impacts to improve practice, and some transparency is provided where authors’ institutions and funding sources are listed in journal articles (e.g., van Putten et al., 2020). However, independent evaluations are recommended, with declarations of interest declared, and preventative actions to minimise impacts of vested interests (Wahlén, 2014; Pleger & Hadorn, 2018). Some journals seem to specify that ‘conflict of interest’ or ‘competing interests’ are declared, for example PLOS and Conservation Science and Practice, while some Marine Policy articles seem not to include this statement (Long, 2017; Gardner et al., 2020) nor Nature Sustainability (O’Garra et al., 2023). Therefore, science publications can raise the standards here by always specifying this field in publication submissions, with guidance about what constitutes a possible conflict of interest.

Ethical consideration is also extended to the impact of research on the environment (Cooney et al., 2021), on survey respondents (Labott et al., 2013), and on researchers themselves (Fair et al., 2022). Impacts on respondents and researchers may differ depending on researchers’ experience, gender, ethnicity, language, judgements, and affiliation to an organisation supporting projects being evaluated or independent (e.g., Long et al., 2019; Long et al., 2021). Lastly, despite anecdotal evidence that project failures are common, there is a dearth of publications on failed projects which would form a rich area for learning (Catalano et al., 2019).

As noted in Chapters 2 to 4, other industries are bound by higher standards to predict and mitigate negative impacts from their activities. Several industries must submit extensive assessments (that predict possible negative impacts from proposed initiatives and provide plans to monitor and mitigate impacts) to independent review boards for permission to proceed, including certain public projects (EU, 2011), academic research (Brittain et al., 2020) and medicine (Griffith, 2012). Risks must be managed using the precautionary principle and reduced to As Low As Reasonably Practicable (ALARP) using Best Practicable Environmental Option (BPEO), with polluters paying for residual emissions (Burgman, 2005; de Sadeleer, 2015; EU, 2004; Lewis, 1988; Pike et al., 2020). Decisions to permit activities

that may cause negative impacts are expected to be science-based, even amongst authors proposing evidence-based decision-making is a fad (Hulpke & Fronmueller, 2021). These requirements are particularly relevant for conservation initiatives as they are designed to create significant change to rare, remote, vulnerable, species, habitats and landscapes, affecting local rights-holders and resource-users. These qualifying features triggering EIAs for example (EU, 2011). Generally, vulnerability assessments and adaptive capacity planning should consider multiple interacting impacts and how vulnerabilities and adaptive capacities differ between sections of societies, including potential thresholds that may be crossed and feedbacks triggered that dampen or amplify impacts (Bennett et al., 2016; Blythe et al., 2017; Whitney et al., 2017). With this information, adaptive capacities should be increased with no-regret decisions that bring the least harm and greatest benefit (Bennett et al., 2016). I extend these suggestions to evaluating and addressing the impacts of conservation initiatives on social and ecological systems and place the duty of care on change-makers to predict and mitigate negative impacts.

For certain industries, NGOs have established governing bodies to manage and mitigate negative impacts on their conservation interests and increasingly on local communities. These include WWF establishing the Gold standard for the VCOs studied in Chapter 4, MSC to certify fisheries and FSC for timber (Auld, Gulbrandsen, & McDermott, 2008; Kollmuss, 2008; Gulbrandsen, 2009). While some research is critical of some of these certification bodies (Bush et al., 2013; Catalano et al., 2019), other research is more favourable about the standards they set and outcomes (Lovell, 2010). A similar independent body could be established for conservation initiatives. It could assess the likely ethical and environmental risks of conservation initiatives, certify ones that pass set criteria, conduct monitoring and evaluation and provide accessible complaints procedures with authority to intervene and seek redress where negative impacts occur. This could help to bring conservation initiatives to the same standards required of other industries. Additionally, an ISO could be established for conservation initiatives, organisations and evaluations, akin to that for environmental impact assessments, environmental management systems (ISO 14000, 14001), carbon offsets (ISO 14064), occupational health and safety (45001). An ISO for biodiversity is currently under development, led by the ISO technical committee ISO/TC 331 (ISO, 2022), which can contribute to improving and increasing conservation practice, if combined ISOs that ensure protection of people as well as the planet.

To address the implications discussed above, the findings of this thesis are collated into a comprehensive conservation framework (CCF) (Figure 5.1). The CCF is designed for organisations aiming to change situations and systems through developing conservation initiatives (change-makers), to help them fulfil their duty to do no harm (Greiber, 2009; Newing et al., 2019), and protect vulnerable people when making changes that impact others (UNFAO, 2015) (Chapter 2, 3). Communities and adopters wishing to make changes within their own systems can also use the CCF. If a conservation certification body were established it could act as the ‘independent’ body in the CCF.

The CCF (Figure 5.1) is inspired by diffusion theory and the five core elements of the conservation standards (CMP). The five elements of the CMP are: 1. assess, 2. plan, 3. implement, 4. analyse and adapt, 5. share (CMP, 2020). However, conceptually, a significant difference between diffusion theory and the CMP is that diffusion theory considers adopters who adopt initiatives, whereas the CMP considers initiatives that are ‘implemented’. The shift from ‘implementation’ of conservation initiatives to ‘adoption’ is key to the CCF where agency remains with adopters. Thus, the CCF conceives adopters as the rights-holders and resource-users, and treats them akin to customers whose opinions matter and must be measured, whose rights and dignity are paramount and must be safeguarded. Voluntary adoption of conservation initiatives inherently includes free and prior informed consent (FPIC) but FPIC is included explicitly in the CCF for those affected by conservation initiatives. The CCF also requires that adopters of conservation initiatives, or those affected, must have access to independent anonymous complaints procedures with repair and recompense, and sanctions against conservation organisations for negative impacts, as with other industries and the certification bodies such as the Gold Standard, MSC, FSC. The elements in the CCF already exist either in conservation, environmental management or adjunct disciplines, and single elements can be added to existing frameworks or in combination.

Using the CCF starts with the top of the first column and progress down each column in turn, starting with 1a) and ending with 5e). It is underpinned by principles and practices that are advocated for by conservation and development organisations to protect people and the planet, principally, do no harm (Chapter 2, 3). Once change-makers become aware of a conservation issue they perceive is a problem that they wish to change, the first step is a situation analysis (Jaansoo, 2019) including a vulnerability analysis and adaptive capacity analysis (Whitney et al., 2017). This leads to understanding of potential adopters and the

context before conceiving whether and what conservation initiatives might be appropriate, in partnership with those affected and potential adopters. Best-Worst Scaling choice experiments could be used to rank the relative importance of different conservation initiative options or factors and templates are provided online (Lewis-Brown, 2023). I encourage sharing of data to permit wider learning opportunities and research.

The first step in column 2 is to combine information from 1a) to 1e) to screen conceived conservation initiatives for significant impacts, as done with EIAs (as described in Chapter 3) with participation of those potentially affected (Wathern, 1992). The results should be reviewed and a decision made of whether to progress further. If continued, plans to develop the conservation initiative should be communicated to other stakeholders not already involved. Co-designing conservation initiatives must include plans to ensure benefits are distributed in ways that are considered fair locally (as discovered in Chapter 2) (Gurney et al., 2021). This step includes co-designing the most important metrics to measure from the perspective of those affected (Woodhouse et al., 2015) within no or minimal interpretation by researchers. Standardised customer satisfaction research methods such as IPA and NPS are recommended (Matzler, Sauerwein, & Heischmidt, 2003) and simple mean averages of ratings scores are not recommended (as discussed in Chapter 3).

Column 3 starts with a full risk and impact assessment and mitigation plans for any significant impacts on people and the planet through for example standard EIA practices (recommended in Chapters 2, 3). Possible impacts would be reduced using ALARP and BPEO inline with environmental protection principles and practices (a key conclusion of Chapter 4). Much of the previous steps are included to some extent in the current CMP, although the CCF brings conservation on par with requirements of other industries. A new element proposed here for conservation, is an ethics review process, as standard in academic research and projects requiring planning approval (Chapter 3). It should be independent and possibly anonymous. FPIC is a requirement elsewhere (UNFAO, 2016) and is therefore included in the CCF along with a pilot, review and revise phase.

Post-adoption, the first step is for customer satisfaction to be measured, with industry research methods, such as IPA and NPS (Chapter 3), and templates are provided online (Lewis-Brown, 2023). Additional independent post-hoc monitoring and evaluation is included in the CCF to ensure negative impacts and rebound effects are identified mitigated (Chapter 2, 3, 4). Social and ecological evaluation methods including comparisons with situations without the conservation initiative are recommended (Smallhorn-West et al., 2019).

Repair and recompense of negative impacts is also included in the CCF (Chapter 2), and results communicated, which may help spread conservation initiatives considered satisfactory by adopters (Chapter 3).

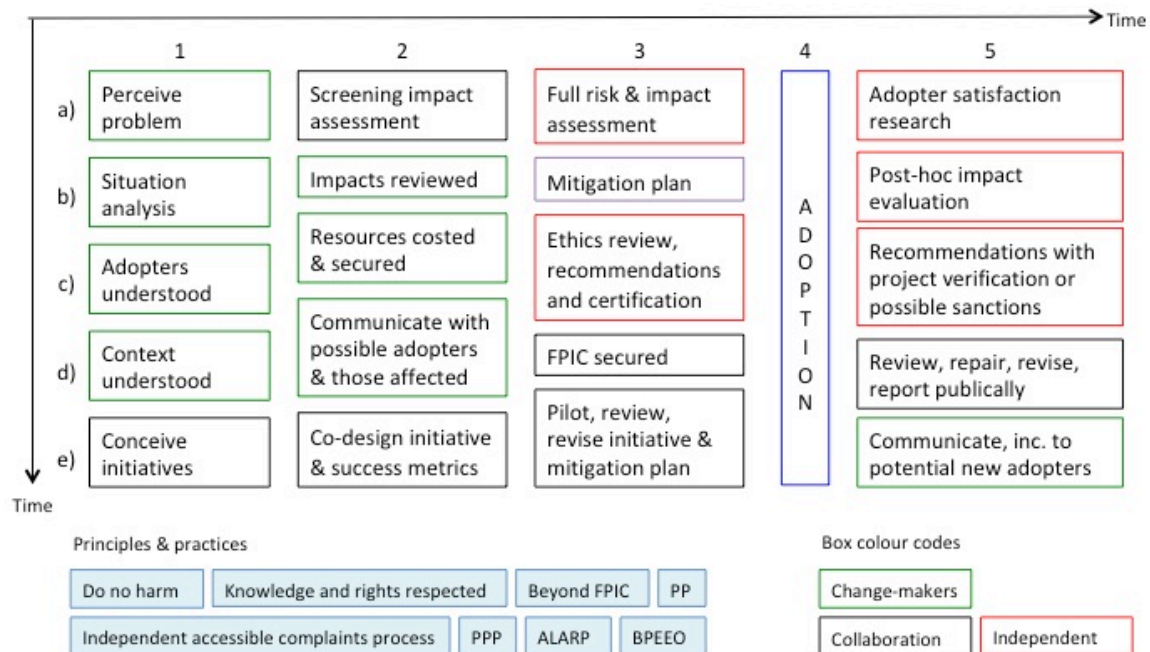


FIGURE 5.1 The comprehensive conservation framework (CCF) for use by those intending to undertake or engage with conservation initiatives that may impact others and as such have a duty of care. They may be external or internal to the system or community where change is intended. The framework flows from the top left corner flowing vertically through each column to the bottom right. Black boxes indicate steps that may be collaborative between change-makers and adopters or communities affected by conservation initiatives. Red boxes indicate steps undertaken by independent and impartial bodies. The elements of the CCF can be implemented singularly or as a suite of measures and is underpinned by policies, principles and practices applied to industries (blue boxes): ALARP (As Low As Reasonably Practicable), BPEO (Best Practicable Environmental Option), FPIC (Free Prior Informed Consent), PPP (Polluter Pays Principle), and PP (Precautionary Principle).

Recommendations for future research

Further research to understand which relative advantages to future generations conservation adopters seek, could inform and improve future conservation practice and increase the uptake of conservation initiatives (Chapter 2). Research to better understand the barriers to adoption, especially conflict, is urgent, and investigations into the issues of translocating conservation initiatives from one culture to another can be part of this work.

Further research is recommended to study adopters' perceptions of conservation using industry standards for customer satisfaction (Chapter 3), and where existing surveys are in place, simply adding the two standard NPS questions may be optimal. The classic NPS questions are rated on a scale of 1 to 10: "How likely are you to recommend this initiative to a friend or colleague" and "Please explain why" (Krol et al., 2015; Bendle, Bagga, & NastasoIU, 2019; Qualtrics, 2022). Research as to whether or not, high NPS results relate to actual referrals and spread of conservation initiatives through social networks would be useful. This could be combined with research to establish how to improve adopter satisfaction that may help increase spread, such as through Importance-Performance-Analysis (Azzopardi & Nash, 2013). I provide templates with example data for Importance-Performance Analysis, Net Promoter Score, and Best-Worst-Scaling in Excel (Lewis-Brown, 2023). Further, research to compare what conservation adopters were told and understood would be the outcomes (positive and possible negatives), with their perceptions of the outcomes could provide useful scientific data. This could be used to improve conservation practices as setting realistic expectations can improve satisfaction with initiatives and therefore likely spread (Agyare et al., 2015).

Diffusion theory states that change agents and researchers assume that adoption and spread of innovations is beneficial through pro-innovation bias (Rogers, 2003; Dearing et al., 2018). However, negative impacts were found amongst adopters of LMMAs supported by an NGO. I did not study adopters' satisfaction with LMMAs that spread through peer-to-peer referral. Therefore, future research could compare adopter satisfaction with impacts of conservation initiatives that spread through peer referral with those that are adopted and managed entirely independently. As 'control over our resources' was a positive attribute during the adoption of LMMAs (Chapter 2), and dissatisfaction with the NGO supporting LMMAs was expressed (Chapter 3), it is possible spread through peer-to-peer referral may be preferable to adopters. Simultaneously, adopters of LMMAs we studied wanted more support such as livestock from the NGO, and therefore spread of LMMAs that include fisheries restrictions without social protections, such as livestock, may cause more negative impacts. Therefore, it is plausible that adopter satisfaction and impacts differ in either direction and scientific research is needed to understand this better and inform conservation practice.

Due to the gravity of threats to people and the planet from climate change, further research into possible rebound effects from adopting VCOs on adoption of other carbon management strategies and carbon emissions is needed urgently required (Chapter 4). This could be

targeted first at the largest polluting organisations, and policy-makers, to have greatest effect on climate mitigation. Deeper understanding of what tools can be used to counter rebound effect would also be beneficial.

Conservation initiatives can make vulnerable people more vulnerable, for example through changing access to resources, livelihoods, or food sources. Therefore, evaluations to predict and mitigate negative impacts from conservation initiatives are needed (Chapter 5). Research including a wider range of stakeholders is also warranted (Bennett et al., 2019; Bennett et al., 2023). For example, further research would be useful to test whether human well-being is protected and improved by using the comprehensive conservation framework (Figure 5.1) with an approach of ‘engage, adopt, satisfaction’, compared with the business as usual conservation approach of ‘implement, enforce, compliance’. Equally, impacts on the environment could be compared between conservation initiatives using and those not using the CCF. The first task would be to seek expert opinions as to whether the CCF can be improved before researching its effects. Many new frameworks are created and proposed, and scientific research into their effectiveness seems necessary.

An advantage for future research of using the CCF is that if the methods proposed here were used widely, it could generate standardised robust and relevant data across conservation initiatives, contexts, and over time, that can be evaluated for stand-alone research, but also for meta-analyses. Finally, research into the economic and practical feasibility and usefulness of an independent certification body for conservation organisations and initiatives would be useful. Such science-based knowledge can help inform robust conservation decision-making.

5.4 Concluding remarks

The research in this thesis has shown that there is pressing need to switch from the previous and current path of injustice and instability, and switch path to create sustainable futures where ethics and justice are integrated into sustainable transformations. This thesis provides data and insights that can help increase the adoption and spread of conservation initiatives, retaining agency with the rights-holders. However, the negative impacts from conservation initiatives on adopters signifies the need to ensure conservation initiatives do no harm, and I propose ways to bring conservation up to the standards expected in other disciplines. I also offer insights to improve the methods and metrics used in conservation science, starting with a requirement for a solid foundation, such as scientific research, to inform publications, and

independence or transparency in conservation evaluations. Drawing the insights and implications of my research together, I offer a comprehensive conservation framework in an attempt to provide a simplified structured process to help humanity change onto the path less travelled by towards the preservation of the Earth, ethically.

6. APPENDICES

APPENDIX 1 Chapter 2 and 3 Survey instrument

Instructions for the Interviewer

Please note; all words that are unlined are guidance notes to the interviewer.

Only the words in *italics* should be read out loud to the interviewee.

Please have the questions Q1 and Q3 to Q8 filled out before the interview starts.

Section 1. Identification

1. Unique consecutive identification number of this survey _____
2. Background Information sheet read out and consent given Yes / No
3. Name of interviewer _____
4. Name of translator _____
5. Name of LMMA or fishing ground _____
6. Village name _____ Country Code: 450 (Madagascar)
7. Interviewee Code (village name / interviewee number) _____
8. Date _____ 9. Sex _____ 10. Start time _____

Section 2. LMMA Characteristics

11. *What is the first thing that comes to mind when you hear “Locally Managed Marine Areas”?*

12. *On the scale below from very easy to very difficult, how easy or difficult is it to know what an LMMA is?*

Very easy	Moderately easy	Neither easy nor difficult	Moderately difficult	Very difficult

Not sure ☐

For the purposes of this survey, we can consider that Locally Managed Marine Areas (LMMAs) are areas of ocean managed by coastal communities to help protect fisheries and safeguard marine biodiversity.

In this part of the survey, I'd like you to think back to when your village was first considering whether or not to establish an LMMA. I will read out four statements about the LMMA, and I want you first to tell me which one of these four statements your village thought would be the BEST thing about establishing an LMMA, and then tell me which one of these four statements the village thought would be the WORST thing about an LMMA. This is repeated several times with different options available.

13. *When your village was deciding whether or not to have an LMMA, which one of these four statements was thought by your village to be the BEST thing about an LMMA?*

And which one was thought by your village to be the WORST thing about an LMMA?

8 CHOICE SETS with 4 attributes each listed according to a balanced block design

BEST		WORST

Best-Worst Scaling Choice Experiment Attribute Statements.

Item number	Choice Item Statement
1	The amount of money we could earn
2	The incentives for villages to establish and run an LMMA
3	Possible connections to other people beyond the village
4	The control we would have over our marine resources
5	New habits that might be needed
6	Whether LMMAs can be tested or changed to meet our needs
7	How complicated or simple it seemed to establish an LMMA
8	Someone in the village had seen or heard about an LMMA and its impacts
9	The benefit to future generations
10	The restriction of certain activities in an LMMA
11	The level of conflict in or beyond the village
12	The health of the environment (non-target species)
13	The monitoring and enforcement of the rules
14	The food we could catch to eat
15	The funding and training provided by an NGO
16	The pressure on the resources due to more people fishing

Bloc design for attributes in each of the 8 choice sets. Each survey had eight choice sets, each with four attributes selected according to the table below. There are eight versions of the bloc design to balance co-appearance. Each attribute appears twice per survey.

Version	Set	Attribute1	Attribute2	Attribute3	Attribute4
1	1	14	7	3	13
1	2	13	4	11	2
1	3	4	10	8	9
1	4	11	12	5	1
1	5	7	16	10	12
1	6	9	3	1	15
1	7	5	14	6	8
1	8	6	2	15	16
2	1	16	9	14	11
2	2	8	13	16	1
2	3	15	12	4	14
2	4	10	15	13	5
2	5	5	9	7	2
2	6	1	6	7	4
2	7	3	6	11	10

2	8	2	8	12	3
3	1	7	14	9	6
3	2	11	5	13	3
3	3	12	15	2	16
3	4	8	11	15	7
3	5	13	9	12	6
3	6	14	1	2	10
3	7	16	5	3	4
3	8	10	4	8	1
4	1	9	2	8	13
4	2	2	4	5	14
4	3	15	8	3	7
4	4	4	11	6	15
4	5	1	6	13	12
4	6	10	16	9	11
4	7	3	1	14	16
4	8	7	10	12	5
5	1	5	8	1	9
5	2	1	7	2	11
5	3	6	5	16	8
5	4	12	11	14	15
5	5	9	3	4	12
5	6	4	13	16	7
5	7	6	3	10	2
5	8	14	13	10	15
6	1	12	2	9	3
6	2	11	1	6	4
6	3	15	5	1	9
6	4	13	15	10	8
6	5	8	14	11	12
6	6	16	10	4	3
6	7	2	7	13	6
6	8	16	7	5	14
7	1	4	13	12	5
7	2	11	14	9	13
7	3	6	12	7	10
7	4	3	11	7	8
7	5	5	3	15	1
7	6	14	1	2	10
7	7	9	16	6	15
7	8	2	16	4	8
8	1	6	4	14	5
8	2	13	3	16	11
8	3	12	13	1	16

8	4	15	2	1	7
8	5	8	12	10	9
8	6	10	11	5	2
8	7	3	8	14	6
8	8	7	15	9	4

14. *Was anything else important to your village when deciding whether or not to establish an LMMA, which we have not discussed yet?*

If the interviewee gives one word answers, such as “education”, “tourism”, or “goats” please ask why this was important or what was that was important.

Thank you, that was very helpful.

15. *How easy or difficult was it to think back to when your village was first deciding whether or not to establish an LMMA?*

Very easy	Somewhat easy	Neither easy nor difficult	Somewhat difficult	Very difficult

Not sure ☐

16. *How easy or difficult was it to answer these questions on behalf of the village?*

Very easy	Somewhat easy	Neither easy nor difficult	Somewhat difficult	Very difficult

Not sure ☐

Section 3. Decision-making

17a. *Does your village currently have an LMMA?* YES / NO

☐ If YES

b. *Does your village want to keep it?*

Yes / No

c. Please *EXPLAIN* why

--

18. How much did you agree or disagree with the decision about whether or not to establish an LMMA?

<i>Strongly Agreed</i>	<i>Slightly Agreed</i>	<i>Neither agreed nor Disagreed</i>	<i>Slightly Disagreed</i>	<i>Strongly Disagreed</i>

Not sure ☐

18b. If you strongly agreed or strongly disagreed, why?

--

Not sure ☐

Thank you. Now, please can you tell me a little more about LMMAs

19. On the scale below from very easy to very difficult, how easy is it to know where the boundaries are?

<i>Very easy</i>	<i>Moderately easy</i>	<i>Neither easy nor difficult</i>	<i>Moderately difficult</i>	<i>Very difficult</i>

Not sure ☐

20. On the scale below from very easy to very difficult, how easy is it to know what the rules are?

<i>Very easy</i>	<i>Moderately easy</i>	<i>Neither easy nor difficult</i>	<i>Moderately difficult</i>	<i>Very difficult</i>

Not sure ☐

Great, thanks. Next I would like to understand how the decision about whether or not to establish an LMMA was made.

21. How would you describe your role when the decision of whether or not to establish an LMMA was made?

☐

Village representative, Council member, Vice President, or President

☐

Other (please explain below)

22. How involved were you in the decision of whether or not to establish an LMMA?

<i>I was unaware of the decision</i>			<i>I was very involved in the decision</i>	
1	2	3	4	5

Not sure

☐

Thank you very much

For the next question, I don't need names or details, but a Yes / No answer would be good:

23a. Was there a particular individual who was influential in the decision about whether or not to establish an LMMA?

Yes / No / Not sure

23b. Someone within the village:

Yes / No / Not sure

23c. Someone from outside the village:

Yes / No / Not sure

Section 4. Perceived outcomes

Now we would like to know whether things have changed since the village decided whether or not to establish an LMMA. I will read out a sentence and I would like you to tell me if things have changed between then and now, on a scale from: Much Better; Moderately better; Neither better nor worse; Moderately worse; Much worse; or Not sure.

24. Have incomes in the village changed?

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

25. Has the amount of food the village can catch to eat changed?

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

26. Have the connections to other people in the village and beyond the village changed?

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

27. Does the village have more or less control over marine resources?

<i>Much more</i>	<i>A little more</i>	<i>Neither more nor less</i>	<i>A little less</i>	<i>Much less</i>

Not sure

28. Has the level of conflict changed?

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

29. Has the health of the environment changed? (non-target species)

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

30. *Has the pressure on resources changed?*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

Next, I'd like to ask you a little more about the changes in the sea. Comparing your village now to the year your village decided whether or not to establish an LMMA, has your village noticed any differences in the following things?

31. *Has there been a change in the types of fish and other animals in the sea?*

<i>Greatly increased</i>	<i>Moderately increased</i>	<i>Neither increased nor decreased</i>	<i>Moderately decreased</i>	<i>Greatly decreased</i>

Not sure

☐

32. *Has the condition of the habitats changed (e.g., corals, mangroves, sea grasses)*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

33. *Has the overall quality of life changed for the village*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

34. *Have the village traditions and customs changed?*

<i>Much stronger</i>	<i>Moderately stronger</i>	<i>Neither stronger nor weaker</i>	<i>Moderately weaker</i>	<i>Much weaker</i>

Not sure

☐

35. *Do you think the distribution of positive and negative impacts from the management here are more fair or less fair than before?*

<i>Much more fair</i>	<i>Moderately more fair</i>	<i>Neither more fair nor less fair</i>	<i>Moderately less fair</i>	<i>Much less fair</i>

Not sure

☐

36. *Has tourism changed in the area?*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

37. *Have people's understanding of the environment changed?*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

☐

Thank you. Now, I would like to ask how things are working for your village since the village made the decision about whether or not to establish an LMMA here.

38. *If your village restricted any fishing activities or gears, has this been good or bad?*

<i>Very good</i>	<i>Moderately good</i>	<i>Neither good nor bad</i>	<i>Moderately bad</i>	<i>Very bad</i>

Not sure

39. *If your village received any chickens, goats etc, did they make life different?*

<i>Much better</i>	<i>Moderately better</i>	<i>Neither better nor worse</i>	<i>Moderately worse</i>	<i>Much worse</i>

Not sure

40. *If your village received any funding or training, was it helpful or not?*

<i>Very helpful</i>	<i>Moderately helpful</i>	<i>Neither helpful nor unhelpful</i>	<i>Moderately unhelpful</i>	<i>Very unhelpful</i>

Not sure

41. *If people have needed to establish new habits, has this been difficult or easy?*

<i>Very easy</i>	<i>Moderately easy</i>	<i>Neither easy nor difficult</i>	<i>Moderately difficult</i>	<i>Very difficult</i>

Not sure

Thank you, that was really useful.

42a. *Did you hear about a proposal for an MPA in the area?* Y / N / not sure

42b. *What does the village think of MPAs in comparison to LMMAs and Why?*

Lastly, remembering this is confidential, I'd like to ask you a few questions about yourself.

43a. *What are your main sources of income;*

43b. *What proportion are they of your total income?*

If they say 'fishing' please ask them to be more specific – what they catch, how and where.

	<i>less than half</i>	<i>about half</i>	<i>more than half</i>	Not sure
<i>i</i>				
<i>ii</i>				
<i>iii</i>				
<i>iv</i>				

44. *What proportion of your household's income is dependent on the sea?*

<i>None</i>	<i>Less than half</i>	<i>Around half</i>	<i>More than half</i>	<i>All</i>

☐ Don't know

45. *Please can you tell me your approximate income weekly in Malagasy Ariary?*

☐ 0 to 50,000
 ☐ 50,001 to 100,000
 ☐ 100,001 to 200,000
☐ above 200,000
 ☐ don't know

46. *How many community organisations are you involved in?* _____

47. *What is your age?* (please tick one category)

18-25 _____ 26-45 _____ 46-65 _____ 66+ _____ Not sure _____

48. *How many years did you spend at school?* _____ Not sure _____

49. *Can you read and write?* Yes / No / Not sure

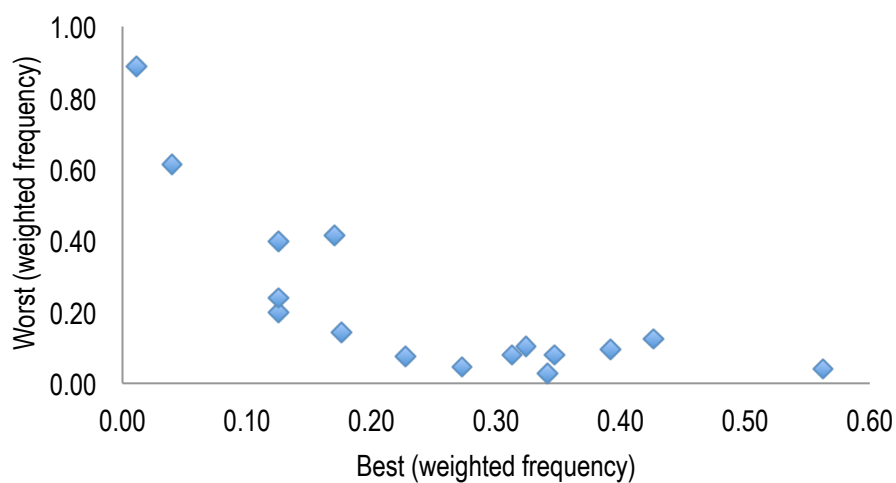
Many thanks. And finally,

50. *Do you have any comments about this survey or about locally managed marine areas that we have not discussed yet?*

THANK YOU VERY MUCH FOR YOUR TIME.
time: _____

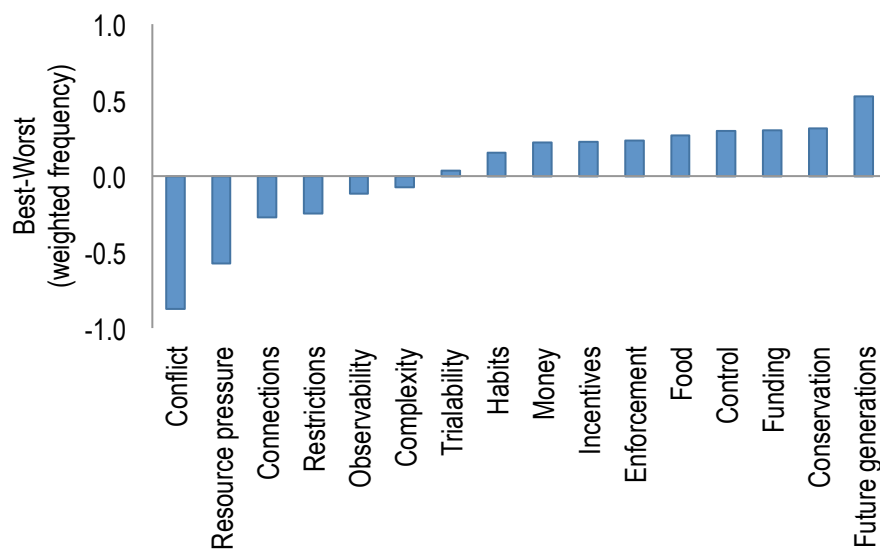
RECORD End

APPENDIX 2 Chapter 2 Supplementary information



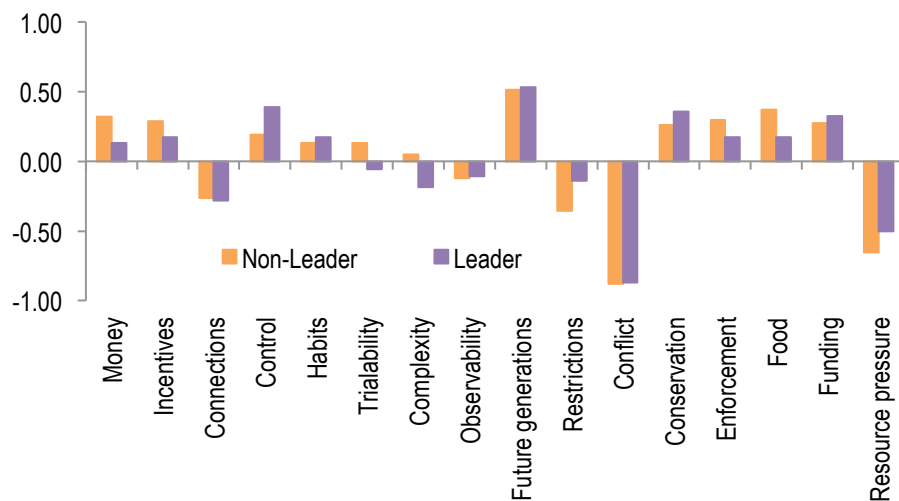
APPENDIX 2.1 Frequency counts of Best vs Worst (n = 88) for each attribute.

Data are weighted for occurrence, with 1.00 indicating that an attribute was selected consistently as either Best or Worst each time it appeared in the choice experiment. Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment. The inverse correlation indicates that Best-Worst Scaling analysis is achievable (Ban et al., 2019).

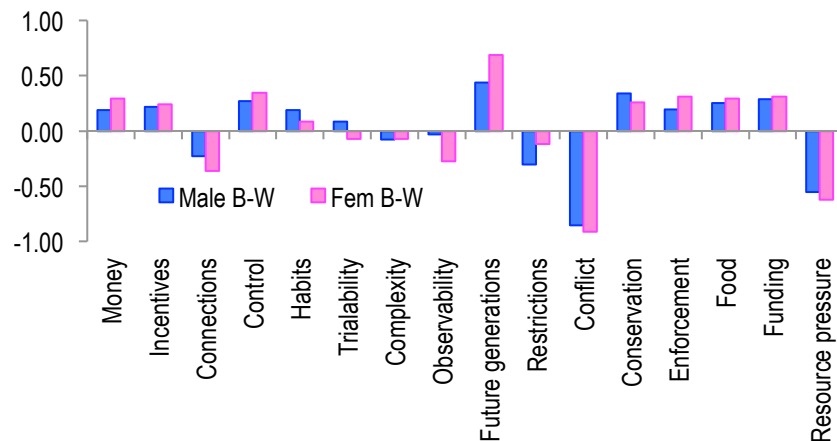


APPENDIX 2.2 Overall preference scale of LMMA attributes

included in the choice experiment, derived by summing the Worst selections for an attribute and subtracting this from the sum of the Best votes for that attribute (B-W). Data are weighted for occurrence in the survey, with 1.00 indicating an attribute was selected consistently as Best or Worst each time it appeared in the choice experiment. Surveys with a completion rate of >60% are included (n = 88). Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment.



APPENDIX 2.3 Attitudes to each attribute expressed by leaders and non-leaders. Best-Worst weighted frequency counts for leaders (n = 46) and non-leaders (n = 42).



APPENDIX 2.4 Best and Worst frequency counts (females (n = 28) and males (n = 60)).

APPENDIX 2.5 The lists of the 33 attributes used in focus groups.

This was to identify the most important attributes and wording. Although participants were invited to add attributes, no new attributes were added, but two were re-worded. The abbreviation codes used in the figures and tables are provided in brackets.

ID	Original wording for Focus Group	ID	Final Wording (abbreviation used in analysis provided in brackets)
1	The monetary costs of establishing an LMMA		
2	The type or number of jobs available		
3	The status of the village		
4	The amount of money we could earn	1	The amount of money we could earn (money)
5	The amount of time it would take us to do our jobs		
6	The <i>food</i> we would be able to catch to eat or sell	14	The food we could catch to eat (food)
7	Connections to people in the village and beyond the village	3	Connections to people beyond the village (connections)
8	The control we would have over marine resources	4	The control we would have over our marine resources (control)
9	The control we would have over decisions affecting us		
10	The level of <i>conflict</i> in the village or between villages using the sea	11	The level of conflict in or beyond the village (conflict)
11	The monitoring and enforcement of the rules	13	The monitoring and enforcement of the rules (monitoring)
12	The complexity of establishing and running an LMMA	7	How complicated or simple it seemed to establish an LMMA (complexity)
13	The number of consultations and discussions needed for the LMMA		
14	The level of reliability of the benefits of the LMMA		
15	Someone in the village had seen an LMMA and its benefits	8	Someone in the village had seen or heard of LMMAs and their impacts (observability)
16	Whether we could see the LMMA and its benefits		

17	Whether we could adapt the LMMA to suit our needs	6	Whether LMMAs can be tested or changed to meet our needs (trialability)
18	Whether we could trial the LMMA and its activities		
19	Whether the impacts of the LMMA could be reversed if we chose		
20	Our safety when changing our activities as a result of the LMMA		
21	Whether there was an expectation or a rule to have an LMMA		
22	The relevance (and distance) of the LMMA to our lives, food supply and livelihoods		
23	The effect it would have on our village traditions and customs		
24	The credibility of the LMMA plan and evidence of its success		
25	The responsibility the village felt for improving the management and health of our seas		
26	Certain activities might be prohibited in the LMMA	10	The restriction of certain activities in an LMMA (restrictions)
27	New habits and activities might be needed for the LMMA	5	New habits that might be needed (habits)
28	Changes we might see in the health of our seas	12	The health of the environment (non-target species) (conservation)
29	The benefit other people or the environment may have from the LMMA	9	The benefit to future generations (future generations)
30	The equality and fairness of decisions, rules and benefits of the LMMA		
31	It aligned with the urgency, scale, and importance of problems we faced	16	The pressure on the resources due to more people fishing (resource pressure)
32	The incentives for villages to establish and run an LMMA	2	The incentives for villages to establish and run an LMMA (incentives)
33	Support and advice provided to establish and run an LMMA	15	The funding and training provided by an NGO (funding)

APPENDIX 2.6 Sensitivity analyses of the effect of completion rate

on the results of the Conditional logit models (Best) for both Best and Worst choices in the choice experiment. Values that are significantly different ($p < 0.01$) to the reference attribute are italicised. Two Best selections were randomly included for the attribute “conflict” to facilitate model estimation, as this attribute was never selected as the Best attribute in the choice experiment.

APPENDIX 2.6a Surveys with a completion rate of >60% used, n = 88.

>60% (n = 88)	BEST			
Attribute	Coefficient	p value	95% Confidence interval	
Money	0.908	0.000	0.403	1.413
Incentives	0.559	0.028	0.059	1.059
Connections	-0.448	0.135	-1.036	0.140

Control	1.078	0.000	0.583	1.573
Habits	0.299	0.249	-0.209	0.807
Trialability	0.000			
Complexity	-0.376	0.217	-0.971	0.220
Observability	-0.376	0.205	-0.957	0.205
Future generations	1.878	0.000	1.391	2.366
Restrictions	0.047	0.864	-0.493	0.588
Conflict	-2.861	0.000	-4.309	-1.413
Conservation	0.967	0.000	0.464	1.470
Enforcement	0.711	0.006	0.199	1.222
Food	0.913	0.000	0.428	1.397
Funding	1.305	0.000	0.814	1.796
Resource pressure	-1.557	0.000	-2.403	-0.712

APPENDIX 2.6b Surveys with a completion rate of >80% used, n = 59.

>=80% (n = 59)	BEST			
Attribute	Coeff- icient	p value	95% Confidence interval	
Money	1.119	0.000	0.506	1.733
Incentives	0.784	0.012	0.172	1.396
Connections	-0.651	0.094	-1.411	0.110
Control	1.144	0.000	0.538	1.750
Habits	0.344	0.285	-0.286	0.974
Trialability	0.000			
Complexity	-0.437	0.260	-1.197	0.323
Observability	-0.593	0.125	-1.350	0.164
Future generations	1.808	0.000	1.209	2.407
Restrictions	0.430	0.180	-0.199	1.059
Conflict	-2.440	0.001	-3.920	-0.959
Conservation	0.959	0.003	0.337	1.581
Enforcement	0.991	0.002	0.370	1.612
Food	0.916	0.002	0.323	1.509
Funding	1.045	0.001	0.427	1.664
Resource pressure	-1.079	0.018	-1.976	-0.182

APPENDIX 2.6c Surveys with a completion rate of 100% used, n = 50.

100% (n = 50)	BEST			
Attribute	Coeff- icient	p value	95% Confidence interval	
Money	1.101	0.001	0.433	1.768
Incentives	0.634	0.063	-0.034	1.302
Connections	-0.542	0.188	-1.349	0.265
Control	1.166	0.000	0.510	1.823

Habits	0.375	0.283	-0.309	1.058
Trialability	0.000			
Complexity	-0.748	0.103	-1.646	0.151
Observability	-0.372	0.354	-1.159	0.415
Future generations	1.870	0.000	1.215	2.524
Restrictions	0.424	0.222	-0.257	1.104
Conflict	-2.266	0.003	-3.762	-0.771
Conservation	1.007	0.003	0.332	1.681
Enforcement	1.027	0.003	0.358	1.697
Food	1.079	0.001	0.441	1.716
Funding	1.000	0.004	0.325	1.675
Resource pressure	-1.062	0.032	-2.032	-0.092

APPENDIX 2.7 Summary of the number of surveys per village and those analysed.

Village name	Village name abbreviation	BWS choice sets in survey	Num. Survey	Num. surveys analysed
Village1**	1	8	26	20
Village2 **	2	8	30	23
Village3**	3	8	30	22
Village4**	4	8	27	23
Totals			167	88

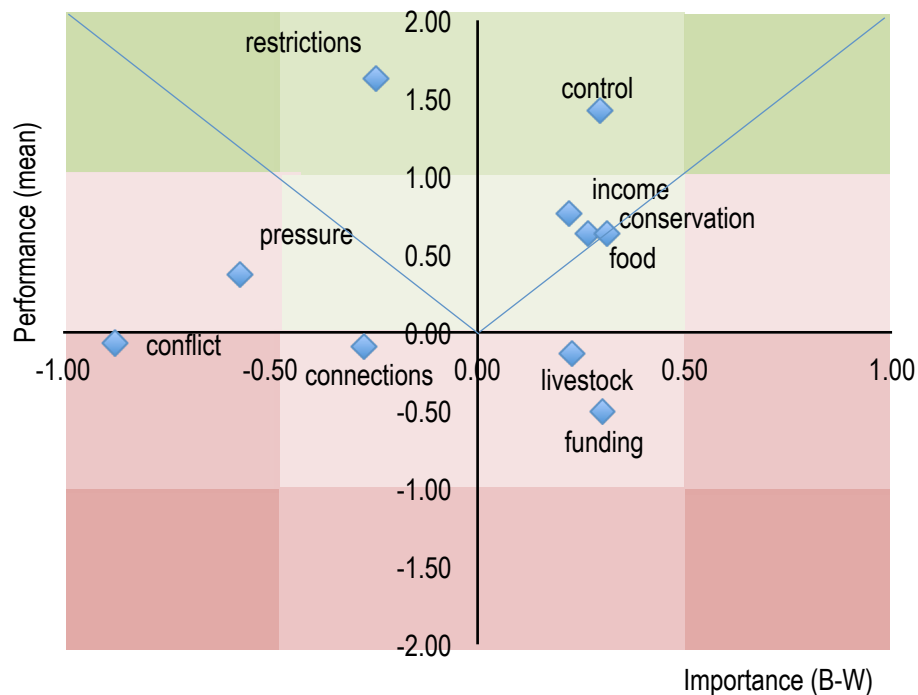
*Conservation International provided training about LMMAs. Village situated outside the regional MPA

**Conservation International provided training, a site visit to an LMMA, funding and livestock incentives (e.g., hens). Village situated within the regional MPA

APPENDIX 2.8 Characteristics of survey respondents recorded in the household surveys. (percentages provided in brackets) and included in the analysis.

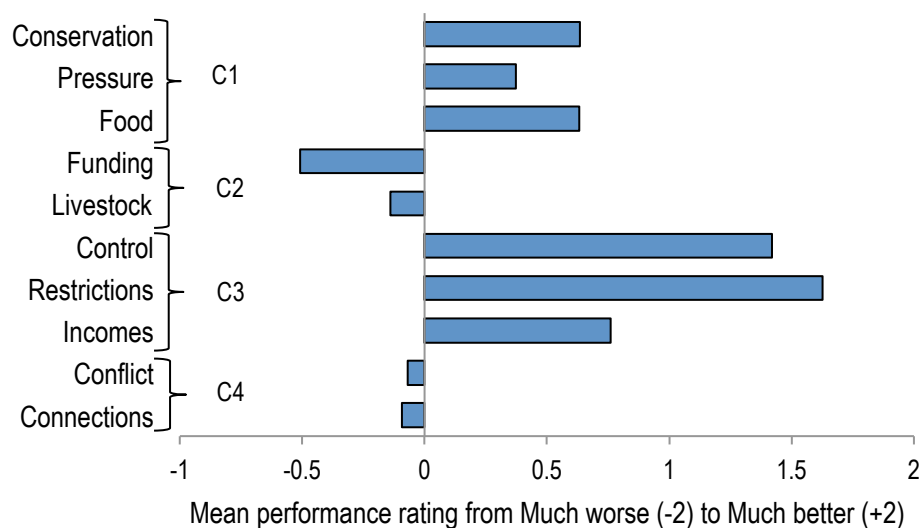
	Male (%)	Female (%)	Total
Leader (%)	35 (39.8%)	11 (12.5%)	46 (52.3%)
Non-leader (%)	25 (28.4%)	17 (19.3%)	42 (47.73)
Total	60 (68.2%)	28 (31.8%)	88 (100%)

APPENDIX 3 Chapter 3 Supplementary information

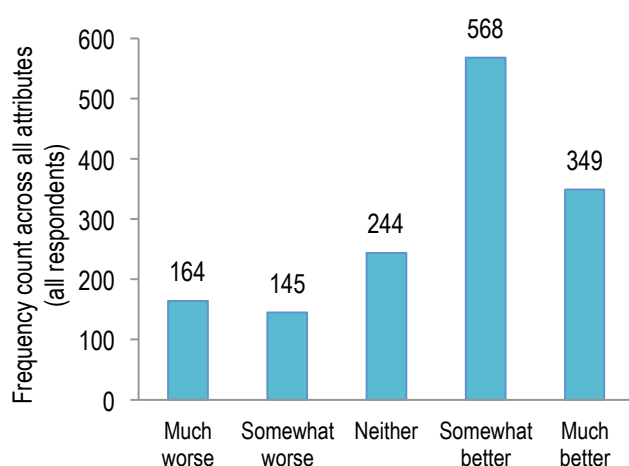


APPENDIX 3.1 Importance-Performance scale-centred plot.

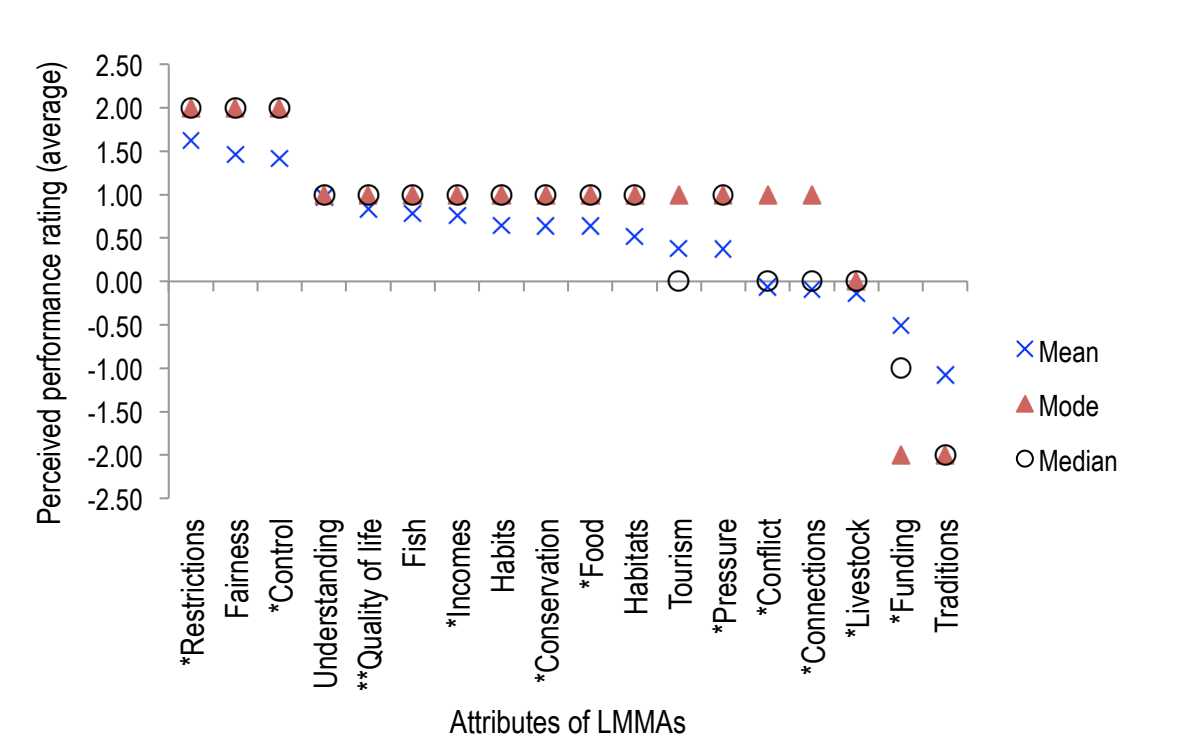
Importance (x-axis) indicates the relative importance of attributes derived from a best-worst scaling choice experiment (best minus worst) where -1 would indicate an attribute ranked as the worst attribute of LMMAs of those presented in the choice experiment 100% of the time is occurred in the choice experiment (100%), and +1 would indicate an attribute ranked as the best attribute of LMMAs 100% of the times it occurred in the choice experiment. In this plot, -1 and +1 both indicate highly important attributes. Performance (y-axis) indicates perceived performance of attributes rated on scale based questions, where respondents rated attributes as having become much worse (-2), through neither better nor worse (0), to much better (+2) over the course of the decade of having had the LMMA. Thus, the attribute relating to funding for the LMMA was rated as somewhat important but this attribute was perceived by respondents on average to have performed somewhat negatively. Meanwhile, restrictions on fishing was ranked as a slightly negative attribute but was perceived to have performed well for respondents on average. Green shading in the top right and top left of the IPA plot indicates zones where attributes falling are important and performing well. Any attribute falling below the two diagonal lines require attention, and attributes in the bottom right and left corners of the plot (shaded red) would be indicated for primary focus for improvement to increase customer satisfaction.



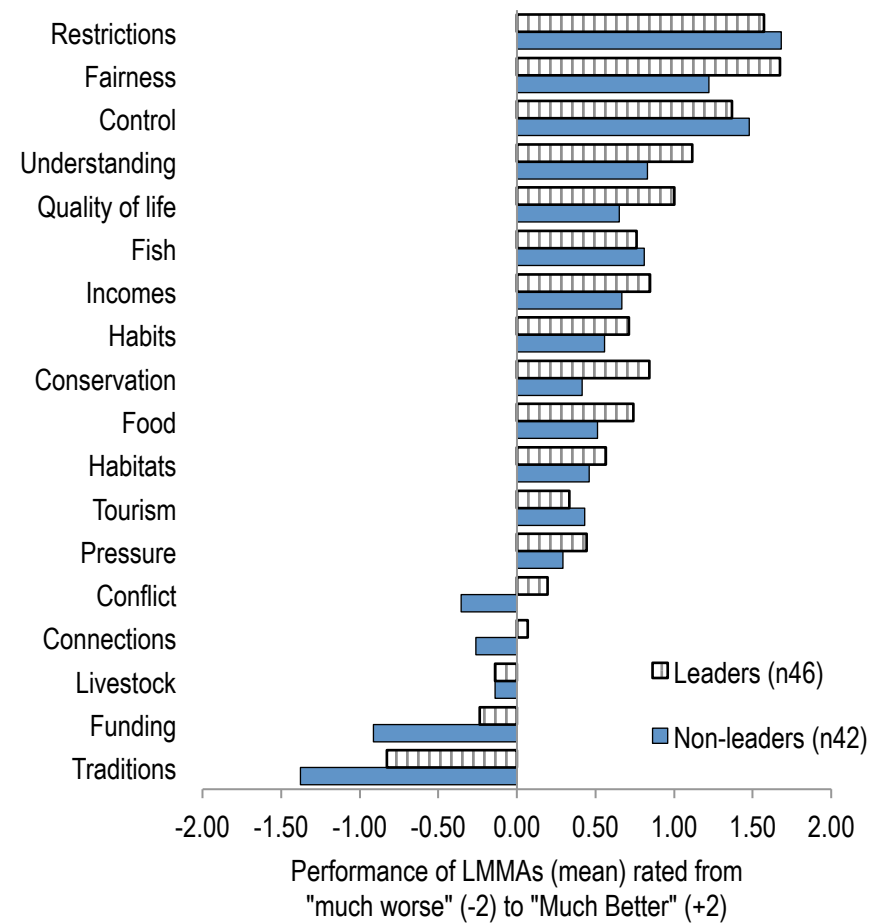
APPENDIX 3.2 Performance rating of outcomes of Locally Managed Marine Areas (LMMAs). Respondents were asked how each attribute had changed since establishing an LMMA, on a scale from Much worse to Much Better. Mean scores are plotted, ranked on the Principle Component Analysis results, indicating four components in the data (C1 to C4).



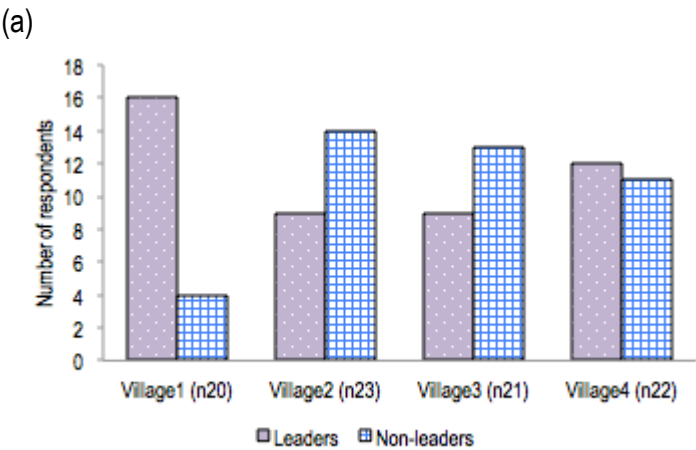
APPENDIX 3.3 Perceived performance (frequency counts) 18 attributes of LMMAs on a scale from “much worse” to “much better” (n = 88)



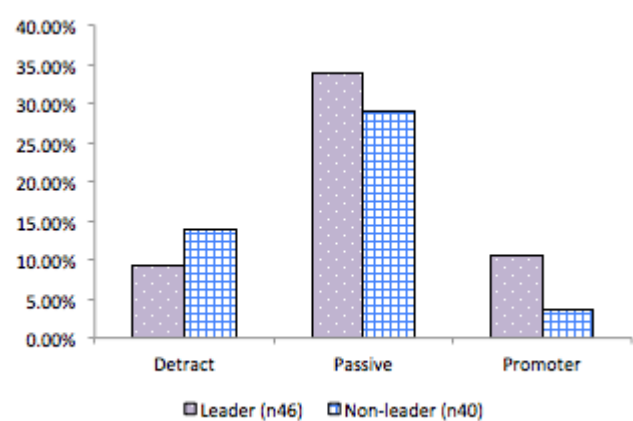
APPENDIX 3.4 Perceived performance of the 18 attributes tested. Based on averages: mean (blue cross), median (black circle) and mode (red triangle). *IPA attributes, and **NPS attribute (n = 88).



APPENDIX 3.5 Perceived performance of LMMAs on 18 attributes (mean) for leaders and non-leaders.

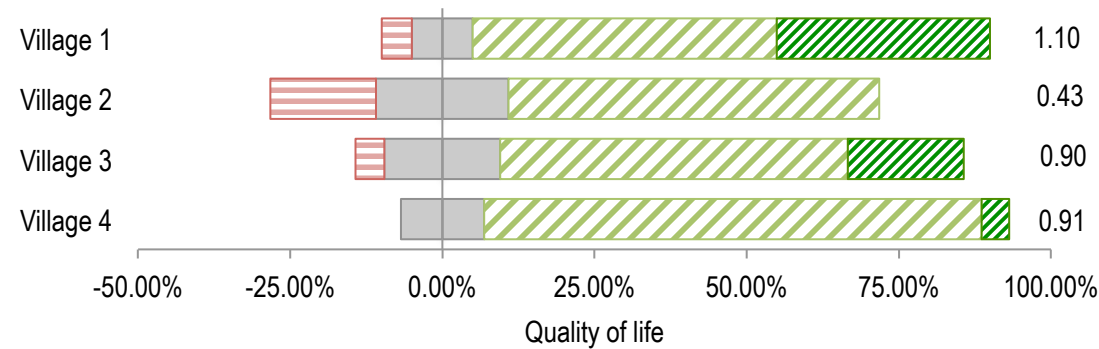


(b)

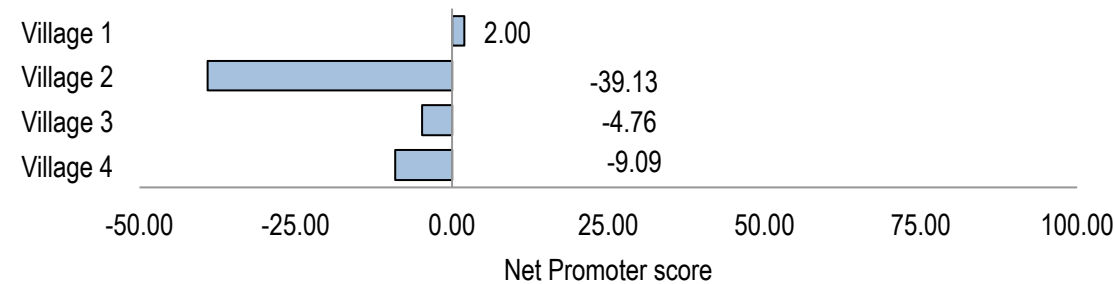


APPENDIX 3.6 The distribution of respondents who identified as leaders and non-leaders (a) who responded from the four villages surveyed (frequency count n = 88) (b) who were detractors, passive or promoters in the NPS (percentage) (n = 86).

(a)

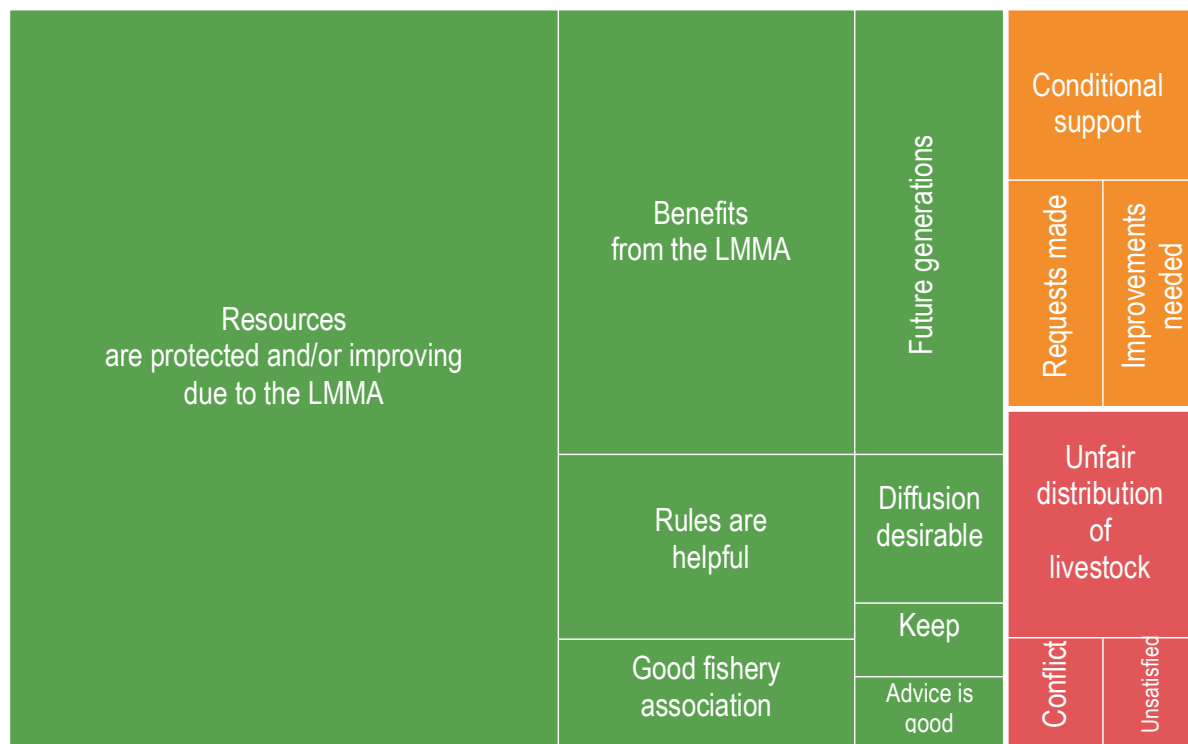


(b)



APPENDIX 3.7 Perceived impact on quality of life following establishment of LMMA 5-point Likert-style scale for villages 1 to 4 (v1 to v4). The divergent bar plot (a) shows the percentage of responses in 5 categories, from left to right: ‘Much worse’ (dark red narrow horizontal hatching ~ none shown as none recorded); ‘Somewhat worse’ (pale red wide horizontal hatching); ‘Neither better nor worse’ (solid grey shading); ‘Somewhat better’ (pale green wide diagonal hatching); to ‘Much better’ (dark green narrow diagonal hatching) with mean scores per village shown. While (b) shows the Net Promoter Score calculated on the same question and data for each village, where NPS per village is

shown, and calculated as: promoters (those responding with 'Much better') minus detractors (those responding with 'Neither better nor worse', 'Moderately worse' or 'Much worse') (n = 88).



APPENDIX 3.8 Relative frequency of reasons respondents wished to keep or abandon LMMA
Colours represent positive (green), mixed (amber), or negative (red) responses to the question of whether respondents would like to keep their LMMA and why (n80).

APPENDIX 3.9 Principle Component Analysis Pattern Matrix (the correlations between each attribute and each component). S1a shows the influence of each factor on each attribute, and S1b shows the relative positions of each attribute of each factor. Colour indicates the coefficients that cluster to form a component with high (yellow), medium (grey) and weak correlations (white).

Table a

	C1 natural resources	C2 support	C3 empowerment	C4 relationships
Conservation	0.871	-0.201	0.104	0.068
Pressure	0.741	0.319	-0.030	-0.215
Food	0.489	-0.202	-0.461	0.269
Funding	0.007	-0.952	0.005	-0.127
Livestock	0.014	-0.910	-0.130	-0.024
Control	-0.311	-0.065	-0.828	-0.107
Restrictions	0.097	0.057	-0.798	-0.038
Income	0.320	-0.125	-0.638	0.280
Conflict	-0.015	0.314	-0.076	0.866

Connections	-0.069	-0.430	0.214	0.679
--------------------	--------	--------	-------	--------------

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Table b

C1 natural resources		C2 support		C3 empowerment		C4 relationships	
Conservation	0.871	Pressure	0.319	Connections	0.214	Conflict	0.866
Pressure	0.741	Conflict	0.314	Conservation	0.104	Connections	0.679
Food	0.489	Restrictions	0.057	Funding	0.005	Income	0.280
Income	0.320	Control	-0.065	Pressure	-0.030	Food	0.269
Restrictions	0.097	Income	-0.125	Conflict	-0.076	Conservation	0.068
Livestock	0.014	Conservation	-0.201	Livestock	-0.130	Livestock	-0.024
Funding	0.007	Food	-0.202	Food	-0.461	Restrictions	-0.038
Conflict	-0.015	Connections	-0.430	Income	-0.638	Control	-0.107
Connections	-0.069	Livestock	-0.910	Restrictions	-0.798	Funding	-0.127
Control	-0.311	Funding	-0.952	Control	-0.828	Pressure	-0.215

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

APPENDIX 3.10 Principle Component Analysis Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.884	28.844	28.844	2.884	28.844	28.844	1.948
2	2.066	20.658	49.502	2.066	20.658	49.502	2.317
3	1.479	14.789	64.291	1.479	14.789	64.291	2.205
4	1.161	11.61	75.902	1.161	11.61	75.902	1.6
5	0.757	7.57	83.472				
6	0.535	5.353	88.825				
7	0.442	4.419	93.244				
8	0.357	3.569	96.814				
9	0.181	1.814	98.628				
10	0.137	1.372	100				

Extraction Method: Principal Component Analysis.

APPENDIX 3.11 Distribution of samples used in the analyses.

Sex	Female	Male	Female	Male	Sum
Leadership	Leader	Leaders	Non-leader	Non-leader	
Village 1	5	11	1	3	20
Village 2	1	8	5	9	23

Village 3	2	7	5	8	22
Village 4	3	9	7	4	23
Sum	11	35	18	24	88

APPENDIX 3.12 Distribution of leader and non-leader responses.

	Non-leaders	% per village	Leaders	% per village	Sum
Village1	4	20.00%	16	80.00%	20
Village2	14	60.87%	9	39.13%	23
Village3	13	59.09%	9	40.91%	22
Village4	11	47.83%	12	52.17%	23
Sum	42		46		88

APPENDIX 4 Chapter 4 Survey and supplementary information

APPENDIX 4.1 Survey instrument for carbon management research

Q1 Understanding the management of carbon emissions in education institutions

Data protection

In this research study, we will use information provided by you in the online survey, and will only use information that we need for the research study. Only Emily Lewis-Brown will have access to your contact details if you provide it in the online survey, and will only use it if I really need it for this study to clarify your answers with you. It will not be passed on to anyone else. Everyone involved in this study will keep your data safe, secure and private. At the end of the study we will save some of the data in case we need to check it. We will make sure no-one can work out who you are from the reports we write. The [participant information sheet](#) tells you more about this.

Instructions

Please complete this survey on a computer rather than a smartphone to enable the best functionality.

Please answer these questions on behalf of your whole further or higher education institution (college or university), rather than your faculty or department.

Thank you very much Email: e.lewis-brown17@imperial.ac.uk

Q2

Consent

Please indicate whether you provide consent for your survey responses to be used in this research project. Your data will be held securely and confidentially, and data will be anonymised. Your participation in this survey is entirely voluntary and you may withdraw at any time. You can email me

(e.lewis-brown17@imperial.ac.uk) at any time to withdraw from the study. Only responses with Yes ticked will be used in the analysis. I confirm that I have read and understand the [participant information sheet](#), dated 16th April 2021 for the study 'Understanding the management of carbon emissions in education institutions' and have had the opportunity to ask questions which have been answered fully, and provide consent for the inclusion of my survey response in this research.

- ☐ Yes
-

Page Break

Q3 Would you like the results of this research to be sent to you?

- ☐ Yes
☐ No
-

Q4 Please insert your email address below (all responses will be anonymised and you will only be contacted by me, and only to clarify responses or to send you the final results of this research)

Q5

DEFINITIONS

Voluntary Carbon Offsets (VCOs) or Voluntary Emission Rights (VERs): Carbon credits or certificates that an individual person or organisation chooses to buy on a voluntary basis to compensate for its carbon emissions to reduce their net emissions. They are entirely voluntary they are bought through the voluntary or compliance offset markets. VCOs or VERs are often certified through an accreditation scheme, and may include carbon sequestration through tree planting; renewable energy production; or energy efficient technology. Voluntary Carbon Offsets are measured in Metric Tonnes of CO₂.

Mandatory Compliance Carbon Offset or Certified Emission Reductions (CER): Carbon credits or certificates bought on the compliance market, regulated through the UN Clean Development Mechanism (CDM), so that nations or organisations can offset carbon emissions to meet national Kyoto Protocol commitments. They are measured in Metric Tonnes of CO₂. For this survey we define ways CERs can be classified: a) Compliance offsets purchased to comply with government set carbon caps are not considered Voluntary Carbon Offsets as they are to comply with mandatory targets; b) Offsets purchased from the compliance offset market to reduce carbon footprint below an institution's carbon cap are considered Voluntary Carbon Offsets, as they are purchased voluntarily.

Renewable Energy Certificates (RECs): RECs may be purchased to financially support the production of renewable energy. Each REC represents 1MWh of renewable energy. While this may be calculated to reduce your carbon footprint, it is not considered a Voluntary Carbon Offset in this survey. Green tariffs: Energy purchased from companies that supply renewable energy to your energy system, either through direct generation or through purchasing RECs (above) from those generating renewable energy. While this may reduce your carbon footprint, it is not considered a Voluntary Carbon Offset in this survey. Institution: Further and higher education colleges, schools, and universities that have independent decision-making and reporting for environmental management purposes. Separate campuses, faculties and departments are considered as part of an institution.

Q6 Please state which institution (college, school, or university) your responses will represent (data and results will remain anonymised).



Q7 When addressing your institutions carbon footprint, which carbon management approach does your institution prioritise?

- ☐ Reduce carbon emissions
- ☐ Offset carbon emissions
- ☐ Both
- ☐ Neither

Q8 Please briefly explain why

Q9 Does your institution have any of the following?

(please tick all that apply)

- ☐ Environmental management accreditation e.g., ISO 14001
- ☐ Carbon reduction policy or plan
- ☐ Carbon offsetting policy or plan
- ☐ Net negative emissions targets
- ☐ Net zero or carbon neutral target
- ☐ Environment / sustainability staff

Display This Question:

If Does your institution have any of the following? (please tick all that apply) = Net zero or carbon neutral target

Q10 If you have a carbon neutral and net zero target date, please state the date and scope

- ☐ Target date (year) _____
- ☐ Which Scope of emissions are included in this target

Q11 Please indicate which one of the following statements most closely applies to your institution

- ☐ Voluntary carbon offset purchases are being considered currently, but no decision made yet
- ☐ Voluntary carbon offset purchases are agreed and planned
- ☐ Voluntary carbon offsets have been purchased
- ☐ Voluntary carbon offset purchases have been considered and rejected
- ☐ Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution = Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

Or Please indicate which one of the following statements most closely applies to your institution = Voluntary carbon offset purchases are agreed and planned

Or Please indicate which one of the following statements most closely applies to your institution = Voluntary carbon offsets have been purchased

Q12 What date did your institution first agree to purchase carbon offsets or fund equivalent activities to offset your institution's carbon emissions?

- Month _____
- Year _____

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution =
Voluntary carbon offset purchases have been considered and rejected

Q13 What date did your institution decide to reject carbon offsetting?

- Month _____
- Year _____

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution =
Voluntary carbon offset purchases are agreed and planned

Or Please indicate which one of the following statements most closely applies to your institution =
Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

Or Please indicate which one of the following statements most closely applies to your institution =
Voluntary carbon offsets have been purchased

Q14

In your view, why does your institution purchase or plan to purchase voluntary carbon offsets or fund equivalent activities to offset carbon emissions?

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution !=
Voluntary carbon offset purchases are agreed and planned

And Please indicate which one of the following statements most closely applies to your institution !=
Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

And Please indicate which one of the following statements most closely applies to your institution !=
Voluntary carbon offsets have been purchased

Q15 In your view, why does your institution not purchase or plan to purchase voluntary carbon offsets or fund equivalent activities to offset carbon emissions?

Q16

Which of the carbon management tools was your institution using in the year 2010 and the year 2020

	2010	2020
☐ Purchase of renewable energy	☐	☐
☐ Purchase of RECs	☐	☐
☐ Generation of renewable energy	☐	☐
☐ Energy efficient technology (e.g., low energy lights, showers or heating)	☐	☐
☐ Travel policy to reduce carbon intensive travel	☐	☐
☐ Engagement with climate science, policy, or campaigns	☐	☐
☐ Promoting energy-saving behaviours	☐	☐
☐ Reducing carbon-intensive foods for sale	☐	☐
☐ Managing space more efficiently to reduce campus footprint	☐	☐
☐ Carbon management in the supply-chains and procurement	☐	☐
☐ Other	☐	☐

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution =

Voluntary carbon offset purchases are agreed and planned

Or Please indicate which one of the following statements most closely applies to your institution =

Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

Or Please indicate which one of the following statements most closely applies to your institution =

Voluntary carbon offsets have been purchased

Q17

Is the funding allocation for voluntary carbon offsets considered independently from funding for carbon reduction measures?

- ☐ Yes
- ☐ No
- ☐ Other (please explain below) _____

Display This Question:

If Please indicate which one of the following statements most closely applies to your institution !=

Voluntary carbon offsets have been purchased

And Please indicate which one of the following statements most closely applies to your institution !=

Voluntary carbon offset purchases are agreed and planned

And Please indicate which one of the following statements most closely applies to your institution !=

Voluntary carbon offsets have not been purchased or agreed, but equivalent activities to offset carbon emissions have been funded or agreed instead (please give brief details below)

Q18

If your institution were to undertake carbon offsets in the future, would the funding allocation for voluntary carbon offsets considered independently from funding for carbon reduction measures?

- ☐ Yes
- ☐ No
- ☐ Other (please explain below) _____

Q19 CARBON DATA

Q20 Which emissions does your institution calculate and which do you report? (please tick all that apply)

☐	☐ Calculate & Report	☐ Calculate	☐ Neither calculate nor report
☐ Scope 1 (direct emissions)	☐	☐	☐
☐ Scope 2 (indirect emissions)	☐	☐	☐
☐ Scope 3 (e.g., supply chain, travel, wastes)	☐	☐	☐

Q21 What method or tool (for example STARs or SIMAP) does your institution use to calculate its carbon footprint?

Q22 Has the method your institution uses for calculating carbon emissions changed over time? If so, please provide details.

- ☐ Yes (if so, please provide details)
- ☐ No
- ☐ Don't know

Q23 To whom are your institution's carbon emissions reported? (please tick all that apply)

- ☐ HESA
- ☐ STARS
- ☐ Internally only
- ☐ Second Nature
- ☐ Climate Neutral Now
- ☐ Website (please provide the link below)
- ☐ Other (please give details below) _____

Q24 Please provide your institution's annual gross Scope 1 and Scope 2 carbon dioxide equivalent emissions data for as many years as possible, as a xls, xlsx or csv file attachment. In the file, please include your institution's name, annual gross Scope1 and Scope 2 carbon dioxide equivalent emissions, annual carbon offsets and annual number of full time equivalent (FTE) students.

Skip To: Q26 If Condition: Uploaded File Is Uploaded. Skip To: Please indicate whether the campuses,....

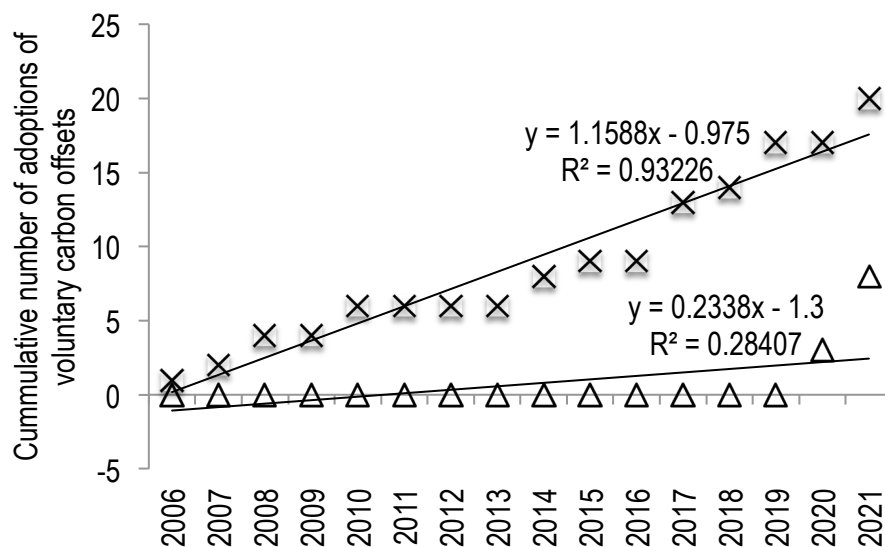
Q26 Please indicate whether the campuses, departments and faculties in your institution calculate, manage, and report environmental management separately from the institution-wide processes.

- ☐ Yes
- ☐ No
- ☐ Don't know

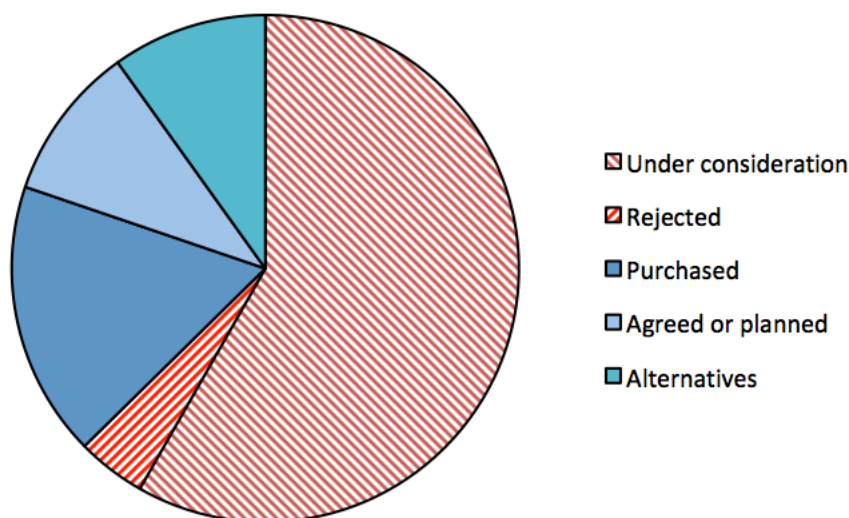
Q27 Thank you very much for your time.

If you have any queries, please contact Emily Lewis-Brown: e.lewis-brown17@imperial.ac.uk.

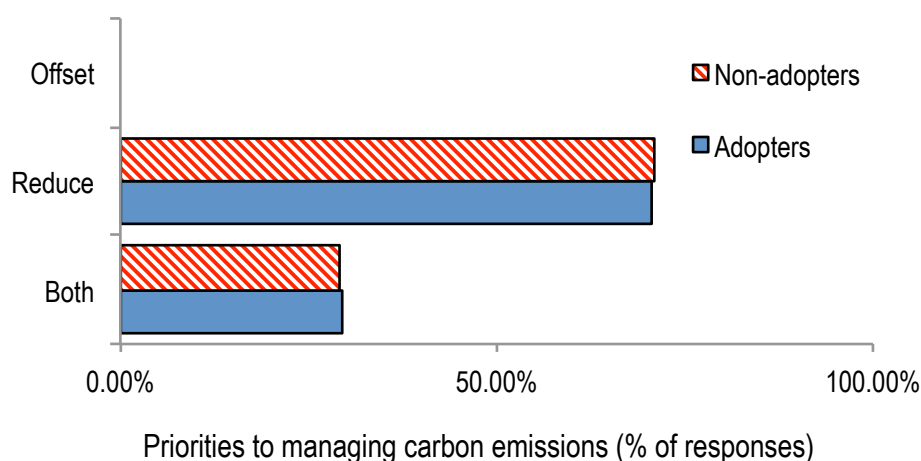
If you have anything further you would like to add or comments about this survey, please add them below.



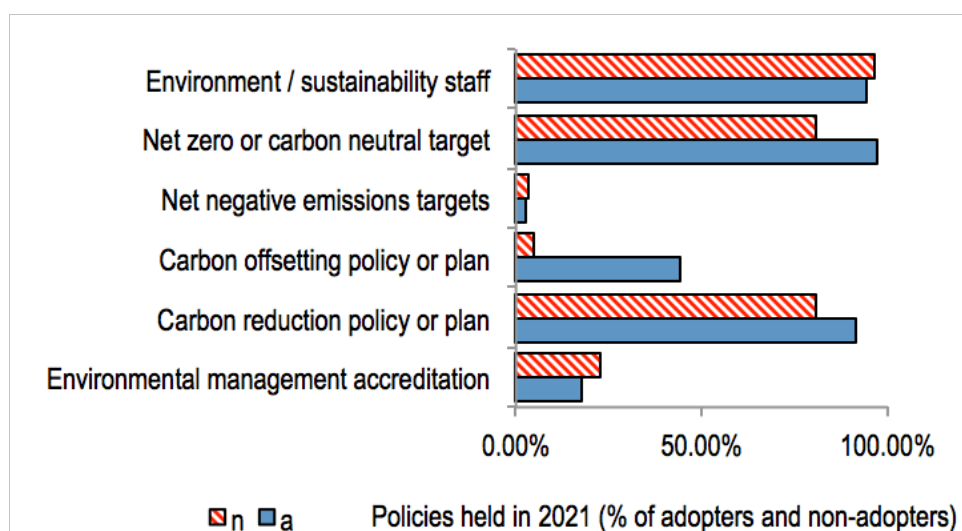
APPENDIX 4.2 Cumulative adoptions of voluntary carbon offsets (UK (triangles) and USA (crosses) universities).



APPENDIX 4.3 Respondent status of VCO adopters or non-adopters with sub-categories. Those who have purchased, plan to purchase or engage in equivalent alternatives to voluntary carbon offsets are coded as adopters (blue solid); and those who are considering but not yet decided whether to adopt or have rejected carbon offsets are coded as non-adopters (red diagonal). Non-adopters considering adopting carbon offsets may move status category in the future.

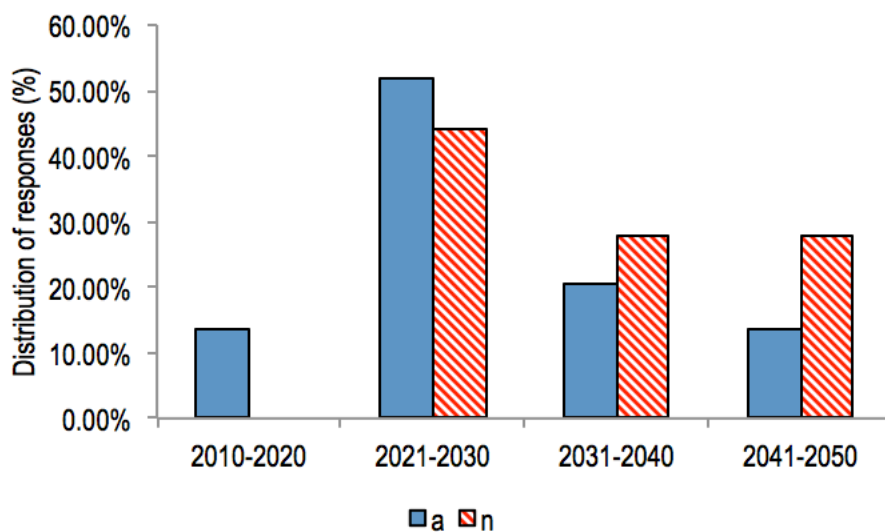


APPENDIX 4.4 Priorities of VCO adopters (blue solid) and non-adopters (red diagonal)

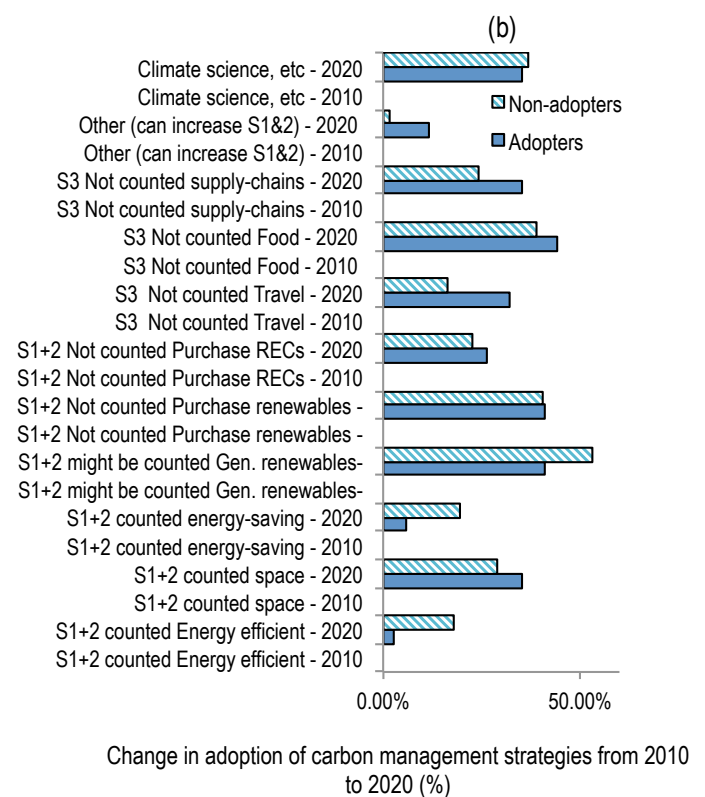
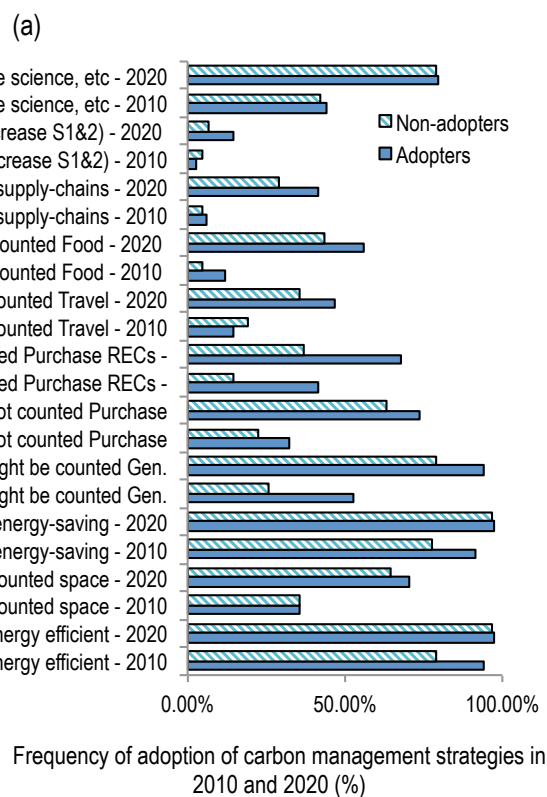


APPENDIX 4.5 Policies held by adopters and non-adopters of voluntary carbon offsets.

Excluding 'carbon offsetting policy or plan' to avoid double-counting, there is no significant difference in the number of policies held by the adopters (blue solid) and non-adopters (red hatching) studied (Welch test 0.792, $p = 0.376$).

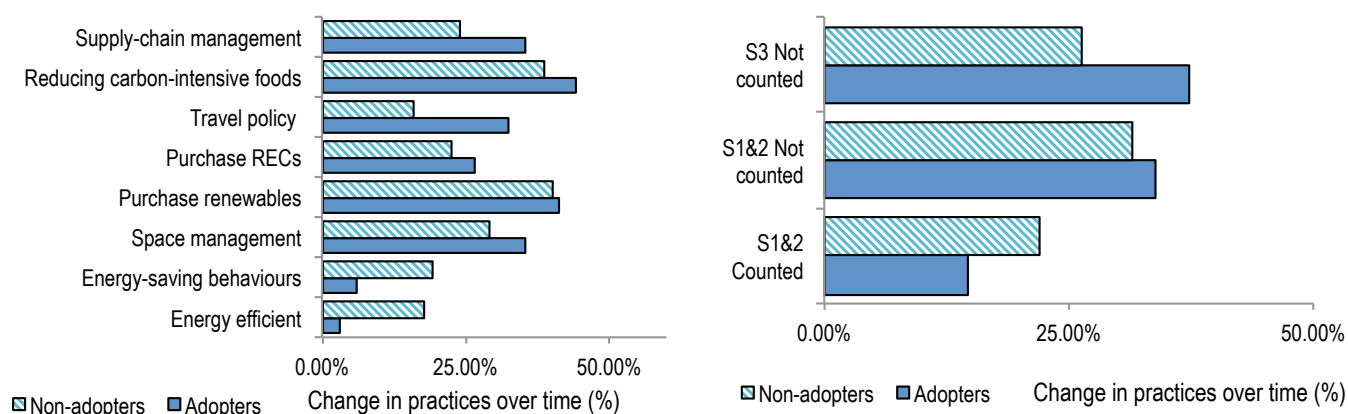


APPENDIX 4.6 The dates of policies to reach net zero for adopters and non-adopters. Percentage of respondents in each group. Adopters (blue solid) ($n = 29$) were significantly more ambitious in their net zero targets than were non-adopters (red diagonal) ($n = 50$) of VCO (Welch test 5.606, $p = 0.022$).



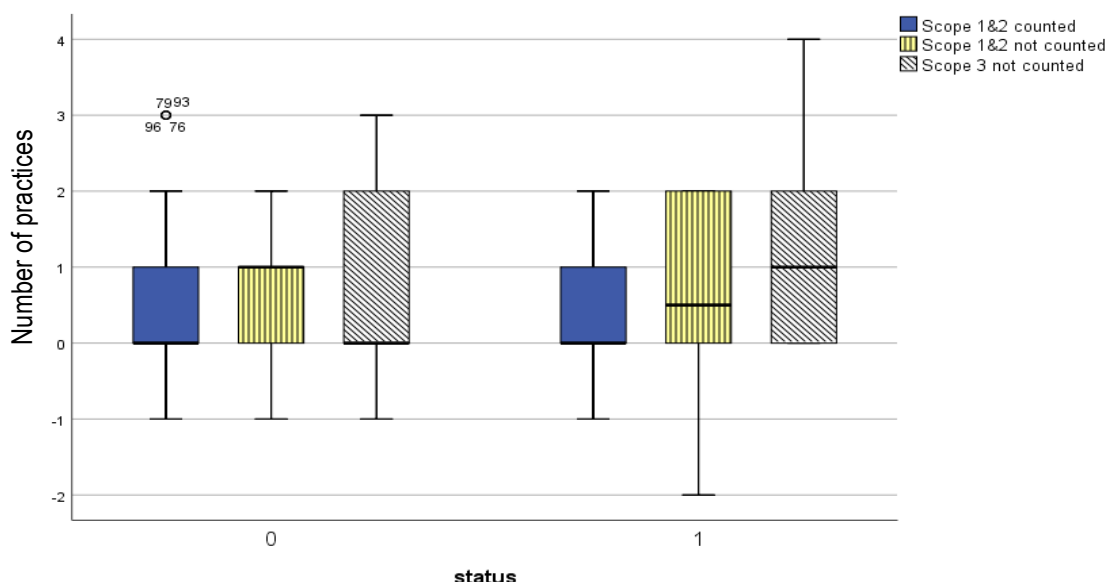
(c)

(d)



APPENDIX 4.7 Practices to manage carbon emissions by adopters and non-adopters

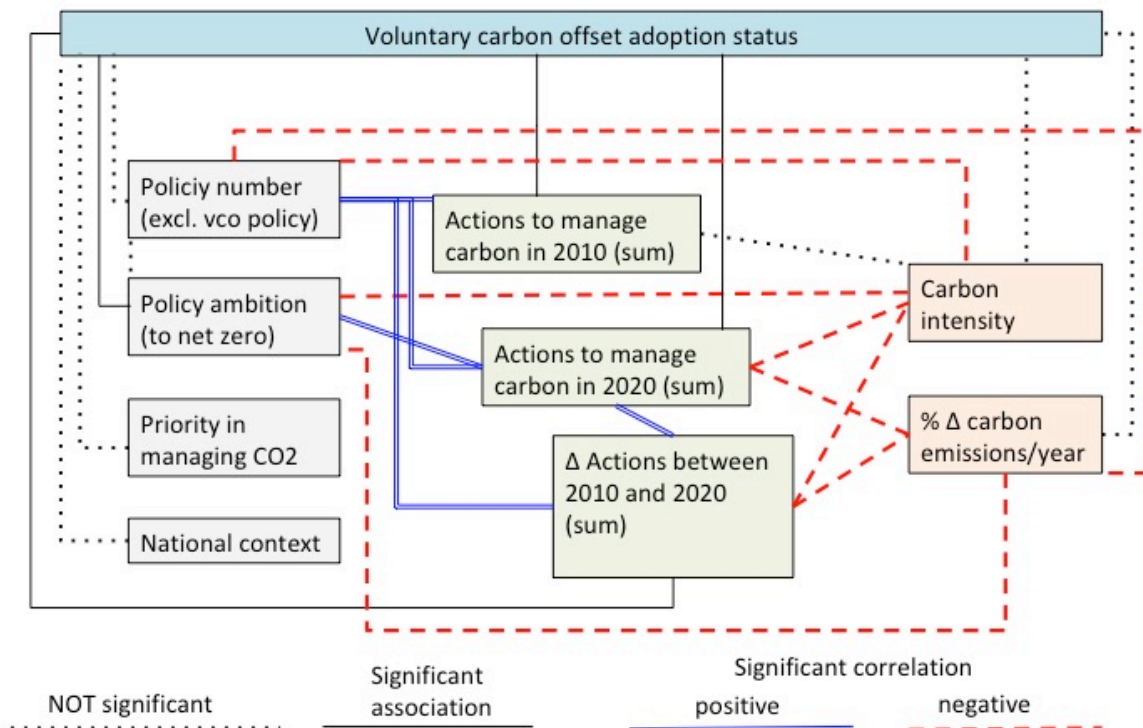
(a) 2010 and 2020; (b) the change between 2010 and 2020; (c) selected categories directly impacting carbon emissions; and (d) percentage change in emissions for aggregated categories of practices impacting emissions that are counted and those that are not counted in carbon emissions reports. Figures (c) and (d) illustrate the increase over time differs for adopters and non-adopters within the three groups of practices that affect the different scopes of emissions differently: A, those affecting scope 1&2 emissions which are counted in carbon emissions calculations; B, those affecting scope 1&2 emissions but are not counted; C, and those affecting scope 3 emissions and are not counted in carbon emissions reports. However, the differences are not significant with this sample size and variability (Welch test 3.203, $p = 0.079$; 0.057, $p = 0.812$; 1.916, $p = 0.170$ respectively).



APPENDIX 4.8 Change in practices to manage emissions by adopters and non-adopters.

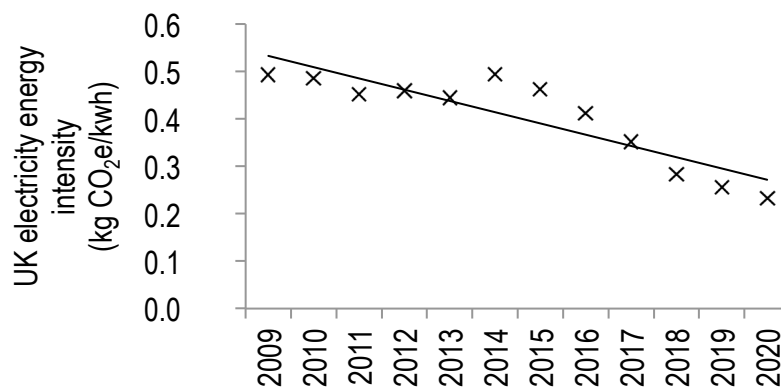
Three categories of practical actions are shown for adopters (1) and non-adopters (0): solid blue box represents practices that count in Scope 1 and 2 gross carbon emissions, such as energy efficiency that can reduce the amount of electricity purchased from the grid (Welch statistic 1.916, $p = 0.170$);

striped yellow relate to practices that relate to Scope 1 and 2 carbon emissions but are not accounted for in gross carbon emission reporting, such as purchase of renewable electricity or renewable energy certificates (Welch statistic 0.057, $p = 0.812$); and diagonal grey relates to scope 3 emissions which are not reported as part of gross scope 1 and 2 emissions and can not be analysed adequately due to insufficient reporting, such as reducing carbon intensive travel (Welch statistic 3.203, $p = 0.079$).



APPENDIX 4.9 Conceptual model of universities' attributes, context and carbon emissions.

The associations between attributes, and between attributes and outcomes were investigated through a series of statistical tests, described in the text. Results are indicated on the model with non-significant (dotted line), significant (continuous lines) and positive + and negative - correlations indicated.



APPENDIX 4.10 Change in carbon intensity of UK national grid electricity over time

Indicating a reduction over time, consistent with the reduction in gross emissions in respondents from UK universities (Louviere et al., 2015).

APPENDIX 4.11 Definition of Scope 1, 2 and 3 emissions (excerpt from Defra, REF).

Scope 1 (Direct emissions): Activities owned or controlled by your organisation that release emissions straight into the atmosphere. They are direct emissions. Examples of scope 1 emissions include emissions from combustion in owned or controlled boilers, furnaces, vehicles; emissions from chemical production in owned or controlled process equipment.

Scope 2 (Energy indirect): Emissions being released into the atmosphere associated with your consumption of purchased electricity, heat, steam and cooling. These are indirect emissions that are a consequence of your organisation's activities but which occur at sources you do not own or control.

Scope 3 (Other indirect): Emissions that are a consequence of your actions, which occur at sources which you do not own or control and which are not classed as scope 2 emissions. Examples of scope 3 emissions are business travel by means not owned or controlled by your organisation, waste disposal, or purchased materials or fuels.

APPENDIX 4.12 Priorities for managing carbon emissions (n = 96).

	Both	Reduce	Offset	Ratio
Adopters	29.41%	70.59%	0.00%	2.40
Non-adopters	29.03%	70.97%	0.00%	2.44
All respondents	29.17%	70.83%	0.00%	2.43

APPENDIX 4.13 Correlation of carbon intensity (CI) and gross emissions (CO₂).

Data provided for the decade from 2009 to 2020 for adopters (n = 34) and non-adopters (n = 62) of voluntary carbon offsets, using Spearman's Rho correlation in SPSS. *indicates significance at the 99% level and **at the 95% level, c.c. indicates the correlation coefficient and 'n' indicates the number of years of data.

	Adopter (n34)	non-adopter (n62)
c.c.	-.797**	-.645*
CI sig	0.002	0.032
n	12	11
c.c.	-.745**	-0.591
CO2 sig	0.008	0.056
n	11	11

APPENDIX 4.14 Welch equality of means tests, with means and standard errors. Data provided for respondent from the UK and USA (n = 94). *indicates a significant Welch test result ($p < 0.05$).

	UK mean	st. error	USA mean	st. error	Equality of Means (Welch)			
					Statistica	df1	df2	Sig.
(a)								
Policies (sum) **	3.417	0.134	2.672	0.087	21.680	1	63.380	0.000
Ambition (S1+S2)	12.750	1.053	15.936	1.570	2.841	1	74.370	0.096
Size (FTE)	15.551	1.313	18.961	2.073	1.932	1	88.667	0.168
Data (span of yrs)**	10.889	0.111	9.466	0.380	94.033	1	66.383	0.000
Practices 2010	3.750	0.337	3.724	0.261	0.004	1	73.488	0.952
Practices 2020 **	7.972	0.334	5.966	0.250	23.120	1	71.258	0.000
Practices (change)**	4.222	0.348	2.241	0.234	22.364	1	65.579	0.000
(b)								
Mean CI **	1.419	0.163	6.023	1.102	17.075	1	59.478	0.000
% Δ CI per yr **	-3.561	0.345	-2.103	0.437	14.898	1	91.994	0.000
% Δ CO ₂ per yr **	-4.180	0.331	-2.032	0.361	8.870	1	89.724	0.004

APPENDIX 5 Chapter 5 Supplementary information – Acronym glossary

Appendix 5.1 Glossary of principles, policies, and practices for environmental management to embed in conservation science and practice

AASHE	Advancement of Sustainability in Higher Education
ALARP	As Low As Reasonably Practicable
ALARP	As Low As Reasonably Practicable
ANOVA	Analysis of Variance
BPEO	Best Practicable Environmental Option
BPEO	Best Practicable Environmental Option
BWS	Best-Worst Scaling
CBD	Convention on Biodiversity
CCF	Comprehensive conservation framework
CER	Certified Emissions Reductions
CFS	Committee on Food Security

CIHR	Conservation Initiative on Human Rights
CMP	Conservation Measures Partnership
CNN	Carbon Neutral Now
CO ₂	Carbon Dioxide
CO ₂ -e	Carbon Dioxide equivalents
EAUC	The Alliance for Sustainability Leadership in Education
EIA	Environmental Impacts Assessment
EIA	Environmental Impacts Assessment
EU	European Union
FPIC	free and prior informed consent (FPIC)
FPIC	Free Prior Informed Consent
GRCS	Global Ratings of Change Scale
HESA	Higher Education Statistics Agency
HLPE	High Level Panel of Experts
ICROA	International Carbon Reduction and Offsetting Accreditation
IPA	Importance-Performance Analysis
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Inter-governmental Panel on Climate Change
ISO	International Standards Organisation
IUCN	International Union on Conservation of Nature
LMMA	Locally Managed Marine Areas
MIHARI	Madagascar's Locally Managed area network
MPA	Marine Protected Area
NGO	Non-Governmental Organisation
NPS	Net Promoter Score
OECD	Organization for Economic Cooperation and Development
PCA	Principle Component Analysis
PP	Precautionary Principle
PPP	Polluter Pays Principle
REC	Renewable Energy Certificates
RSPB	Royal Society for the Protection of Birds
SDG	Sustainable Development Goals
STARS	The Sustainability Tracking, Assessment & Rating System of AASHE
UN	United Nations
UNEP	United Nations Environment Programme
UNFAO	United Nations Food and Agriculture Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNHCR	United Nations High Commission on Refugees
VCO	Voluntary Carbon Offsets
WWF	Known in the USA as World Wildlife Fund

APPENDIX 6 Permissions

Hi Emily,

According to Wiley policy, you are permitted to use your published paper CSP2-20-0138.R1, “The importance of future generations and conflict management in conservation,” in your Ph.D. thesis. Please allow this email to serve as notice that this permission has been provided.

Best wishes,
Jordan

Jordan Taylor, Ph.D.

He/him/his

Associate Managing Editor, Content Review

APPENDIX 7 Work undertaken associated with this PhD

Reports & articles

2019 Advocacy strategies for community-based conservation and sustainable development. Report for Blue Ventures. Author

2021 Policy on voluntary carbon offsets, Centre for Environmental Policy, Imperial College of London. Author.

2021 How can carbon offsetting help UK further and higher education institutions achieve net zero emissions? COP26 Universities Network Briefing. Co-author. [Available online](#).

2021 Selfless values help motivate nature conservation. News items about Chapter 2, co-authored with Simon Levy. Imperial College London. [Available online](#).

2023 Do we have a duty to clean up our climate pollution? Grantham Institute blog based on Chapter 4, in collaboration with Neil Jenkins and Lottie Morgan. Imperial College London. [Available online](#).

Presentations & Posters

2018 Why do people do conservation? DTP conference poster. Imperial College London.

2019 The will of the people. Science seminar speech. Imperial College London

2019 Why bother? NERC DTP Conference speech. University College London

2021 Carbon offsets. Sustainability Week speech. University College London

2022 Don't be so crude: why metrics and methods matter. Food Security and Nutrition Research Network conference speech. University College London

7. BIBLIOGRAPHY

- Abalo, J., Varela, J., & Manzano, V. (2007). Importance values for Importance-Performance Analysis: A formula for spreading out values derived from preference rankings. *Journal of Business Research*, 60(2), 115-121. doi:10.1016/j.jbusres.2006.10.009
- Aburto, J. A., Gaymer, C. F., Haoa, S., & González, L. (2015). Management of marine resources through a local governance perspective: Re-implementation of traditions for marine resource recovery on Easter Island. *Ocean & Coastal Management*, 116, 108-115. doi:10.1016/j.ocecoaman.2015.07.008
- Adair, C. (2016). *Carbon Markets and Offsets Guidance*. Retrieved from Boston, USA: <https://secondnature.org/wp-content/uploads/Carbon-Markets-and-Offsets-Guidance-1.pdf>
- Admiraal, J. F., Van Den Born, R. J. G., Beringer, A., Bonaiuto, F., Cicero, L., Hiedanpää, J., Knights, P., Knippenberg, L. W. J., Molinario, E., Musters, C. J. M., Naukkarinen, O., Polajnar, K., Popa, F., Smrekar, A., Soininen, T., Porras-Gomez, C., Soethe, N., Vivero-Pol, J.-L., & De Groot, W. T. (2017). Motivations for committed nature conservation action in Europe. *Environmental Conservation*, 44(2), 148-157. doi:10.1017/s037689291700008x
- Agrawal, A., Chhatre, A., & Gerber, E. (2015). Motivational Crowding in Sustainable Development Interventions. *American Political Science Review*, 109(03), 470-487. doi:10.1017/s0003055415000209
- Agyare, A., Murray, G., Dearden, P., & Rollins, R. (2015). Conservation in Context: Variability in Desired and Perceived Outcomes of Community Based Natural Resources Governance in Ghana. *Society & Natural Resources*, 28(9), 975-994.
- Ahmadia, G. N., Glew, L., Provost, M., Gill, D., Hidayat, N. I., Mangubhai, S., Purwanto, & Fox, H. E. (2015). Integrating impact evaluation in the design and implementation of monitoring marine protected areas. *Philos Trans R Soc Lond B Biol Sci*, 370(1681). doi:10.1098/rstb.2014.0275
- Allen, M., Axelsson, K., Caldecott, B., Hale, T., Hepburn, C., Conor Hickey, Mitchell-Larson, E., Malhi, Y., Otto, F., Seddon, N., & Smith, S. (2020). *The Oxford Principles for Net Zero Aligned Carbon Offsetting*. Retrieved from Oxford, UK:
- Alongi, D. M. (2002). Present state and future of the world's mangrove forests. *Environmental Conservation*, 29(3), 331-349. doi:10.1017/s0376892902000231
- Andam, K. S., Ferraro, P. J., Sims, K. R. E., Healy, A., & Holland, M. B. (2010). Protected areas reduced poverty in Costa Rica and Thailand. *Proceedings of the National Academy of Sciences - PNAS*, 107(22), 9996-10001. doi:10.1073/pnas.0914177107
- Anderson, K. (2012). The inconvenient truth of carbon offsets. *Nature*, Vol 484(7).
- Arensman, B., van Waegeningh, C., & van Wessel, M. (2018). Twinning "Practices of Change" With "Theory of Change": Room for Emergence in Advocacy Evaluation. *Am J Eval*, 39(2), 221-236. doi:10.1177/1098214017727364

- Ariely, D. a. (2009). *Predictably irrational : the hidden forces that shape our decisions* (Revised and expanded ed.). London: Harper.
- Arlidge, W. N. S., Bull, J. W., Addison, P. F. E., Burgass, M. J., Gianuca, D., Gorham, T. M., Jacob, C., Shumway, N., Sinclair, S. P., Watson, J. E. M., Wilcox, C., & Milner-Gulland, E. J. (2018). A Global Mitigation Hierarchy for Nature Conservation. *Bioscience*, 68(5), 336-347. doi:10.1093/biosci/biy029
- Arton, A., Leiman, A., Petrokofsky, G., Toonen, H., & Longo, C. S. (2020). What do we know about the impacts of the Marine Stewardship Council seafood ecolabelling program? A systematic map. *Environmental Evidence*, 9(1). doi:10.1186/s13750-020-0188-9
- Aswani, S., Albert, S., & Love, M. (2017). One size does not fit all: Critical insights for effective community-based resource management in Melanesia. *Marine Policy*, 81, 381-391. doi:<https://doi.org/10.1016/j.marpol.2017.03.041>
- Atkinson, N. L. (2007). Developing a Questionnaire to Measure Perceived Attributes of eHealth Innovations. *Am J Health Behav.*, 31(6), 612-621.
- Auld, G., Gulbrandsen, L. H., & McDermott, C. L. (2008). Certification Schemes and the Impacts on Forests and Forestry. *Annual Review of Environment and Resources*, 33(1), 187-211. doi:10.1146/annurev.enviro.33.013007.103754
- Azzopardi, E., & Nash, R. (2013). A critical evaluation of importance–performance analysis. *Tourism Management*, 35, 222-233. doi:10.1016/j.tourman.2012.07.007
- Bagcchi, S. (2020). Madagascar's vulnerable children. *The Lancet Infectious Diseases*, 20(4), 416. doi:10.1016/s1473-3099(20)30183-3
- Balas, E. A., & Chapman, W. W. (2018). Road Map For Diffusion Of Innovation In Health Care. *Health Aff (Millwood)*, 37(2), 198-204. doi:10.1377/hlthaff.2017.1155
- Ban, N. C., Gurney, G. G., Marshall, N. A., Whitney, C. K., Mills, M., Gelcich, S., Bennett, N. J., Meehan, M. C., Butler, C., Ban, S., Tran, T. C., Cox, M. E., & Breslow, S. J. (2019). Well-being outcomes of marine protected areas. *Nature Sustainability*, 2(6), 524-532. doi:10.1038/s41893-019-0306-2
- Barron, A. R., Domeshek, M., Metz, L. E., Draucker, L. C., & Strong, A. L. (2021). Carbon neutrality should not be the end goal: Lessons for institutional climate action from U.S. higher education. *One Earth*, 4(9), 1248-1258. doi:10.1016/j.oneear.2021.08.014
- Batres, M., Wang, F. M., Buck, H., Kapila, R., Kosar, U., Licker, R., Nagabhushan, D., Rekhelman, E., & Suarez, V. (2021). Environmental and climate justice and technological carbon removal. *The Electricity Journal*, 34(7). doi:10.1016/j.tej.2021.107002
- Benbow, S., Humber, F., Oliver, T. A., Oleson, K. L. L., Raberinary, D., Nadon, M., Ratsimbazafy, H., & Harris, A. (2014). Lessons learnt from experimental temporary octopus fishing closures in south-west Madagascar: benefits of concurrent closures. *African Journal of Marine Science*, 36(1), 31-37. doi:10.2989/1814232x.2014.893256
- Bendle, N. T., Bagga, C. K., & Nastasoiu, A. (2019). Forging a Stronger Academic-Practitioner Partnership–The Case of Net Promoter Score (NPS). *Journal of Marketing Theory and Practice*, 27(2), 210-226. doi:10.1080/10696679.2019.1577689
- Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conserv Biol*, 30(3), 582-592. doi:10.1111/cobi.12681

- Bennett, N. J., Alava, J. J., Ferguson, C. E., Blythe, J., Morgera, E., Boyd, D., & Côté, I. M. (2023). Environmental (in)justice in the Anthropocene ocean. *Marine Policy*, 147. doi:10.1016/j.marpol.2022.105383
- Bennett, N. J., Blythe, J., Cisneros-Montemayor, A. M., Singh, G. G., & Sumaila, U. R. (2019). Just Transformations to Sustainability. *Sustainability*, 11(14). doi:10.3390/su11143881
- Bennett, N. J., & Dearden, P. (2014). Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy*, 44, 107-116. doi:10.1016/j.marpol.2013.08.017
- Bennett, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J., Epstein, G., Greenberg, A., Nelson, M. P., Sandlos, J., Stedman, R., Teel, T. L., Thomas, R., Veríssimo, D., & Wyborn, C. (2017a). Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation*, 205, 93-108. doi:10.1016/j.biocon.2016.10.006
- Bennett, N. J., Teh, L., Ota, Y., Christie, P., Ayers, A., Day, J. C., Franks, P., Gill, D., Gruby, R. L., Kittinger, J. N., Koehn, J. Z., Lewis, N. a., Parks, J., Vierros, M., Whitty, T. S., Wilhelm, A., Wright, K., Aburto, J. A., Finkbeiner, E. M., Gaymer, C. F., et al. (2017b). An appeal for a code of conduct for marine conservation. *Marine Policy*, 81, 411-418. doi:10.1016/j.marpol.2017.03.035
- Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., & Allison, E. H. (2018). Environmental Stewardship: A Conceptual Review and Analytical Framework. *Environ Manage*, 61(4), 597-614. doi:10.1007/s00267-017-0993-2
- Bergseth, B. J., Arias, A., Barnes, M. L., Caldwell, I., Datta, A., Gelcich, S., Ham, S. H., Lau, J. D., Ruano - Chamorro, C., Smallhorn - West, P., Weekers, D., Zamborain - Mason, J., & Cinner, J. E. (2023). Closing the compliance gap in marine protected areas with human behavioural sciences. *Fish and Fisheries*. doi:10.1111/faf.12749
- Beverland, M. B., Wilner, S. J. S., & Micheli, P. (2015). Reconciling the tension between consistency and relevance: design thinking as a mechanism for brand ambidexterity. *Journal of the Academy of Marketing Science*, 43(5), 589-609. doi:10.1007/s11747-015-0443-8
- Blasberg, J., Vishwanath, V., & Allen, J. (2008). Tools for converting consumers into advocates. *Strategy & Leadership*, 36(2), 16-23. doi:10.1108/10878570810858176
- Blythe, J., Nash, K., Yates, J., & Cumming, G. (2017). Feedbacks as a bridging concept for advancing transdisciplinary sustainability research. *Current Opinion in Environmental Sustainability*, 26-27, 114-119. doi:10.1016/j.cosust.2017.05.004
- Borchers, A., & Pieler, T. (2010). Programming pluripotent precursor cells derived from *Xenopus* embryos to generate specific tissues and organs. *Genes (Basel)*, 1(3), 413-426. doi:10.3390/genes1030413
- Borsci, S., Buckle, P., & Walne, S. (2020). Is the LITE version of the usability metric for user experience (UMUX-LITE) a reliable tool to support rapid assessment of new healthcare technology? (Embargoed to Nov 2020). *Applied Ergonomics: human factors in technology and society*, 84. doi: 10.1016/j.apergo.2019.103007
- Brittain, S., Ibbett, H., de Lange, E., Dorward, L., Hoyte, S., Marino, A., Milner-Gulland, E. J., Newth, J., Rakotonarivo, S., Veríssimo, D., & Lewis, J. (2020). Ethical

- considerations when conservation research involves people. *Conservation Biology*, 34(4), 925-933. doi:<https://doi.org/10.1111/cobi.13464>
- Broekhoff, D., Gillenwater, M., Colbert-Sangree, T., & Cage, P. (2019). *Securing Climate Benefit: A Guide to Using Carbon Offsets*. Retrieved from [Offsetguide.org/pdf-download/](https://offsetguide.org/pdf-download/)
- Brouwer, R., Brander, L., & Van Beukering, P. (2008). "A convenient truth": air travel passengers' willingness to pay to offset their CO2 emissions. *Climatic Change*, 90(3), 299-313. doi:10.1007/s10584-008-9414-0
- Brown, S. L., Asher, T., & Cialdini, R. B. (2005). Evidence of a positive relationship between age and preference for consistency. *Journal of Research in Personality*, 39(5), 517-533. doi:10.1016/j.jrp.2004.07.001
- Buck, H. J. (2020). Should carbon removal be treated as waste management? Lessons from the cultural history of waste. *Interface Focus*, 10(5), 20200010. doi:10.1098/rsfs.2020.0010
- Bull, J., Baker, J., Griffiths, V. F., Jones, J., & Milner-Gulland, E. J. (2018). *Ensuring No Net Loss For People As Well As Biodiversity: Good Practice Principles*. Retrieved from Oxford, UK.:
- Burgman, M. A. (2005). Risks and decisions for conservation and environmental management. In. Cambridge, UK: Cambridge University Press.
- Bush, S. R., Toonen, H., Oosterveer, P., & Mol, A. P. J. (2013). The 'devils triangle' of MSC certification: Balancing credibility, accessibility and continuous improvement. *Marine Policy*, 37, 288-293. doi:10.1016/j.marpol.2012.05.011
- Campbell-Arvai, V., Hart, P. S., Raimi, K. T., & Wolske, K. S. (2017). The influence of learning about carbon dioxide removal (CDR) on support for mitigation policies. *Climatic Change*, 143(3-4), 321-336. doi:10.1007/s10584-017-2005-1
- Canzi, G., Kronick, C. and Clough, K. (2006). *Joint statement on offsetting carbon emissions - by Friends of the Earth, Greenpeace and WWF-UK*. Retrieved from London UK:
- Carmichael, R., Gross, R., Hanna, R., Rhodes, A., & Green, T. (2021). The Demand Response Technology Cluster: Accelerating UK residential consumer engagement with time-of-use tariffs, electric vehicles and smart meters via digital comparison tools. *Renewable and Sustainable Energy Reviews*, 139. doi:10.1016/j.rser.2020.110701
- Carson, R. (1999). *Silent spring* ([New ed.]. ed.). London: Penguin.
- Catalano, A. S., Lyons-White, J., Mills, M. M., & Knight, A. T. (2019). Learning from published project failures in conservation. *Biological Conservation*, 238. doi:10.1016/j.biocon.2019.108223
- CBD. (2011). *Tkarihwaí:ri - Code of Ethical Conduct to Ensure Respect for the Cultural and Intellectual Heritage of Indigenous and Local Communities Relevant to the Conservation and Sustainable Use of Biological Diversity*. Retrieved from Montreal, Canada:
- Kunming-Montreal Global Biodiversity Framework, (2022).
- Ceppi, P. (2006). *Developing A Robust Carbon Offsetting Strategy*. Retrieved from London, UK: <https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Developing A Robust Carbon Offsetting Strategy - REPORT.pdf>

- Cetas, E. R., & Yasue, M. (2017). A systematic review of motivational values and conservation success in and around protected areas. *Conserv Biol*, 31(1), 203-212. doi:10.1111/cobi.12770
- CFS. (2012). *Policy Roundtable on Social Protection for Food Security and Nutrition*. Retrieved from Rome:
- Chadwick, D. (2016). *Carbon Management In The Higher Education Sector: A guide to good practice*. Retrieved from London:
- Chen, K.-Y. (2014). Improving importance-performance analysis: The role of the zone of tolerance and competitor performance. The case of Taiwan's hot spring hotels. *Tourism Management*, 40, 260-272. doi:10.1016/j.tourman.2013.06.009
- Chitnis, M., Sorrell, S., Druckman, A., Firth, S. K., & Jackson, T. (2013). Turning lights into flights: Estimating direct and indirect rebound effects for UK households. *Energy Policy*, 55, 234-250. doi:10.1016/j.enpol.2012.12.008
- Cinner, J., & Huchery, C. (2014). A Comparison of Social Outcomes Associated with Different Fisheries Co - Management Institutions. *Conservation Letters*, 7(3), 224-232. doi:10.1111/conl.12057
- Clarke, P., & Jupiter, S. D. (2010). Law, custom and community-based natural resource management in Kubulau District (Fiji). *Environmental Conservation*, 37(1), 98-106. doi:10.1017/S0376892910000354
- CMP. (2020). Open Standards for the Practice of Conservation v4.0. In (pp. 88).
- CNN, U. (2022). *UN Climate Neutral Now Guidelines for Participation*. Retrieved from https://unfccc.int/sites/default/files/resource/CNN_Guidelines.pdf
- Collins, A. M., Coughlin, D., & Randall, N. (2019). Engaging environmental policy-makers with systematic reviews: challenges, solutions and lessons learned. *Environmental Evidence*, 8(1). doi:10.1186/s13750-018-0144-0
- Cooney, R., Tahar, A., Kennedy, A., & Clifford, E. (2021). Accounting for Research Induced Environmental Impacts Using Life Cycle Assessment. *Frontiers in Sustainability*, 2. doi:10.3389/frsus.2021.631685
- Crompton, T., & Kasser, T. (2010). Human Identity: A Missing Link in Environmental Campaigning. *Environment: Science and Policy for Sustainable Development*, 52(4), 23-33. doi:10.1080/00139157.2010.493114
- Crosman, K. M., Allison, E. H., Ota, Y., Cisneros-Montemayor, A. M., Singh, G. G., Swartz, W., Bailey, M., Barclay, K. M., Blume, G., Colléter, M., Fabinyi, M., Faustman, E. M., Fielding, R., Griffin, P. J., Hanich, Q., Harden-Davies, H., Kelly, R. P., Kenny, T.-A., Klinger, T., Kittinger, J. N., et al. (2022). Social equity is key to sustainable ocean governance. *npj Ocean Sustainability*, 1(1). doi:10.1038/s44183-022-00001-7
- Davis, K., Burton, M., & Kragt, E. (2016). *Discrete choice models: scale heterogeneity and why it matters*. Working Paper 1602. Working Paper 1602.
- Davis, K. J., Kragt, M. E., Gelcich, S., Burton, M., Schilizzi, S., & Pannell, D. J. (2015). Why are Fishers not Enforcing Their Marine User Rights? *Environmental and Resource Economics*, 67(4), 661-681. doi:10.1007/s10640-015-9992-z
- de Chalendar, J. A., Taggart, J., & Benson, S. M. (2019). Tracking emissions in the US electricity system. *Proc Natl Acad Sci U S A*, 116(51), 25497-25502. doi:10.1073/pnas.1912950116
- de Lange, E., Woodhouse, E., & Milner-Gulland, E. J. (2016). Evaluating the impacts of conservation interventions on human well-being: guidance for practitioners. *Oryx*, 51(1), 14-15. doi:10.1017/S0030605316001423

- de Sadeleer, N. (2015). Preliminary Reference on Environmental Liability and the Polluter Pays Principle: Case C-534/13,Fipa. *Review of European, Comparative & International Environmental Law*, 24(2), 232-237. doi:10.1111/reel.12115
- Dearing, J. W. (2008). Evolution of diffusion and dissemination theory. *J Public Health Manag Pract*, 14(2), 99-108. doi:10.1097/01.PHH.0000311886.98627.b7
- Dearing, J. W. (2009). Applying Diffusion of Innovation Theory to Intervention Development. *Res Soc Work Pract*, 19(5), 503-518. doi:10.1177/1049731509335569
- Dearing, J. W., & Cox, J. G. (2018). Diffusion Of Innovations Theory, Principles, And Practice. *Health Aff (Millwood)*, 37(2), 183-190. doi:10.1377/hlthaff.2017.1104
- Di Franco, A., Thiriet, P., Di Carlo, G., Dimitriadis, C., Francour, P., Gutiérrez, N. L., Jeudy de Grissac, A., Koutsoubas, D., Milazzo, M., Otero, M. d. M., Piante, C., Plass-Johnson, J., Sainz-Trapaga, S., Santarossa, L., Tudela, S., & Guidetti, P. (2016). Five key attributes can increase marine protected areas performance for small-scale fisheries management. *Scientific Reports*, 6, 38135. doi:10.1038/srep38135 <https://www.nature.com/articles/srep38135 - supplementary-information>
- Dickman, A., Johnson, P., Coals, P., Harrington, L., Tyrrell, P., Somerville, K., Cotterill, A., & Whetham, D. (2020). Wars over Wildlife: Green Militarisation and Just War Theory. *Conservation and Society*, 18(3), 293-297. doi:10.4103/cs.cs_19_34
- Dobson, A. M., de Lange, E., Keane, A., Ibbett, H., & Milner-Gulland, E. J. (2019). Integrating models of human behaviour between the individual and population levels to inform conservation interventions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 374(1781), 20180053-undefined. doi:10.1098/rstb.2018.0053
- Edgar, G. J., Stuart-Smith, R. D., Willis, T. J., Kininmonth, S., Baker, S. C., Banks, S., Barrett, N. S., Becerro, M. A., Bernard, A. T. F., Berkhout, J., Buxton, C. D., Campbell, S. J., Cooper, A. T., Davey, M., Edgar, S. C., Försterra, G., Galván, D. E., Irigoyen, A. J., Kushner, D. J., Moura, R., et al. (2014). Global conservation outcomes depend on marine protected areas with five key features. *Nature*, 506, 216. doi:10.1038/nature13022 <https://www.nature.com/articles/nature13022 - supplementary-information>
- Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage, (2004).
- EU Directive on the assessment of the effects of certain public and private projects on the environment., 2011/92/EU C.F.R. (2011).
- Fair, H., Schreer, V., Keil, P., Kiik, L., & Rust, N. (2022). Dodo dilemmas: Conflicting ethical loyalties in conservation social science research. *Area*. doi:10.1111/area.12839
- Farmer, J. R., Knapp, D., Meretsky, V. J., Chancellor, C., & Fischer, B. C. (2011). Motivations influencing the adoption of conservation easements. *Conserv Biol*, 25(4), 827-834. doi:10.1111/j.1523-1739.2011.01686.x
- Faul, F., Erdfelder, E., Lang, A.-G. & Buchner, A. . (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175-191.
- Field, C. B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A

- Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Pp. 1-582.
- Finn, A., & Louvier, J. (1992). Determining the Appropriate Response to Evidence of Public Concern: The Case of Food Safety. *Journal of Public Policy and Marketing*, 11(1), 12-25.
- Fischer, D., Stewart, A. L., Bloch, D. A., Lorig, K., Laurent, D., & Holman, H. (1999). Capturing the patient's view of change as a clinical outcome measure. *Jama*, 282(12), 1157-1162. doi:10.1001/jama.282.12.1157
- Foale, S., Cohen, P., Januchowski-Hartley, S., Wenger, A., & Macintyre, M. (2011). Tenure and taboos: origins and implications for fisheries in the Pacific. *Fish and Fisheries*, 12(4), 357-369. doi:10.1111/j.1467-2979.2010.00395.x
- Font Vivanco, D., Kemp, R., & van der Voet, E. (2016). How to deal with the rebound effect? A policy-oriented approach. *Energy Policy*, 94, 114-125. doi:10.1016/j.enpol.2016.03.054
- Garcia-Rubies, A., Hereu, B., & Zabala, M. (2013). Long-term recovery patterns and limited spillover of large predatory fish in a Mediterranean MPA. *PLoS One*, 8(9), e73922. doi:10.1371/journal.pone.0073922
- Gardner, C. J., Cripps, G., Day, L. P., Dewar, K., Gough, C., Peabody, S., Tahindraza, G., & Harris, A. (2020). A decade and a half of learning from Madagascar's first locally managed marine area. *Conservation Science and Practice*, 2(12), e298. doi:10.1111/csp2.298
- Gardner, C. J., Latham, J. E., & Rocliffe, S. (2017). Intended and unintended outcomes in fisheries learning exchanges: Lessons from Mexico and Madagascar. *Marine Policy*, 77, 219-226. doi:10.1016/j.marpol.2016.04.040
- Gardner, C. J., Nicoll, M. E., Birkinshaw, C., Harris, A., Lewis, R. E., Rakotomalala, D., & Ratsifandrihamanana, A. N. (2018). The rapid expansion of Madagascar's protected area system. *Biological Conservation*, 220, 29-36. doi:10.1016/j.biocon.2018.02.011
- Gerbens-Leenes, P. W., Mekonnen, M. M., & Hoekstra, A. Y. (2011). *A comparative study on the water footprint of poultry, pork and beef in different countries and production systems*. Retrieved from Delft, the Netherlands.:
- Gholamzadehmir, M., Sparks, P., & Farsides, T. (2019). Moral licensing, moral cleansing and pro-environmental behaviour: The moderating role of pro-environmental attitudes. *Journal of Environmental Psychology*, 65. doi:10.1016/j.jenvp.2019.101334
- Gilchrist, H., Rocliffe, S., Anderson, L. G., & Gough, C. L. A. (2020). Reef fish biomass recovery within community-managed no take zones. *Ocean & Coastal Management*, 192. doi:10.1016/j.ocecoaman.2020.105210
- Gladkikh, T. M., Collazo, J. A., Torres - Abreu, A., Reyes, A. M., & Molina, M. (2020). Factors that influence participation of Puerto Rican coffee farmers in conservation programs. *Conservation Science and Practice*, 2(4), e172. doi:10.1111/csp2.172
- Glew, L., Mascia, M. B., & Pakiding, F. (2012). *Solving the Mystery of MPA Performance: monitoring social impacts. Field Manual (version 1.0)*. Retrieved from Washington D.C. and Manokwari, Indonesia.:
- Gold-Standard. (2019). *Gold Standard for the Global Goals: Principles and Requirements* Retrieved from

- Govan, H. (2009). *Status and potential of locally-managed marine areas in the Pacific Island Region: meeting nature conservation and sustainable livelihood targets through wide-spread implementation of LMMAs*. Retrieved from <https://mpira.ub.uni-muenchen.de/23828/>
- Graneheim, U. H., Lindgren, B.-M., & Lundman, B. (2017). Methodological challenges in qualitative content analysis: A discussion paper. *Nurse education today*, 56, 29-34. doi:10.1016/j.nedt.2017.06.002
- Greenberg, D., & Fang, C. C. (2015). The Myth of Climate Neutrality: Carbon Onsetting as an Alternative to Carbon Offsetting. *Sustainability: The Journal of Record*, 8(2), 70-75. doi:10.1089/sus.2015.0017
- Greiber, T. (2009). *Conservation with Justice. A Rights-based Approach*. Retrieved from Gland, Switzerland:
- Groves, C. R., Jensen, D. B., Valutis, L. L., Redford, K. H., Shaffer, M. L., Scott, J., Baumgartner, M., Jeffrey V., Higgins, J. V., Beck, M. W., & A. Mark G. (2002). Planning for Biodiversity Conservation: Putting Conservation Science into Practice. *Bioscience*, Vol. 52(No. 6), 499-512.
- Guadagno, R. E., Asher, T., Demaine, L. J., & Cialdini, R. B. (2001). When Saying Yes Leads to Saying No: Preference for Consistency and the Reverse Foot-in-the-Door Effect. *Personality & social psychology bulletin*, 27(7), 859-867. doi:10.1177/0146167201277008
- Gulbrandsen, L. H. (2009). The emergence and effectiveness of the Marine Stewardship Council. *Marine Policy*, 33(4), 654-660. doi:10.1016/j.marpol.2009.01.002
- Günther, S. A., Staake, T., Schöb, S., & Tiefenbeck, V. (2020). The behavioral response to a corporate carbon offset program: A field experiment on adverse effects and mitigation strategies. *Global Environmental Change*, 64. doi:10.1016/j.gloenvcha.2020.102123
- Gurney, G. G., Cinner, J., Ban, N. C., Pressey, R. L., Pollnac, R., Campbell, S. J., Tasidjawa, S., & Setiawan, F. (2014). Poverty and protected areas: An evaluation of a marine integrated conservation and development project in Indonesia. *Global Environmental Change*, 26, 98-107. doi:10.1016/j.gloenvcha.2014.04.003
- Gurney, G. G., & Darling, E. S. (2017). *A Global Social-Ecological Systems Monitoring Framework for Coastal Fisheries Management: A Practical Monitoring Handbook*. Retrieved from
- Gurney, G. G., Mangubhai, S., Fox, M., Kiatkoski Kim, M., & Agrawal, A. (2021). Equity in environmental governance: perceived fairness of distributional justice principles in marine co-management. *Environmental Science & Policy*, 124, 23-32. doi:10.1016/j.envsci.2021.05.022
- Hall, S. (2002). *The Use of Technical Measures in Responsible Fisheries: Area and Time Restrictions*. Rome, Italy: UNFAO.
- Hansen, J., Sato, M., Kharecha, P., von Schuckmann, K., Beerling, D. J., Cao, J., Marcott, S., Masson-Delmotte, V., Prather, M. J., Rohling, E. J., Shakun, J., Smith, P., Lais, A., Russell, G., & Ruedy, R. (2017). Young people's burden: requirement of negative CO2 emissions. *Earth System Dynamics*, 8(3), 577-616. doi:10.5194/esd-8-577-2017
- Hansson, H., & Lagerkvist, C. J. (2016). Dairy farmers' use and non-use values in animal welfare: Determining the empirical content and structure with anchored best-worst scaling. *Journal of Dairy Science*, 99(1), 579-592. doi:10.3168/jds.2015-9755

- Harpe, S. E. (2015). How to analyze Likert and other rating scale data. *Currents in Pharmacy Teaching and Learning*, 7(6), 836-850. doi:10.1016/j.cptl.2015.08.001
- Harvey, C. A., Rambeloson, A. M., Andrianjohaninarivo, T., Andriamaro, L., Rasolohery, A., Randrianarisoa, J., Ramanahadray, S., Christie, M., Siwicka, E., Remoundou, K., Vélchez-Mendoza, S., & MacKinnon, J. L. (2018). Local Perceptions of the Livelihood and Conservation Benefits of Small-Scale Livelihood Projects in Rural Madagascar. *Society & Natural Resources*, 31(9), 1045-1063. doi:10.1080/08941920.2018.1484974
- HESA. (2021). Open data and official statistics. Retrieved from <https://www.hesa.ac.uk/data-and-analysis>
- Hestres, L. E. (2015). Climate change advocacy online: theories of change, target audiences, and online strategy. *Environmental Politics*, 24(2), 193-211. doi:10.1080/09644016.2015.992600
- HLPE. (2012). *Social protection for food security*. Retrieved from Rome:
- Hoffman, S. D., & Duncan, G. J. (1988). Multinomial and Conditional Logit Discrete-Choice Models in Demography. *Demography*, 25(3), 415-427. doi:10.2307/2061541
- Hole. (2006). Small-sample properties of tests for heteroscedasticity in the conditional logit model. *Economics Bulletin*, 3 (18), 1-14.
- Hoyle, D. (2011). Listening to people in Cameroon. *Nature*, VOL 474 (June).
- Hulpke, J. F., & Fronmueller, M. P. (2021). What's not to like about evidence-based management: a hyper-rational fad? *International Journal of Organizational Analysis*, 30(7), 95-123. doi:10.1108/ijoa-06-2020-2278
- Ibanitoru, P. (2021). *A Critical Analysis of the Polluter Pays Principle in International Climate Change Law* (Degree of Master of Laws 2020), Aberdeen,
- Idundun, E., Hursthouse, A. S., & McLellan, I. (2021). Carbon Management in UK Higher Education Institutions: An Overview. *Sustainability*, 13(19). doi:10.3390/su131910896
- Infield, M., Entwistle, A., Anthem, H., Mugisha, A., & Phillips, K. (2018). Reflections on cultural values approaches to conservation: lessons from 20 years of implementation. *Oryx*, 52(2), 220-230. doi:10.1017/S0030605317000928
- IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Chapter 2.2*. Retrieved from Bonn, Germany:
- IPCC. (2018). *Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Retrieved from Geneva, Switzerland,:
- IPCC. (2023). *Summary for Policymakers*.
- ISO. (2022). The biodiversity bottom line. Retrieved from <https://www.iso.org/contents/news/2022/11/the-biodiversity-bottom-line.html#:~:text=Led%20by%20technical%20committee%20ISO,holistic%2C%20unifying%20and%20global%20approach>.
- IUCN-UNEP-WWF. (1980). *World Conservation Priorities*. Retrieved from Gland, Switzerland:
- Jaansoo, A. (2019). *Methodology for Situation Analysis* Retrieved from

- Jackson, T. (2011). Societal transformations for a sustainable economy. *Natural Resources Forum*, 35(3), 155-164. doi:10.1111/j.1477-8947.2011.01395.x
- Jakobsen, H. (2012). Focus groups and methodological rigour outside the minority world: making the method work to its strengths in Tanzania. *Qualitative Research*, 12(2), 111-130. doi:10.1177/1468794111416145
- Jebari, J., Táíwò, O. m. O., Andrews, T. M., Aquila, V., Beckage, B., Belaia, M., Clifford, M., Fuhrman, J., Keller, D. P., Mach, K. J., Morrow, D. R., Raimi, K. T., Visioni, D., Nicholson, S., & Trisos, C. H. (2021). From moral hazard to risk-response feedback. *Climate Risk Management*, 33. doi:10.1016/j.crm.2021.100324
- Jupiter, S. D., Cohen, P. J., Weeks, R., Tawake, A., & Govan, H. (2014). Locally-managed marine areas: multiple objectives and diverse strategies. *Pacific Conservation Biology*, 20(2), 165-179. doi:<https://doi.org/10.1071/PC140165>
- Jupiter, S. D., Epstein, G., Ban, N. C., Mangubhai, S., Fox, M., & Cox, M. (2017). A Social-Ecological Systems Approach to Assessing Conservation and Fisheries Outcomes in Fijian Locally Managed Marine Areas. *Society & Natural Resources*, 30(9), 1096-1111. doi:10.1080/08941920.2017.1315654
- Kadkhodayan, H., & Alizadeh, T. (2022). Fabrication of high-performance multifunctional Fe-doped La₂ZnTiO₆ double perovskite/activated carbon nanocomposite for efficient photocatalytic degradation of dyes, nitrate and carbon dioxide pollutants. *Materials Today Chemistry*, 26. doi:10.1016/j.mtchem.2022.101034
- Kamper, S. J., Maher, C. G., & Mackay, G. (2009). Global rating of change scales: a review of strengths and weaknesses and considerations for design. *The Journal of manual & manipulative therapy*, 17(3), 163-170. doi:10.1179/jmt.2009.17.3.163
- Kareiva, P., & Marvier, M. (2012). What Is Conservation Science? *Bioscience*, 62(11), 962-969. doi:10.1525/bio.2012.62.11.5
- Kashwan, P., & Ribot, J. (2021). Violent Silence: The Erasure of History and Justice in Global Climate Policy. *Current History*, 120(829), 326-331. doi:10.1525/curh.2021.120.829.326
- Kauppi, P., Sedjo, R., Apps, M., Cerri, C., Fujimori, T., Janzen, H., Krankina, O., Makundi, W., Marland, G., Masera, O., Nabuurs, G.-J., Razali, W., Ravindranath, N. H., Keith, D., Kheshgi, H., & Liski, J. (2001). *Technological and Economic Potential of Options to Enhance, Maintain, and Manage Biological Carbon Reservoirs and Geo-engineering*. Retrieved from <https://archive.ipcc.ch/ipccreports/tar/wg3/pdf/4.pdf>
- Kawaka, J. A., Samoilys, M. A., Murunga, M., Church, J., Abunge, C., & Maina, G. W. (2017). Developing locally managed marine areas: Lessons learnt from Kenya. *Ocean & Coastal Management*, 135, 1-10. doi:10.1016/j.ocecoaman.2016.10.013
- Keller, D. P., Lenton, A., Littleton, E. W., Oschlies, A., Scott, V., & Vaughan, N. E. (2018). The Effects of Carbon Dioxide Removal on the Carbon Cycle. *Curr Clim Change Rep*, 4(3), 250-265. doi:10.1007/s40641-018-0104-3
- Keller, E. (2009). The danger of misunderstanding 'culture'. *Madagascar Conservation and Development*, 4(2), 82-85.
- Koberstein, P., & Applegate, J. (2021). CARBON CONUNDRUM: A Native Alaskan company's promise to save its forests benefits local ecosystems, but given the zero-sum game that's carbon offsets, it delays meaningful action on climate change. *Earth Island journal*, 35(4), 33.
- Kollmuss, A., Zink, H., Polycarp, C., (2008). *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*. Retrieved from

- Kotchen, M., & Moon, J. J. (2012). Corporate Social Responsibility for Irresponsibility. *The B.E. Journal of Economic Analysis & Policy*, 12(1). doi:10.1515/1935-1682.3308
- Kough, A. S., Belak, C. A., Paris, C. B., Lundy, A., Cronin, H., Gnanalingam, G., Hagedorn, S., Skubel, R., Weiler, A. C., & Stoner, A. W. (2019). Ecological spillover from a marine protected area replenishes an over - exploited population across an island chain. *Conservation Science and Practice*, 1(3). doi:10.1111/csp2.17
- Krol, M. W., de Boer, D., Delnoij, D. M., & Rademakers, J. J. (2015). The Net Promoter Score--an asset to patient experience surveys? *Health Expect*, 18(6), 3099-3109. doi:10.1111/hex.12297
- Kuehne, G. L., Rick; Pannell, David J.; Wilkinson, Roger; Dolling, Perry; Ouzman, Jackie; Ewing, Mike. (2017). Predicting farmer uptake of new agricultural practices: A tool for research, extension and policy. *Agricultural Systems*, 156, 115-125. doi:<https://doi.org/10.1016/j.agsy.2017.06.007>
- Kuhn, K.-U., & Uler, N. (2019). Behavioral sources of the demand for carbon offsets: an experimental study. *A Journal of the Economic Science Association*, 22(3), 676-704. doi:10.1007/s10683-018-09601-y
- Labott, S. M., Johnson, T. P., Fendrich, M., & Feeny, N. C. (2013). Emotional risks to respondents in survey research. *J Empir Res Hum Res Ethics*, 8(4), 53-66. doi:10.1525/jer.2013.8.4.53
- Laffoley, D., Baxter, J. M., Amon, D. J., Currie, D. E. J., Downs, C. A., Hall - Spencer, J. M., Harden - Davies, H., Page, R., Reid, C. P., Roberts, C. M., Rogers, A., Thiele, T., Sheppard, C. R. C., Sumaila, R. U., & Woodall, L. C. (2019). Eight urgent, fundamental and simultaneous steps needed to restore ocean health, and the consequences for humanity and the planet of inaction or delay. *Aquatic Conservation: Marine and Freshwater Ecosystems*. doi:10.1002/aqc.3182
- Lai, I. K. W., & Hitchcock, M. (2015). Importance-performance analysis in tourism: A framework for researchers. *Tourism Management*, 48, 242-267. doi:10.1016/j.tourman.2014.11.008
- Laitinen, M. A. (2018). Net Promoter Score as Indicator of Library Customers' Perception. *Journal of Library Administration*, 58(4), 394-406. doi:10.1080/01930826.2018.1448655
- Lamichhane, B. R., Pokheral, C. P., Poudel, S., Adhikari, D., Giri, S. R., Bhattarai, S., Bhatta, T. R., Pickles, R., Amin, R., Acharya, K. P., Dhakal, M., Regmi, U. R., Ram, A. K., & Subedi, N. (2017). Rapid recovery of tigers *Panthera tigris* in Parsa Wildlife Reserve, Nepal. *Oryx*, 52(1), 16-24. doi:10.1017/s0030605317000886
- Lancsar, E., Louviere, J., Donaldson, C., Currie, G., & Burgess, L. (2013). Best worst discrete choice experiments in health: Methods and an application. *Social Science & Medicine*, 76, 74-82. doi:<https://doi.org/10.1016/j.socscimed.2012.10.007>
- Larrosa, C., Carrasco, L. R., & Milner-Gulland, E. J. (2016). Unintended Feedbacks: Challenges and Opportunities for Improving Conservation Effectiveness. *Conservation Letters*, 9(5), 316-326. doi:10.1111/conl.12240
- Le Manach, F., Gough, C., Harris, A., Humber, F., Harper, S., & Zeller, D. (2012). Unreported fishing, hungry people and political turmoil: the recipe for a food security crisis in Madagascar? *Marine Policy*, 36(1), 218-225. doi:10.1016/j.marpol.2011.05.007
- Leadley, P. W., Krug, C. B., Alkemade, R., Pereira, H. M., U.R, S., Walpole, M., Marques, A., Newbold, T., Teh, L. S. L., van Kolck, J., Bellard, C., Januchowski-Hartley, S. R., &

- Mumby, P. J. (2014). *Progress towards the Aichi Biodiversity Targets: An Assessment of Biodiversity Trends, Policy Scenarios and Key Actions*. Secretariat of the Convention on Biological Diversity. Retrieved from Montreal, Canada.:
- Leclerc, D., Obersteiner, M., Barrett, M., Butchart, S. H. M., Chaudhary, A., De Palma, A., DeClerck, F. A. J., Di Marco, M., Doelman, J. C., Durauer, M., Freeman, R., Harfoot, M., Hasegawa, T., Hellweg, S., Hilbers, J. P., Hill, S. L. L., Humpenoder, F., Jennings, N., Krisztin, T., Mace, G. M., et al. (2020). Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature*, 585(7826), 551-556. doi:10.1038/s41586-020-2705-y
- Lee, J. A. S., G.; Louviere, J. (2008). The best-worst scaling approach: an alternative to Schwartz's Values Survey. *J Pers Assess*, 90(4), 335-347. doi:10.1080/00223890802107925
- Lewis, J. (1988). *Report / 12th, Best practicable environmental option*. London: H.M.S.O.
- Lewis-Brown, E. (2023). *Templates for BWS IPA and NPS project evaluations*. Retrieved from: <https://doi.org/10.5281/zenodo.7541503>
- Lewis-Brown, E., Beatty, H., Davis, K., Rabearisoa, A., Ramiamanana, J., Mascia, M. B., Ewers, R., M., & Mills, M. (2023). Importance-Performance Analysis shows where improvements can be made which increase the spread of Locally Managed Marine Areas. . *In Prep*.
- Lewison, R. L., Johnson, A. F., Gan, J., Pelc, R., Westfall, K., & Helvey, M. (2019). Accounting for unintended consequences of resource policy: Connecting research that addresses displacement of environmental impacts. *Conservation Letters*. doi:10.1111/conl.12628
- Locke, E. A., & Latham, G. P. (2019). The development of goal setting theory: A half century retrospective. *Motivation Science*, 5(2), 93-105. doi:10.1037/mot0000127
- Long, S. (2017). Short-term impacts and value of a periodic no take zone (NTZ) in a community-managed small-scale lobster fishery, Madagascar. *PLoS One*, 12(5), e0177858. doi:10.1371/journal.pone.0177858
- Long, S., Jones, P. J. S., Randriana, Z., & Hadj-Hammou, J. (2021). Governance analysis of a community managed small-scale crab fishery in Madagascar: novel use of an empirical framework. *Marine Policy*, 127. doi:10.1016/j.marpol.2017.11.022
- Long, S., Thurlow, G., Jones, P. J. S., Turner, A., Randrianantenaina, S. M., Gammage, T., Savage, J., & Ndriamanja, J. R. (2019). Critical analysis of the governance of the Sainte Luce Locally Managed Marine Area (LMMA), southeast Madagascar. *Marine Policy*. doi:10.1016/j.marpol.2019.103691
- Louviere, J. J., Flynn, T. N., & Marley, A. A. J. (2015). *Best-Worst Scaling: Theory, Methods and Applications*. Cambridge: Cambridge University Press.
- Lovell, H. C. (2010). Governing the carbon offset market. *Wiley Interdisciplinary Reviews: Climate Change*, 1(3), 353-362. doi:10.1002/wcc.43
- Loveridge, R., Sallu, S. M., Pesh, I. J., & Marshall, A. (2020). Measuring human wellbeing: A protocol for selecting local indicators. *Environmental Science & Policy*, 114, 461-469. doi:10.1016/j.envsci.2020.09.002
- Luoma, C. (2023). Reckoning with Conservation Violence on Indigenous Territories: Possibilities and Limitations of a Transitional Justice Response. *International Journal of Transitional Justice*. doi:10.1093/ijtj/ijad002

- Ma, T., Hu, Y., Wang, M., Yu, L., & Wei, F. (2021). Unity of Nature and Man: a new vision and conceptual framework for the Post-2020 Global Biodiversity Framework. *National Science Review*, 8(7), nwaa265. doi:10.1093/nsr/nwaa265
- Mach, K. J., Planton, S. and Stechow, C. von (2014). *Annex II: Glossary In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* Retrieved from Geneva, Switzerland:
- Malakar, K., Mishra, T., & Patwardhan, A. (2018). A framework to investigate drivers of adaptation decisions in marine fishing: Evidence from urban, semi-urban and rural communities. *Sci Total Environ*, 637-638, 758-770. doi:10.1016/j.scitotenv.2018.04.429
- Malay, D., Zhonhua, G., Deo, P., & Fengting, L. (2014). *Greening University Toolkit V2.0*. Retrieved from [https://wedocs.unep.org/bitstream/handle/20.500.11822/11964/Greening University Toolkit V2.0.pdf?sequence=1&isAllowed=y](https://wedocs.unep.org/bitstream/handle/20.500.11822/11964/Greening%20University%20Toolkit%20V2.0.pdf?sequence=1&isAllowed=y)
- Mannan, B., & Haleem, A. (2017). Understanding major dimensions and determinants that help in diffusion & adoption of product innovation: using AHP approach. *Journal of Global Entrepreneurship Research*, 7(1). doi:10.1186/s40497-017-0072-4
- Markusson, N., McLaren, D., & Tyfield, D. (2018). Towards a cultural political economy of mitigation deterrence by negative emissions technologies (NETs). *Global Sustainability*, 1. doi:10.1017/sus.2018.10
- Marshall, N. A., Thiault, L., Beeden, A., Beeden, R., Benham, C., Curnock, M. I., Diedrich, A., Gurney, G. G., Jones, L., Marshall, P. A., Nakamura, N., & Pert, P. (2019). Our Environmental Value Orientations Influence How We Respond to Climate Change. *Front Psychol*, 10, 938. doi:10.3389/fpsyg.2019.00938
- Martilla, J. A., & James, J. C. (1977). Importance-Performance Analysis. *Journal of Marketing*, 41(1), 77-79.
- Mascia, M. B., Fox, H. E., Glew, L., Ahmadia, G. N., Agrawal, A., Barnes, M., Basurto, X., Craigie, I., Darling, E., Geldmann, J., Gill, D., Holst, R., Jensen, S., Lester, O. P., S.E., M., P.; Mumby, P. J., Nenadovic, M., Parks, J. E., Pomeroy, R. S., & White, A. (2017). A novel framework for analyzing conservation impacts: evaluation, theory, and marine protected areas. *Ann N Y Acad Sci*, 1399(1), 93-115. doi:10.1111/nyas.13428
- Mascia, M. B., & Mills, M. (2018). When conservation goes viral: The diffusion of innovative biodiversity conservation policies and practices. *Conservation Letters*, 11(3), 12442-12451. doi:10.1111/conl.12442
- Matulis, B. S., & Moyer, J. R. (2017). Beyond Inclusive Conservation: The Value of Pluralism, the Need for Agonism, and the Case for Social Instrumentalism. *Conservation Letters*, 10(3), 279-287. doi:10.1111/conl.12281
- Matzler, K., Sauerwein, E., & Heischmidt, K. (2003). Importance-performance analysis revisited: the role of the factor structure of customer satisfaction. *The Service Industries Journal*, 23(2), 112-129. doi:10.1080/02642060412331300912
- Mayol, T. L. (2013). Madagascar's nascent locally managed marine area network. *Madagascar Conservation & Development*, 8(2). doi:10.4314/mcd.v8i2.8
- Mbaru, E., Hicks, C., Gurney, G., & Cinner, J. (2021). Evaluating outcomes of conservation with multidimensional indicators of well - being. *Conservation Biology*, cob1.13743-undefined. doi:10.1111/cobi.13743

- Mbaru, E. K., & Barnes, M. L. (2017). Key players in conservation diffusion: Using social network analysis to identify critical injection points. *Biological Conservation*, 210, 222-232. doi:<https://doi.org/10.1016/j.biocon.2017.03.031>
- McLaren, D. (2020). Quantifying the potential scale of mitigation deterrence from greenhouse gas removal techniques. *Climatic Change*, 162(4), 2411-2428. doi:10.1007/s10584-020-02732-3
- MIHARI. (2020). Madagascar LMMA Database Retrieved from <https://mihari-network.org/fr/base-de-donnees/public-dashboard/>
- Mills, M., Bode, M., Mascia, M. B., Weeks, R., Gelcich, S., Dudley, N., Govan, H., Archibald, C. L., Romero-de-Diego, C., Holden, M., Biggs, D., Glew, L., Naidoo, R., & Possingham, H. P. (2019). How conservation initiatives go to scale. *Nature Sustainability*, 2(10), 935-940. doi:10.1038/s41893-019-0384-1
- Mitchell-Larson, E., Green, T., Lewis-Brown, E., Jennings, N., Joly, C., Goodwin, F., Reay, D., Rothman, R., Scott, C., Allen, M., & Forster, P. (2020). *How can carbon offsetting help UK further and higher education institutions achieve net zero emissions? COP26 Universities Network Briefing*. Retrieved from https://www.gla.ac.uk/media/Media_770459_smxx.pdf
- Moore, G. C. a. I. B. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research*, 2(3), 192-222.
- Morgan, N. A., & Rego, L. L. (2006). The Value of Different Customer Satisfaction and Loyalty Metrics in Predicting Business Performance. *Marketing Science*, 25(5), 426-439. doi:10.1287/mksc.1050.0180
- Morgan, N. A., Rego, L. L., Kristensen, K., & Westlund, A. (2004). The One Number You Need to Grow (letter to the editor). *Harvard Business Review*, 82, 134-137.
- Motawa, I., & Oladokun, M. G. (2015). Structural equation modelling of energy consumption in buildings. *International Journal of Energy Sector Management*, 9(4), 435-450. doi:10.1108/ijesm-11-2014-0004
- Munir, M. (2013). History and Development of the Polluter Pays Principle. *SSRN Electronic Journal*. doi:10.2139/ssrn.2322485
- Muri, H. (2018). The role of large—scale BECCS in the pursuit of the 1.5°C target: an Earth system model perspective. *Environmental Research Letters*, 13(4). doi:10.1088/1748-9326/aab324
- Nagel, J., & Lies, T. S. (2022). Re-gendering Climate Change: Men and Masculinity in Climate Research, Policy, and Practice. *Frontiers in Climate*, 4. doi:10.3389/fclim.2022.856869
- Newell, S. L., Nagabhatla, N., Doubleday, N. C., & Bloecker, A. (2019). The Potential for Locally Managed Marine Area (LMMAs) as a Participatory Strategy for Coastal and Marine Ecosystems-the Global Commons. *International Journal of Sustainable Development*, 12(4), 47-61.
- Newing, H., Eagle, C., Puri, R., & Watson, C. (2011). *Conducting Research in Conservation*. London: Routledge.
- Newing, H., & Perram, A. (2019). What do you know about conservation and human rights? *Oryx*, 53(4), 595-596. doi:10.1017/s0030605319000917
- Nilsson, D., Gramotnev, G., Baxter, G., Butler, J. R. A., Wich, S. A., & McAlpine, C. A. (2016). Community motivations to engage in conservation behavior to conserve the Sumatran orangutan. *Conservation Biology*, 30(4), 816-826. doi:10.1111/cobi.12650

- O'Leary, B. C., Ban, N. C., Fernandez, M., Friedlander, A. M., Garcia-Borboroglu, P., Golbuu, Y., Guidetti, P., Harris, J. M., Hawkins, J. P., Langlois, T., McCauley, D. J., Pikitch, E. K., Richmond, R. H., & Roberts, C. M. (2018). Addressing Criticisms of Large-Scale Marine Protected Areas. *Bioscience*, 68(5), 359-370. doi:10.1093/biosci/biy021
- O'Brien, K. (2012). Closing the gap between knowledge and action. *Progress in Human Geography*, 37(4), 587-596. doi:10.1177/0309132512469589
- O'Garra, T. (2009). Bequest Values for Marine Resources: How Important for Indigenous Communities in Less-Developed Economies? *Environmental and Resource Economics*, 44(2), 179-202. doi:10.1007/s10640-009-9279-3
- OECD. (1972). *The Polluter-Pays Principle Oecd Analyses and Recommendations*. Retrieved from
- OECD. (2020). *A Comprehensive Overview of Global Biodiversity Finance*. Retrieved from <https://www.oecd.org/environment/resources/biodiversity/report-a-comprehensive-overview-of-global-biodiversity-finance.pdf>
- Oldekop, J. A., Holmes, G., Harris, W. E., & Evans, K. L. (2016). A global assessment of the social and conservation outcomes of protected areas. *Conserv Biol*, 30(1), 133-141. doi:10.1111/cobi.12568
- Oliver, T. A., Oleson, K. L., Ratsimbazafy, H., Raberinary, D., Benbow, S., & Harris, A. (2015). Positive Catch & Economic Benefits of Periodic Octopus Fishery Closures: Do Effective, Narrowly Targeted Actions 'Catalyze' Broader Management? *PLoS One*, 10(6), e0129075. doi:10.1371/journal.pone.0129075
- Osborne, T., & Hassine, N. B. (2016). *Poverty and Employment in Madagascar 2001–2012: A Synthesis of Recent Findings*. Retrieved from Washington DC: <https://documents1.worldbank.org/curated/en/413071489776943644/pdf/113582-v2-FINAL-PUBLIC-7817-Madagascar-Poverty-Report.pdf>
- Ostrom, E. (2009). A generalised framework for Analysis Socio-Ecological Systems. *Science*, 325(5939), 419-422.
- Pacala, S., & Socolow, R. (2004). Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *Science (American Association for the Advancement of Science)*, 305(5686), 968-972. doi:10.1126/science.1100103
- Pannell, D., Marshall, G., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, 46(1407-1424).
- Peay, H. L., Hollin, I., Fischer, R., & Bridges, J. F. (2014). A community-engaged approach to quantifying caregiver preferences for the benefits and risks of emerging therapies for Duchenne muscular dystrophy. *Clin Ther*, 36(5), 624-637. doi:10.1016/j.clinthera.2014.04.011
- Pike, H., Khan, F., & Amyotte, P. (2020). Precautionary Principle (PP) versus As Low As Reasonably Practicable (ALARP): Which one to use and when. *Process Safety and Environmental Protection*, 137, 158-168. doi:10.1016/j.psep.2020.02.026
- Pinstrup-Andersen, P., & Pandya-Lorch, R. (1998). Food security and sustainable use of natural resources: a 2020 Vision. *Ecological Economics*, 26(1), 1-10. doi:[https://doi.org/10.1016/S0921-8009\(97\)00067-0](https://doi.org/10.1016/S0921-8009(97)00067-0)
- Pleger, L. E., & Hadorn, S. (2018). The big bad wolf's view: The evaluation clients' perspectives on independence of evaluations. *Evaluation*, 24(4), 456-474. doi:10.1177/1356389018796004
- Qualtrics. (2022). Net Promoter Score. Retrieved from <https://www.qualtrics.com/uk/lp/cx-lp/nps->

- [3/?utm_source=google&utm_medium=ppc&utm_campaign=UKI|SRC|GEN|NPS&campaignid=16160083426&utm_content=&adgroupid=135919700369&utm_keyword=net%20promoter%20score%20survey&utm_term=net%20promoter%20score%20survey&matchtype=p&device=c&placement=&network=g&creative=581363190887&gclid=Cj0KCQjwyOuYBhCGARIsAIdGQRPREeUIT_n0mWUNiVqxq9_6aWnMtu5TKyLDZU4_C3_Mh70AJpPDUrEaAi9REALw_wcB](https://www.google.com/adsense/3/?utm_source=google&utm_medium=ppc&utm_campaign=UKI|SRC|GEN|NPS&campaignid=16160083426&utm_content=&adgroupid=135919700369&utm_keyword=net%20promoter%20score%20survey&utm_term=net%20promoter%20score%20survey&matchtype=p&device=c&placement=&network=g&creative=581363190887&gclid=Cj0KCQjwyOuYBhCGARIsAIdGQRPREeUIT_n0mWUNiVqxq9_6aWnMtu5TKyLDZU4_C3_Mh70AJpPDUrEaAi9REALw_wcB)
- Rambaree, K. (2020). Environmental Justice in the Case of the Chagos Marine Protected Area: Implications for International Social Work. *Sustainability*, 12(20). doi:10.3390/su12208349
- Ramirez, S., Dwivedi, P., Ghilardi, A., & Bailis, R. (2014). Diffusion of non-traditional cookstoves across western Honduras: A social network analysis. *Energy Policy*, 66, 379-389. doi:10.1016/j.enpol.2013.11.008
- Randrianarison, H., Ramiaramanana, J., & Wätzold, F. (2017). When to Pay? Adjusting the Timing of Payments in PES Design to the Needs of Poor Land-users. *Ecological Economics*, 138, 168-177. doi:10.1016/j.ecolecon.2017.03.040
- Ranganathan, J., Corbier, L., Bhatia, P., Schmitz, S., Gage, P., & Oren, K. (2015). *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*. Retrieved from Washington, USA: <https://ghgprotocol.org/corporate-standard>
- Reichheld, F. F. (2003). The One Number You Need to Grow. *Harvard Business Review*, 81, 46-54.
- Reid, P. C., Fischer, A. C., Lewis-Brown, E., Meredith, M. P., Sparrow, M., Andersson, A. J., Antia, A., Bates, N. R., Bathmann, U., Beaugrand, G., Brix, H., Dye, S., Edwards, M., Furevik, T., Gangstø, R., Hátún, H., Hopcroft, R. R., Kendall, M., Kasten, S., Keeling, R., et al. (2009). Chapter 1 Impacts of the Oceans on Climate Change. In *Advances in Marine Biology* (Vol. 56, pp. 1-150): Academic Press.
- Reise, S. P., Waller, N. G., & Comrey, A. L. (2000). Factor Analysis and Scale Revision. *Psychological assessment*, 12(3), 287-297. doi:10.1037/1040-3590.12.3.287
- Reynolds, J. (2014). A critical examination of the climate engineering moral hazard and risk compensation concern. *The Anthropocene Review*, 2(2), 174-191. doi:10.1177/2053019614554304
- Reynolds, J. L. (2022). Linking solar geoengineering and emissions reductions: strategically resolving an international climate change policy dilemma. *Climate Policy*, 22(3), 285-300. doi:10.1080/14693062.2021.1993125
- Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala, G., von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kummu, M., Mohan, C., Nogués-Bravo, D., Petri, S., et al. Earth beyond six of nine planetary boundaries. *Science Advances*, 9(37), eadh2458. doi:10.1126/sciadv.adh2458
- Risner, J., & Sutherland, A. (2021). Static grid carbon factors – Can we do better? *Building Services Engineering Research and Technology*, 42(3), 257-277. doi:10.1177/0143624421991964
- Robbins Schug, G., Buikstra, J. E., DeWitte, S. N., Baker, B. J., Berger, E., Buzon, M. R., Davies-Barrett, A. M., Goldstein, L., Grauer, A. L., Gregoricka, L. A., Halcrow, S. E., Knudson, K. J., Larsen, C. S., Martin, D. L., Nystrom, K. C., Perry, M. A., Roberts, C. A., Santos, A. L., Stojanowski, C. M., Suby, J. A., et al. (2023). Climate change, human health, and resilience in the Holocene. *Proc Natl Acad Sci U S A*, 120(4), e2209472120. doi:10.1073/pnas.2209472120

- Robertson, T., Greenhalgh, S., Korovulavula, I., Tikoibua, T., Radikedike, P., & Stahlmann-Brown, P. (2020). Locally managed marine areas: Implications for socio-economic impacts in Kadavu, Fiji. *Marine Policy*, 117. doi:10.1016/j.marpol.2020.103950
- Robinson, O. C. (2013). Sampling in Interview-Based Qualitative Research: A Theoretical and Practical Guide. *Qualitative Research in Psychology*, 11(1), 25-41. doi:10.1080/14780887.2013.801543
- Rocliffe, S., & Harris, A. (2014a). *Experiences of periodic closures in small-scale invertebrate fisheries*. Retrieved from
- Rocliffe, S., Peabody, S., Samoilys, M., & Hawkins, J. P. (2014b). Towards a network of locally managed marine areas (LMMAs) in the Western Indian Ocean. *PLoS One*, 9(7), e103000. doi:10.1371/journal.pone.0103000
- Rode, J., Gómez-Baggethun, E., & Krause, T. (2015). Motivation crowding by economic incentives in conservation policy: A review of the empirical evidence. *Ecological Economics*, 117, 270-282. doi:<https://doi.org/10.1016/j.ecolecon.2014.11.019>
- Rogers, A. A., & Burton, M. P. (2017). Social preferences for the design of biodiversity offsets for shorebirds in Australia. *Conserv Biol*, 31(4), 828-836. doi:10.1111/cobi.12874
- Rogers, E. (1983). *Diffusion of Innovations*.
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.
- Romero de Diego, C., Dean, A., Jagadish, A., Witt, B., Mascia, M. B., & Mills, M. (2021). Drivers of adoption and spread of wildlife management initiatives in Mexico. *Conservation Science and Practice*, 3(7). doi:10.1111/csp2.438
- Rosenberg, S. W. (2001). *Opinion Formation, in International Encyclopedia of the Social & Behavioral Sciences* (N. J. Smelser & P. B. Baltes Eds.): Elsevier Ltd.
- Rowell, D., & Connelly, L. B. (2012). A History of the Term "Moral Hazard". *The Journal of risk and insurance*, 79(4), 1051-1075. doi:10.1111/j.1539-6975.2011.01448.x
- RSPB. (2015). *Using Regulation as a Last Resort: Assessing the Performance of Voluntary Approaches*. Retrieved from UK: <https://www.rspb.org.uk/globalassets/downloads/documents/positions/economics/using-regulation-as-a-last-resort.pdf>
- Ruiz-Mallén, I., Schunko, C., Corbera, E., Rös, M., & Reyes-García, V. (2015). Meanings, drivers, and motivations for community-based conservation in Latin America. *Ecology and Society*, 20(3). doi:10.5751/es-07733-200333
- Ryan, C., & Sterling, L. (2001). Visitors to Litchfield National Park, Australia: A Typology Based on Behaviours. *Journal of Sustainable Tourism*, 9(1), 61-75. doi:10.1080/09669580108667389
- Saeed, R., Sattar, A., Iqbal, Z., Imran, M., & Nadeem, R. (2012). Environmental impact assessment (EIA): an overlooked instrument for sustainable development in Pakistan. *Environ Monit Assess*, 184(4), 1909-1919. doi:10.1007/s10661-011-2088-5
- Saif, O., Keane, A., & Staddon, S. (2022). Making a case for the consideration of trust, justice and power in conservation relationships. *Conserv Biol*, 36(4). doi:10.1111/cobi.13903
- Sainsbury, K., Burgess, N. D., Sabuni, F., Howe, C., Puis, E., Killenga, R., & Milner-Gulland, E. J. (2015). Exploring stakeholder perceptions of conservation outcomes from alternative income generating activities in Tanzanian villages adjacent to Eastern

- Arc Mountain forests. *Biological Conservation*, 191, 20-28.
doi:10.1016/j.biocon.2015.06.001
- Salazar, G., Mills, M., & Verissimo, D. (2019). Qualitative impact evaluation of a social marketing campaign for conservation. *Conserv Biol*, 33(3), 634-644.
doi:10.1111/cobi.13218
- Sanchirico, J. N., Malvadkar, U., Hastings, A., & Wilen, J. E. (2006). When Are No-Take Zones an Economically Optimal Fishery Management Strategy? *Ecological Applications*, 16(5), 1643-1659.
- Sandbrook, C. (2015). What is conservation? *Oryx*, 49(4), 565-566.
doi:10.1017/s0030605315000952
- Sauls, L. A., & López Illescas, V. (2023). Redefining rights - based conservation through philanthropy: The Ford Foundation in Mesoamerica. *Conservation Science and Practice*. doi:10.1111/csp2.12942
- Schwartz, S. H. (1996). Value priorities and behavior: Applying a theory of integrated value systems. In J. M. O. C. Seligman, & M. P. Zanna (Ed.), *The psychology of values: The Ontario Symposium* (Vol. 8, pp. 119-144).
- Second-Nature. (2021). Second Nature Reporting Platform. Retrieved from <https://reporting.secondnature.org/>
- Setiawan, A., Cinner, J. E., Sutton, S. G., & Mukminin, A. (2012). The Perceived Impact of Customary Marine Resource Management on Household and Community Welfare in Northern Sumatra, Indonesia. *Coastal management*, 40(3), 239-249.
doi:10.1080/08920753.2012.677626
- Sever, I. (2015). Importance-performance analysis: A valid management tool? *Tourism Management*, 48, 43-53. doi:10.1016/j.tourman.2014.10.022
- Shanableh, A., Aderibigbe, S., Omar, M., & Shabib, A. (2022). Challenges and Opportunities of Multi-Disciplinary, Inter-Disciplinary and Trans-Disciplinary Research. In A. Badran, E. Baydoun, & J. R. Hillman (Eds.), *Higher Education in the Arab World: Research and Development* (pp. 311-325). Cham: Springer International Publishing.
- Sharma, V., Joshi, H., & Bowes, M. J. (2021). A Tale of Two Rivers: Can the Restoration Lessons of River Thames (Southern UK) Be Transferred to River Hindon (Northern India)? *Water Air Soil Pollut*, 232(5), 212. doi:10.1007/s11270-021-05152-w
- Simin, M. T., & Janković, D. (2014). Applicability Of Diffusion Of Innovation Theory In Organic Agriculture. *Journal of the Economics of Agriculture*, 61(2), 517-529.
- Smallhorn-West, P., Allison, E., Gurney, G., Karnad, D., Kretser, H., Lobo, A. S., Mangubhai, S., Newing, H., Pennell, K., Raj, S., Tilley, A., Williams, H., & Peckham, S. H. (2023). Why human rights matter for marine conservation. *Frontiers in Marine Science*, 10. doi:10.3389/fmars.2023.1089154
- Smallhorn-West, P. F., Weeks, R., Gurney, G., & Pressey, R. L. (2019). Ecological and socioeconomic impacts of marine protected areas in the South Pacific: assessing the evidence base. *Biodiversity and Conservation*, 29(2), 349-380.
doi:10.1007/s10531-019-01918-1
- Smith, P., Haberl, H., Popp, A., Erb, K. H., Lauk, C., Harper, R., Tubiello, F. N., de Siqueira Pinto, A., Jafari, M., Sohi, S., Masera, O., Bottcher, H., Berndes, G., Bustamante, M., Ahammad, H., Clark, H., Dong, H., Elsiddig, E. A., Mbow, C., Ravindranath, N. H., et al. (2013a). How much land-based greenhouse gas mitigation can be achieved

- without compromising food security and environmental goals? *Glob Chang Biol*, 19(8), 2285-2302. doi:10.1111/gcb.12160
- Smith, R. A., & Findeis, J. L. (2013b). Exploring audience segmentation: investigating adopter categories to diffuse an innovation to prevent famine in rural Mozambique. *J Health Commun*, 18(1), 6-19. doi:10.1080/10810730.2012.688249
- Snyder, B. F. (2020). Beyond the social cost of carbon: Negative emission technologies as a means for biophysically setting the price of carbon. *Ambio*, 49(9), 1567-1580. doi:10.1007/s13280-019-01301-y
- Sotos, M. (2015). *GHG Protocol Scope 2 Guidance*. Retrieved from USA:
- Sowman, M., & Sunde, J. (2018). Social impacts of marine protected areas in South Africa on coastal fishing communities. *Ocean & Coastal Management*, 157, 168-179. doi:10.1016/j.ocecoaman.2018.02.013
- Spalding, M., Meliane, I., Bennett, N., Dearden, P., Patil, P., & Brumbaugh, R. (2016). Building towards the marine conservation end-game: consolidating the role of MPAs in a future ocean. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 26, 185-199. doi:10.1002/aqc.2686
- Steffen, W., Richardson, K., Rockstrom, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sorlin, S. (2015). Sustainability. Planetary boundaries: guiding human development on a changing planet. *Science*, 347(6223), 1259855. doi:10.1126/science.1259855
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3), 309-317. doi:<https://doi.org/10.1016/j.jenvp.2008.10.004>
- Stolton, S., Dudley, N. and M. Hockings,. (2021). *METT Handbook: A guide to using the Management Effectiveness Tracking Tool (METT)*. Second edition guidance for using METT-4. . Retrieved from Gland, Switzerland:
- Sun, K.-A., & Kim, D.-Y. (2013). Does customer satisfaction increase firm performance? An application of American Customer Satisfaction Index (ACSI). *International Journal of Hospitality Management*, 35, 68-77. doi:10.1016/j.ijhm.2013.05.008
- Suuronen, P., Jounela, P., & Tschernij, V. (2010). Fishermen responses on marine protected areas in the Baltic cod fishery. *Marine Policy*, 34(2), 237-243. doi:10.1016/j.marpol.2009.07.001
- Tang, Q., & Luo, L. (2014). Carbon Management Systems and Carbon Mitigation. *Australian Accounting Review*, 24(1), 84-98. doi:10.1111/auar.12010
- Tayouga, S. G., Sara. (2016). The Socio-Ecological Factors that Influence the Adoption of Green Infrastructure. *Sustainability*, 8(12), 1277. doi:10.3390/su8121277
- Tengo, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting diverse knowledge systems for enhanced ecosystem governance: the multiple evidence base approach. *Ambio*, 43(5), 579-591. doi:10.1007/s13280-014-0501-3
- Thomson, I., Tuck, P., Channuntapipat, C., Charnock, R., O'Bonsu, N., & TyreeHageman, J. (2021). *Net Zero Accounting for a Net Zero UK*. Retrieved from Birmingham UK:
- Tilton, J. E. (2016). Global climate policy and the polluter pays principle: A different perspective. *Resources Policy*, 50, 117-118. doi:10.1016/j.resourpol.2016.08.010

- Tonge, J., & Moore, S. A. (2007). Importance-satisfaction analysis for marine-park hinterlands: A Western Australian case study. *Tourism Management*, 28(3), 768-776. doi:10.1016/j.tourman.2006.05.007
- Convention on Biological Diversity, (1992).
- UNEP. (2019). *Global Environment Outlook – GEO-6: Summary for Policymakers* (U. N. Environment Ed.). Cambridge: Cambridge University Press.
- UNEP. (2020). *The Little Book of Green Nudges: 40 Nudges to Spark Sustainable Behaviour on Campus*. Retrieved from Nairobi and Arendal:
- Decision Adopted By The Conference Of The Parties To The Convention On Biological Diversity, (2022).
- UNFAO. (2015). *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*. Retrieved from Rome:
- UNFAO. (2016). *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities: Manual for project practitioners*. Retrieved from Rome:
- UNFAO. (2017). *The relationship between the governance of small-scale fisheries and the realization of the right to adequate food in the context of the Sustainable Development Goals*. Retrieved from Rome:
- United Nations Framework Convention On Climate Change, (1992).
- UNFCCC. (2022). Climate Neutral Now Brochure. In UNFCCC (Ed.), <http://climateneutralnow.org> (Vol. 1, pp. 2). <https://unfccc.int/climate-action/climate-neutral-now>: UNFCCC.
- Report of the United Nations Conference on the Human Environment, (1972).
- Transforming Our World: The 2030 Agenda For Sustainable Development, A/RES/70/1, (2015).
- Draft agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, 54 (2023a).
- Draft agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, (2023b).
- Valente, T. W., & Rogers, E. M. (1995). The origins and development of the diffusion of innovations paradigm as an example of scientific growth. *Sci Commun*, 16(3), 242-273. doi:10.1177/1075547095016003002
- van Putten, I., Longo, C., Arton, A., Watson, M., Anderson, C. M., Himes-Cornell, A., Obregon, C., Robinson, L., & van Steveninck, T. (2020). Shifting focus: The impacts of sustainable seafood certification. *PLoS One*, 15(5), e0233237. doi:10.1371/journal.pone.0233237
- Wagner, G., & Zizzamia, D. (2022). Green Moral Hazards. *Ethics, Policy & Environment*, 25(3), 264-280. doi:10.1080/21550085.2021.1940449
- Wahlén, C. (2014). Constructing Conservation Impact: Understanding Monitoring and Evaluation in Conservation NGOs. *Conservation and Society*, 12(1). doi:10.4103/0972-4923.132133
- Waldron, A., Mooers, A. O., Miller, D. C., Nibbelink, N., Redding, D., Kuhn, T. S., Roberts, J. T., & Gittleman, J. L. (2013). Targeting global conservation funding to limit immediate biodiversity declines. *Proceedings of the National Academy of Sciences of the United States of America*, 110(29), 12144-12148.
- Wathern, P. (1992). *Environmental impact assessment : theory and practice*: Routledge.

- Weeks, R., & Jupiter, S. D. (2013). Adaptive comanagement of a marine protected area network in Fiji. *Conserv Biol*, 27(6), 1234-1244. doi:10.1111/cobi.12153
- Wejnert, B. (2002). Integrating Models of Diffusion of Innovations: A Conceptual Framework. *Annual Review of Sociology*, 28, 297-326.
- Wellcome. (2022). Carbon offset policy for travel. Retrieved from <https://wellcome.org/grant-funding/guidance/carbon-offset-policy-travel>
- West, P., Igoe, J., & Brockington, D. (2006). Parks and Peoples: The Social Impact of Protected Areas. *Annual Review of Anthropology*, 35(1), 251-277. doi:10.1146/annurev.anthro.35.081705.123308
- Westerman, K., & Benbow, S. (2013). The Role of Women in Community-based Small-Scale Fisheries Management: The Case of the South West Madagascar Octopus Fishery. *Western Indian Ocean J. Mar. Sci.*, 12(2), 119-132.
- Whitehead, H., & Shin, M. (2022). Current global population size, post-whaling trend and historical trajectory of sperm whales. *Sci Rep*, 12(1), 19468. doi:10.1038/s41598-022-24107-7
- Whitney, C. K., Bennett, N. J., Ban, N. C., Allison, E. H., Armitage, D., Blythe, J. L., Burt, J. M., Cheung, W., Finkbeiner, E. M., Kaplan-Hallam, M., Perry, I., Turner, N. J., & Yumagulova, L. (2017). Adaptive capacity: from assessment to action in coastal social-ecological systems. *Ecology and Society*, 22(2). doi:10.5751/es-09325-220222
- Wilkinson, J. M. (2011). Re-defining efficiency of feed use by livestock. *Animal*, 5(7), 1014-1022. doi:10.1017/S175173111100005X
- Wisdom, J. P., Chor, K. H., Hoagwood, K. E., & Horwitz, S. M. (2014). Innovation adoption: a review of theories and constructs. *Adm Policy Ment Health*, 41(4), 480-502. doi:10.1007/s10488-013-0486-4
- Wittek, R., & Bekkers, R. (2015). Altruism and Prosocial Behavior. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* (pp. 579-583). Oxford: Elsevier.
- Woo, J., Fatima, R., Kibert, C. J., Newman, R. E., Tian, Y., & Srinivasan, R. S. (2021). Applying blockchain technology for building energy performance measurement, reporting, and verification (MRV) and the carbon credit market: A review of the literature. *Building and Environment*, 205. doi:10.1016/j.buildenv.2021.108199
- Woodhouse, E., Homewood, K. M., Beauchamp, E., Clements, T., McCabe, J. T., Wilkie, D., & Milner-Gulland, E. J. (2015). Guiding principles for evaluating the impacts of conservation interventions on human well-being. *Philos Trans R Soc Lond B Biol Sci*, 370(1681). doi:10.1098/rstb.2015.0103
- Woodhouse, E., Lange, E. d., & Milner-Gulland, E. J. (2016). *Evaluating the impacts of conservation interventions on human wellbeing. Guidance for practitioners*. Retrieved from London, UK:
- WWF. (2022). *Assessing equitable management and governance for area-based conservation: assessment tool and protocol*. Retrieved from Washington, USA:
- Yang, Y. (2017). Rethinking system boundary in LCA—reply to “Lifting the fog on the characteristics and limitations of hybrid LCA” by Thomas Gibon and Thomas Schaubroeck (2017). *The International Journal of Life Cycle Assessment*, 22(6), 1009-1011. doi:10.1007/s11367-017-1295-x
- Zorzi, E., & Rabearisoa, A. (2013). *How the integration of fishers' perception on environment in a multinomial probit model gives an example of green economies in small-scale fishing* (Vol. 12). Western Indian Ocean Journal of Marine Science.

