IT TAKES A VILLAGE TO UNDERSTAND A MANTA RAY:

The contribution of multiple data sources to manta ray research and conservation in the Maldives

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Contents

List of Tables and Figures

Disclaimer

I, Abi Sehmi, declare my understanding of Plymouth University's plagarism regulations and that all work included in this dissertation is my own. All sources used have been acknowledged and cited in the reference list. The final word count for this work is 4,995 excluding the impact summary, executive summary, figure and table legends, references and appendices as specified.

Acknowledgements

1. Impact Summary

The Manta Trust is a UK charity established in 2011 with the purpose of furthering research and conservation of mobulid rays globally. With a team formed of scientists, educators, and media experts they aim to conserve mobulid rays by combining their three pillars of research, education and collaboration.

The Maldivian Manta Ray Project (MMRP) was the inaugural project of the Manta Trust. Established in 2005, the project centres on the collection of data pertaining to manta rays across the Maldives, building a long-term and nationwide database formed of over 85,000 sighting records, dating back to 1987. Many contributions come via the '*IDtheManta*' database where members of the public can contribute to the citizen science project which has helped garner understanding regarding the manta ray populations of the Maldives and develop mechanisms for protecting manta rays throughout the Maldives and internationally.

This research endeavoured to gain deeper understanding of the social context informing the Manta Trust's Maldivian Manta Ray Project, which had never before been undertaken. There is growing consensus within the conservation community that biological achievements alone do not equate to conservation success, and that social science should be incorporated within conservation projects. With a community of researchers, resorts, dive operators and more active within the Maldives and dependant on manta ray tourism, the Manta Trust initiated this research to gain deeper understanding of who the community of contributors to the Maldivian Manta Ray Project are, what enables or prevents wider contribution, as well as how contributions have altered over time and across the Maldives, a unique location formed of 26 geographic atolls and thousands of islands.

This MMRP focussed project allows the Manta Trust to gain insight into who informs their research, and make decisions grounded in a social context regarding how they form and frame education initiatives, as well as allowing stronger, more meaningful and equitable collaborations to be developed with contributors in the future. As the Manta Trust aim to instigate more social science projects with local communities, this project can act as a stepping stone to understand; what information they need to collect moving forward and the diverse means they can incorporate, in order to represent and encourage variegated perspectives and participation within the Maldivian Manta Ray Project.

2. Executive Summary

Conservation has gone through many iterations, and been guided by many motivations from 'nature for itself' to 'nature for people' to 'people and nature' (Mace, 2014). Regardless of the stance taken it is an inevitable reality that human behaviour informs conservation (Fox *et al.*, 2006), and that for conservation to be a success it must integrate and comprehend the dimension humanity plays within it (Bennett and Dearden, 2014). In order to truly succeed, the integration of social science is necessary to understand the human and cultural dimensions that shape conservation initiatives.

The Manta Trust, a UK charity (*Our Approach*, 2020; Barraud, 2017), have been running the Maldivian Manta Ray Project (MMRP) in the Maldives since 2011. Over which time they have utilised marine citizen science to form a database of over 85,000 sighting records, which has helped shape understanding of manta ray populations and develop nationwide and global species protection (*Maldivian Manta Ray Project*, 2020).

Whilst the MMRP has been widely successful in its use of natural sciences, this is the first occasion the MMRP database has been examined through a social lens. Analysis on the MMRP dataset was conducted using ExCel to discern trends in who, where (spatial analysis) and when (temporal analysis) contribution occurred. Following this, interviews with 18 present and past MMRP staff members were conducted, to gain further insight and understanding of MMRP participation, via Zoom and analysed using Nvivo.

Researchers were found to be the highest contributors (63,201) to the database, followed by dive professionals with 8,458 submissions. 49,090 submissions had also been made via the Four Seasons Resort, with whom the MMRP has a long standing partnership. Baa, Ari and North Malé atolls were the most contributed to sub-regions, all of which were centrally located and tourist hotspots. Dhaalu, Gaafu and Fuvahmulah were the least contributed to regions with 11, 9 and 2 contributions respectively, though another four atolls have received no contributions throughout the period. Months August to October had the most contributions overall, and April and May the least, which reflects both the monsoon, and thus manta ray (Anderson, Adam and Goes, 2011; Harris *et al.*, 2020; *Maldivian Manta Ray Project*, 2020) as well as tourist seasons (*International Tourism, Number of Arrivals - Maldives*, 2021; Matthews, 2020) for the Maldives.

The interviews revealed that whilst women were perceived to comprise the majority of employees within the MMRP, this gender trait was reversed for Maldivians where the interviewees perceived the local MMRP employees to be predominantly male. MMRP interviewees displayed open and inclusive attitudes in regard to program participation, however, 30% of participant's comments regarding skills pertained to the benefits of a scientific background and 21% to diving or swimming, which could act as a barrier to wider engagement, including that of Maldivians, despite all participants mentioning advantages to their involvement. 94% of participants noted education as a primary outreach method.

In future, the MMRP should include demographic data, such as gender, age and nationality on their '*IDtheManta*' platform in order to better explore the social elements that build their community and inform their program. To overcome barriers to Maldivian participation, in addition to their successful education program, they could also consider incorporation of diverse outreach methods beyond 'pure' education, grounded in Maldivian culture and spiritual heritage to foster the affinity necessary to inspire conservation action and assist the Manta Trust in fulfilling their wider objectives of collaboration.

3. Introduction

Conservation has gone through many iterations from 'nature for itself' to 'nature despite people', 'nature for people', and 'people and nature' (Mace, 2014). Regardless of the stance taken it is an inevitable reality that human behaviour informs conservation (Fox *et al.*, 2006), and that for conservation to be a success it must integrate and comprehend the dimension humanity plays within it (Bennett and Dearden, 2014), from how humans impact conservation to what role they have to play, and how significant that role is in determining the success or failure of a conservation project. Conservation thrives or fails through the will of people and societies, and society is impacted by place (Moon, Adams and Cooke, 2019), with each place imbued with its own deeply embedded cultural facets and distinct means of adapting to our fast-paced modern world.

Natural sciences have historically held the predominant place in guiding conservation actions (Bennett *et al.*, 2017; Bennett *et al.*, 2021) with social sciences mostly absent (McKinley, Acott and Yates, 2020). Yet ecological comprehension in singularity is not sufficient for conservation success (Fox *et al.*, 2006). Historic segregation of these disciplines has been attributed to lack of commonality between biologists and social scientists, lack of funding (McKinley, Acott and Yates, 2020; Bennett *et al.*, 2021) and engrained impediments to collaborative practice (Fox *et al.*, 2006).

Whilst social sciences can be disruptive to conservation effort by highlighting inequities or flaws embedded within conservation design (Bennett *et al.*, 2017), many conservation organisations do adopt participatory elements into their endeavours (Mascia *et al.*, 2003) with the value of integrating social sciences to support marine conservation activities increasingly recognised (Moon *et al.*, 2021; Mascia *et al.*, 2003). By integrating social sciences into conservation, one can enhance project design to achieve ecological results, improve management and governance and account for conservation actions by prioritising procedural equity (Bennett *et al.*, 2017).

The Manta Trust is a UK charity established in 2011 (*Our Approach*, 2020; Barraud, 2017). The Manta Trust have been running the Maldivian Manta Ray Project (MMRP) since 2005 (*Maldivian Manta Ray Project*, 2020) during which time over 70,000 photographic identifications of manta ray sightings have been uploaded to their system (Kruger, 2020) between 1987 and 2019. Utilising citizen science and photo-ID, as well as dedicated research efforts, these submissions have collated invaluable, diverse and long-term data that has helped to shape understanding of the manta ray species, behaviour and the variables that impact them for governments, scientists and local communities alike (*Maldivian Manta Ray Project*, 2020). The MMRP also incorporates education and outreach programs (Barraud, 2017) predicated on the Manta Trust's three pillars of Research, Education, Collaboration (*Manta Trust Home* 2021). Yet, whilst the MMRP dataset has been used extensively to develop understanding regarding manta ray populations it has never before been analysed through a social lens, delving into who has worked towards the development of this extensive database and the factors that enable or limit contribution.

The breadth of information provided via the MMRP attests to the potential for citizen science and collaborative process to overcome the restrictions of scientific practice, with marine research in particular often restricted by funding, due to logistical complications (Cigliano and Ballard, 2018). Citizen science assists non-governmental-organisations (NGOs) in overcoming this and achieving their conservation endeavours (Cigliano and Ridlon, 2018). This has been the case elsewhere, such as an Australian manta ray project where 67% was informed via citizen science, rising to 100% in remote regions (Armstrong *et al.*, 2019).

However, marine citizen scientists differ significantly from terrestrial volunteers, on one hand they are

primed to be passionate and dedicated due to their comfort and experience in the water, yet this in itself can be inequitable as divers acquire these skills through expensive and time consuming training processes (Cigliano and Ridlon, 2018). Citizen science has the power to connect people more pertinently to their place and social environment, garnering a sense of stewardship (Townhill and Hyder, 2018; Haywood, Parrish and Dolliver, 2016; Kelly *et al.*, 2020). By empowering individuals and communities through tactile engagement and education an NGO can not only benefit the local community but also achieve its own aims by improving local abilities, reducing the need for external faculties (Crane *et al.*, 2018; Sakurai and Uehara, 2020) and transitioning away from Western-led, post-colonial conservation (Katja, 2019).

The Maldives is an island nation divided into 26 atolls, comprised of 1192 coral islands (Barraud, 2017; Techera and Cannell-Lunn, 2019; Sawers, 2014; Maloney, 1976). Citizens are required to practice Islam by law (Fulu and Miedema, 2016; Barraud, 2017) and traditional gender roles are typically held, where men pursue employment and women fulfil domestic duties (Barraud, 2017). Global challenges associated with conservation efforts may be exacerbated in the Maldives as a nation marked by historic factionalism, for instance, until recently it was illegal to purchase land on any island other than that of your birth, or fish in another islands' waters (whether inhabited or not) without permission. Even the initial tourist boom in the 1970's resulted in very little integration between locals and tourists (Maloney, 1976) with resorts being sequestered on their own islands and locals on others.

Tourism is the largest growing industry worldwide (Agardy, 1993), forming 10% of global gross domestic product (GDP) and 1 in 10 jobs internationally (Charles, Keenleyside and Chapple, 2018). Within the Maldives manta ray tourism alone generates US$8.1 million per annum (Sawers, 2014) contributing towards tourism superseding fishing as the largest industry and forming 28% of their GDP (Kitchen-Wheeler, 2010; Cannell-Lunn, 2019). Rapid development can understandably lead to local communities pursuing a higher standard of living (Jones, Qiu and De Santo, 2013), such as in the Maldives where most young people pursue careers in tourism (Barraud, 2017). Tourism may also lead to wider conservation (Jones, Qiu and De Santo, 2013) and societal issues, such as locals being displaced by transnational corporations (Bennett *et al.*, 2021).

Growth in ecotourism, whilst problematic, can prove beneficial by providing reasons for local people to cease dependence on extractive industries, like fishing, and instead recognise the value of protecting integral species (Agardy, 1993). In the Maldives, bans on traditional shark and manta ray fishing were implemented due to the economic incentives provided by abundant ecotourism, allowing opportunity for dedicated conservation efforts to arise (Sawers, 2014). Furthermore, the diving industry employs many locals (Kitchen-Wheeler, 2010; Emerton, Baig and Saleem, 2009) and the Four Seasons Resort partners with the Manta Trust to deliver their Marine Environmental Education Program (Barraud, 2017) resulting in integrative and progressive conservation practice that may otherwise be difficult to achieve.

The transition towards dominant ecotourism within the Maldives makes understanding the cumulative impacts of people on manta ray conservation all the more pertinent. Simultaneously, ecotourism unlocks the potential for NGOs, the private sector and local people to collaborate on conservation research, with the private sector capable of funding further research and outreach, providing support measures, and engaging tourists as well as local communities (Bottema and Bush, 2012).

This project aims to conduct analysis of the Manta Trust's MMRP data to discern trends relating to who contributes (employment, gender), where (spatial analysis) and when (temporal analysis) contributions took place. Following the initial analysis the sub-aim is to identify (at greater depth) both the hotspots and the gaps regarding 'who, where, when' through interviews with present and past MMRP staff to reveal barriers and enablers to wider participation and assist the Manta Trust with future efforts to ensure sustained and equitable conservation operating in alignment with their wider goals.

Table 1. Classifications selected from the wider MMRP dataset for social analysis, including descriptions of each category and reasons for their use.

MMRP Classifications	Description	Reasons for use in social investigation
Sub-region	26 sub-regions within the Maldives, relating to geographical atolls where submissions have occurred.	Insight into trends in submission location within the Maldives.
Date (Month/ Year)	Date of submission, this was then broken down into Year and Month.	Insight into when submissions were made, uncover trends in contributions over time.
Account Holder	Name of submitter, including organisations and the general public..	Reveals top organisation contributors/ collaborations.
Account Type	Broad categories of submissions based on submitter or organisation type.	Provides insight into who is contributing to the MMRP.
General Public (GP)	Submissions from tourists/ guests via *IDtheManta* or MMRP staff.	
Government Organisation (GO)	Government department submissions.	
Media Production (MP)	Submissions from professional photographers and videographers.	
Not-for-Profits (NFP)	Submissions from Not-for-profits, including the Manta Trust.	
Tourism Operators (TO)	Submissions from resorts, dive and snorkel guides & any other tourism related businesses.	
Research Institute (RI)	Submissions from independent researchers (separate from the Manta Trust) e.g. universities.	
Data Source Type	Specific submitter categories predicated on individual contributor source/ profession.	Provides deeper insight into who is contirbuting to the MMRP dataset.
Professional Guide	Submissions by dive and snorkel staff.	
General Public	Guest/ tourist submissions via *IDtheManta* portal or directly to MMRP staff.	
EPA Ranger	Submissions by Environmental Protection Agency employees.	
Film Crew	Submissions from media production crew members.	
Marine Biologist	Submissions by marine scientists employed by tourism operators.	
Online Data Mining	Contributions harvested from online sources, e.g. Youtube.	
Tourism Videographer	Submissions from professional videographers, employed by tourism operators.	
Researcher	Submissions by scientists employed by Not-for-Profits (inc. Manta Trust) & research institutes.	
Resort Staff	Submissions by resort staff not working in marine departments, e.g. reception.	
Primary Observer	Full name of submitter.	First name used to ascertain contributor gender.
Gender	Male, female or unknown status of contributor.	Provides some demographic data regarding contributors.
Operator	Employer / company running dive or snorkel excursions (from one or more bases).	Provides insight into top contributor/ collaborator organisations.
Base Type	Whether contribution came from land or boat as main base of operation.	

4. Methods

4.1. Analysis of the MMRP Dataset

In order to create a socially-angled dataset the first step was to assess the manta ray related categories from the MMRP dataset provided by the Manta Trust and determine how 'social' data could be derived from this base. The 'Date' category was adapted to create 'Month' and 'Year' columns. The 'Primary Observer' category was used to discern the gender of contributors by making a pivot table of Primary Observer's first names and manually allocating each 'male' or 'female', unknown or ambiguous names such as 'Alex' were disregarded from the process to avoid bias. For full classifications and descriptions see Table 1. This newly formed social dataset was then used to examine variables such as region (where), year and month (when), data source type, account type and gender (who) using pivot tables.

Nine pivot table counts were created for gender, year, month, month/ year, sub-region, site, base type, base, account type, data source type and operator. Twenty nine comparison pivot tables were created as follows, with yearly entries compared to sub-region, site, base type, base, account type, data source type, operator and month. Month was compared to sub-region, site, base type, account type, data source type and operator. Sub-region to account type, data source type, operator, account holder, site name. Account holder to data source type, operator, account type and site name. Finally gender was compared to account type, sub-region, data source type and operator. A series of maps, pie charts and line graphs were then created for each category to display the pivot analysis results (Appendix 1.1-1.3).

4.2. MMRP Staff Interviews

A selection of present and past MMRP staff members were contacted for interview, resulting in 18 structured interviews being conducted over Zoom with 8 present and 10 past MMRP staff members. Appendix 2.1 shows the final interview guide which included demographic questions regarding age, gender, nationality, education and Maldivian living status, alongside contribution enablers, spatial and temporal factors and deeper questions regarding the social context informing MMRP contribution. The interviews were recorded to cloud via Zoom and manually transcribed. Demographic and quantitative data regarding perceptions were then added to an ExCel spreadsheet to retain participant anonymity. The documents were then uploaded to Nvivo 12 for analysis.

4.3. Interview Analysis

Coding was developed using thematic analysis and manually coded using a mixture of deductive and inductive approaches based on my research question and aims. Five initial nodes were created using a deductive coding approach, these being Gender Engagement, Inclusivity and Accessibility, Participation in Manta Ray Conservation, including sub-nodes of Barriers, Enablers and Overcoming Barriers. Following this an inductive approach was used resulting in the final codebook shown in Table 2.

Following coding, frequently mentioned topics within each category were counted. NVivo's query tools were then used to create word clouds, picking out the 50 most frequently used, stemmed words (longer than 3 letters) for each code, with connecting words such as 'like' and 'kind' added to the Stop Words list. Queries of frequently used words were conducted for specific nodes. 'Mantas' was chosen for Community and Economic impacts, 'women' for Gender and Local Female Engagement, 'resort' for Manta Ray Conservation Participation, 'education' for Outreach, 'marine' for Skills and 'Maldives' for Local Engagement.

Table 2. Names and descriptions for the final codes derived from the MMRP interviews. Number of files (total 18) refers to the number of interviewee comments contributing to each code. Total number of references allocated to each code are also included.

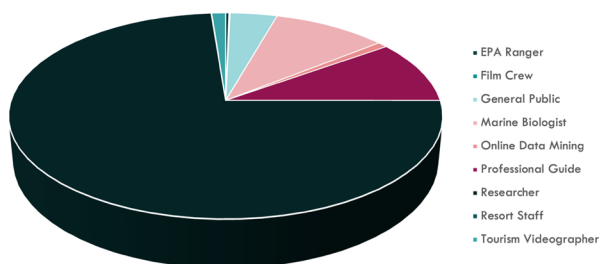| Name	Description	Files	References
COVID-19	Mentions of current and future impacts of COVID-19 on manta ray and MMRP conservation efforts within the Maldives.	18	54
Community Engagement Impacts	Highly mentioned impacts on community engagement due to COVID-19 (sub-theme).	11	16
Economy & Tourism	Highly mentioned impacts of COVID-19 (sub-themes)	10	12
Gender Engagement	Perceptions regarding the reasons behind male and female engagement in the MMRP, either as contributors or staff.	18	69
Inclusivity and Accessibility	Thoughts and instances regarding barriers, enablers and means of overcoming barriers towards equitable inclusion of individuals towards MMRP activities. As well as means necessary to allow accessibility to MMRP activities and marine citizen science.	17	120
Negatives	Instances where lack of or issues with inclusivity and accessibility were mentioned.	12	33
Positives	Instances of successes in regard to inclusivity and accessibility within the MMRP program were mentioned.	15	30
Local Engagement	Thoughts regarding the advantages and disadvantages of including Maldivian locals within the MMRP. As well as enablers, barriers and means of overcoming barriers to local participation and engagement in the MMRP's manta ray conservation activities.	18	263
Advantages	Thoughts and perspectives on the advantages gained from including Maldivian locals in MMRP activities.	18	31
Barriers	Thoughts regarding the barriers that prevent the inclusion or participation of Maldivian locals with the MMRP.	18	103
Disadvantages	Thoughts regarding the disadvantages of including Maldivian locals within the MMRP.	3	5
Enablers	Thoughts and observations regarding the mechanisms that allow and enable Maldivian locals to engage with MMRP activities.	15	46
Overcoming Barriers	Thoughts and suggestions regarding the potential means of overcoming the barriers that prevent Maldivian locals from participating in MMRP activities.	18	78
Local Female Engagement	Thoughts and observations specific to the engagement of Maldivian women in MMRP activities, including barriers and enablers to their participation.	18	52
Maldivian Community Impact	Observations regarding the ways in which the MMRP program and manta ray conservation affects the local Maldivian community.	17	39
Maldivian Economic Impacts	Observations regarding the economic impacts of the MMRP program and manta ray conservation on the local Maldivian community.	18	35
Manta Ray Conservation Participation	Thoughts regarding the enablers, barriers and means of overcoming barriers to wider citizen science participation and work within the MMRP manta ray conservation program. As well as the successes and issues encountered in the program and cultivating participation.	18	295
Barriers	Thoughts regarding barriers to citizen science participation and ability to work within the MMRP.	18	67
Enablers	Thoughts regarding the mechanisms that enable citizen science participation and ability to work within the MMRP.	18	123
Issues	Issues or difficulties associated with the MMRP program and model in terms of engagement and impact.	6	6
Overcoming Barriers	Thoughts regarding ways in which barriers to citizen science participation and ability to work within the MMRP could be overcome.	17	55
Successes	Instances and thoughts regarding the successes achieved throughout the course of the MMRP, and expansion of their citizen science, participatory process.	17	44
Outreach	Observations and descriptions regarding the MMRP and Manta Trust's current outreach activities within the Maldives, including the successes and barriers to fostering engagement.	18	97
Skills	Skills considered necessary by present and past MMRP staff to gain employment with or contribute towards the MMRP and their manta ray conservation activities.	18	82
When (Temporal)	Perceptions regarding temporal impacts towards high and low MMRP contributions.	18	51
High Contributions	Perceptions regarding times of year with highest MMRP contributions.	18	28
Low Contributions	Perceptions regarding times of year with lowest MMRP contributions.	18	23
Where (Spatial)	Perceptions regarding geographic highs and lows of MMRP contributions.	18	58
High Contributions	Perceptions regarding areas with highest MMRP contributions within the Maldives.	18	29
Low Contributions	Perceptions regarding areas with lowest MMRP contributions within the Maldives.	18	29

5. Results

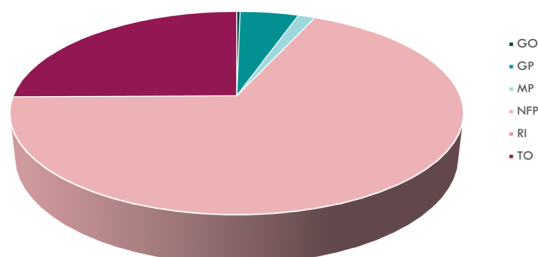## 5.1. MMRP Dataset Analysis.

Who

Fig 1 shows numbers of 'who' contributions, including 9 different data source types (DST), of these n=63,201 have been made by Researchers, n=8,458 by Professional Guides, shortly followed by n=8,439 contributions from Marine Biologists. The least DST contributions, n=42, come from Resort Staff. Of account types, most contributions (n=58,457) have been made by Not-For-Profits followed by Tourist Organisations (n=21,572) and the General Public (n=4208). The least come from Research Institutes with only n=3 contributions.

The Four Seasons Maldives, with whom the MMRP have a long standing partnership (Barraud, 2017), has the most operator submissions, beginning in 2002 with n=49,090, followed by Six Sense Maldives with n=4071 submissions beginning in 2012. In terms of gender, men have typically made more contributions to the MMRP dataset than women, though in 2003, 2012 and 2019 female contributions overtook those of men (Fig 2).

(a) Count of contributions by Data Source Types

Legend: EPA Ranger, Film Crew, General Public, Marine Biologist, Online Data Mining, Professional Guide, Researcher, Resort Staff, Tourism Videographer

(b) Count of contributions by Account Types

Legend: GO, GP, MP, NFP, RI, TO

(c) Count of contributions from Top 10 Operators

Legend: Albatros Maldives, Coco Collection, Diamonds Maldives, Emperor Divers Maldives, Euro-Divers Maldives, Four Seasons Maldives, Intercontinental Maldives, ProDivers Maldives, Six Senses Maldives
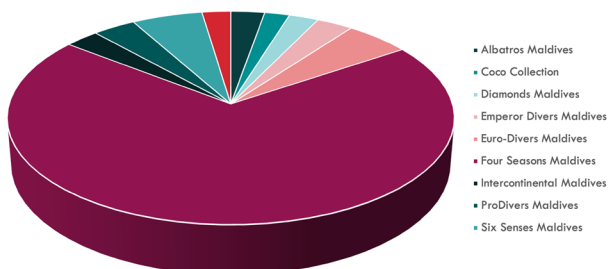
(d) Count of contributions by Gender

Legend: Female, Male, unknown
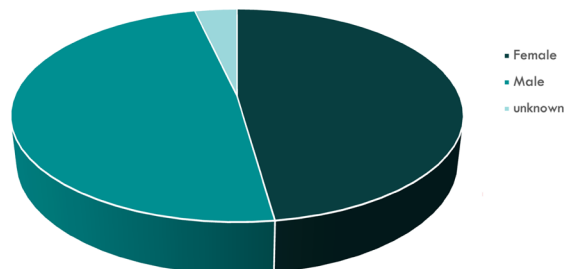
Fig 1. Percentage of contributions within the 'Who' category from across the entire dataset (1987 – 2019), (a) shows Data Source Types (b) Account Types (c) the top 10 operators and (d) proportions of gender contributions.
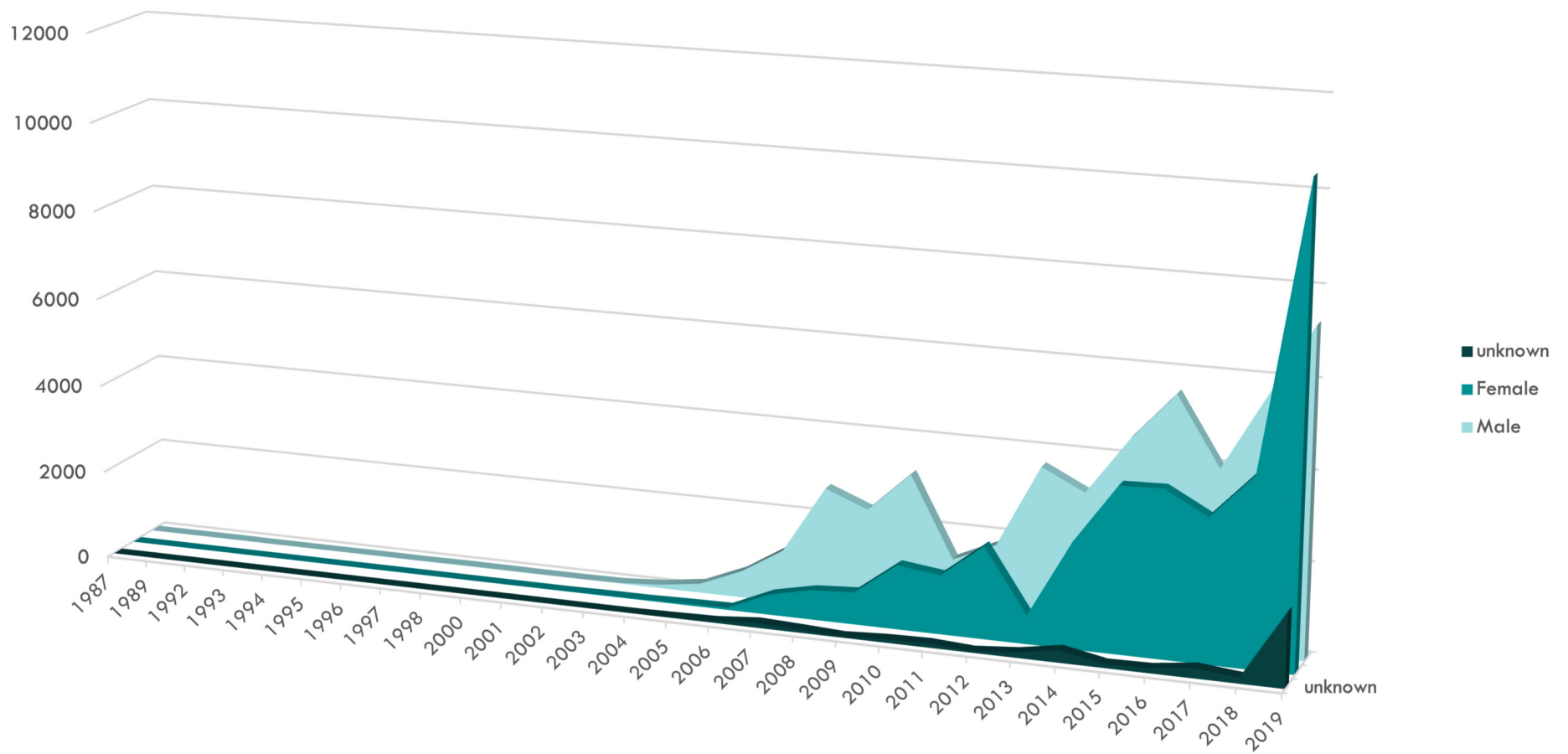
Fig 2. Number of contributions to the MMRP by males and females throughout its entirety, from 1987 – 2019. Unknown refers to names that were not allocated due to uncertainty or potential for bias.
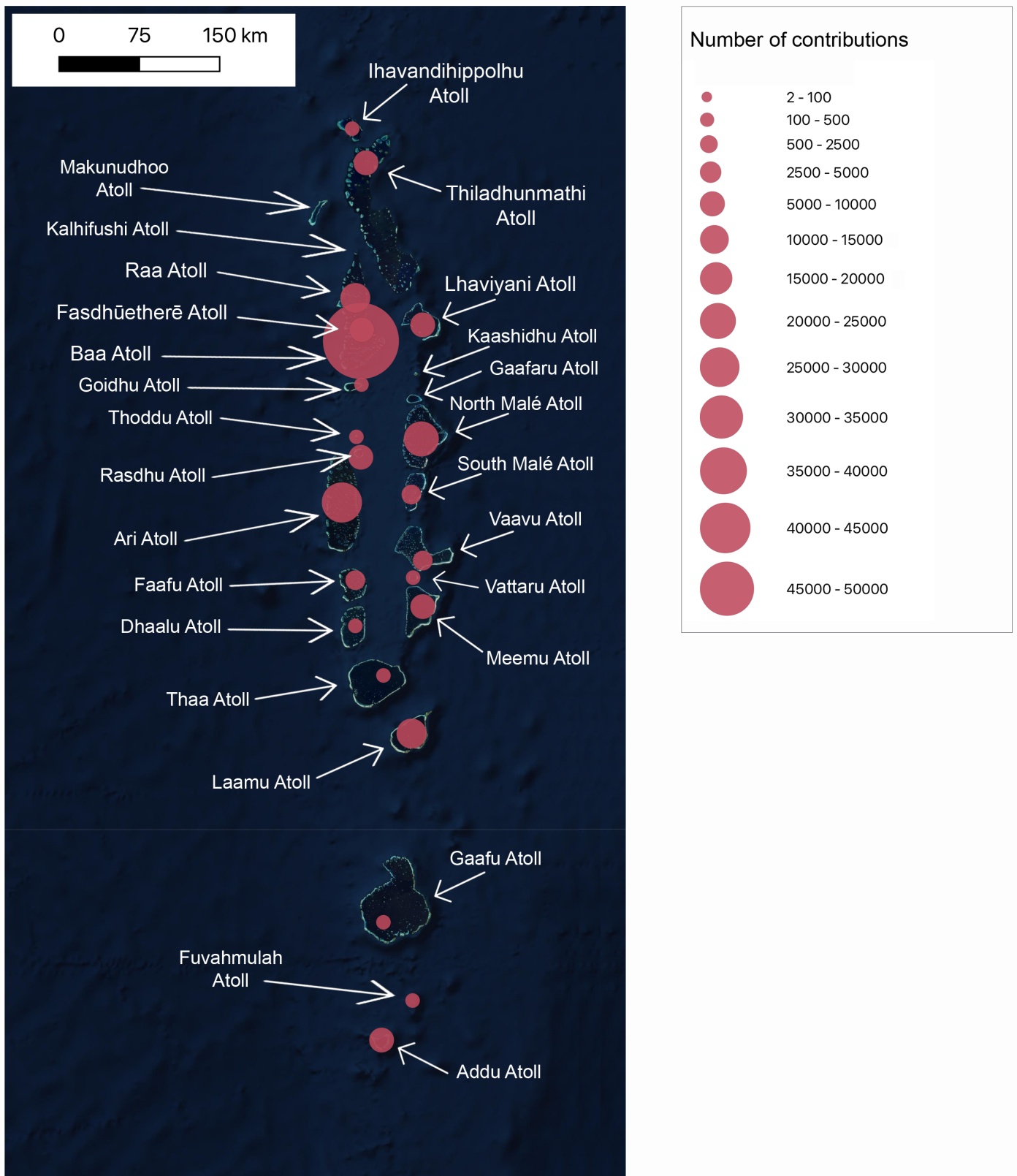
Fig. 3. Map of Maldives with total number of contributions to the MMRP from 1987 – 2019, across all atolls (sub-regions) of the Maldives. Makunudhoo, Kalhifushi, Kaashidhu and Gaafaru atolls have had no contributions throughout the entire period. Baa Atoll, which is home to Hanifaru Bay and a UNESCO Biosphere Reserve, has had the most, with n=48,166 contributions. To view trends from 2019 – 2005 (the year the MMRP was officially established) and by month over all years (1987 – 2019) see Appendix 1.2. All maps were created using QGIS.

Where and When

There are 26 sub-regions in the MMRP dataset, each representing a geographical atoll in the Maldives. All contributions by sub-region are displayed in Fig. 3. Baa, Ari and North Malé atolls have the most contributions with n=48,166, n=12,565 and n=9,602 respectively. Dhaalu, Gaafu and Fuvahmulah atolls have the least with 11, 9 and 2 respectively. Four atolls have received no contributions throughout the entire period. Overall contributions steadily increased over time with the most (n=19,522) occurring in 2019. The months August to October have the most contributions, and April and May have the least.

5.2. Interview Analysis

5.2.1. Quantitative Data

Demographic Data was ascertained by interview questions D1-7, all questions organised by theme can be seen in Table 3, with Table 4 outlining all demographic results.

Question 14 (Q14) uncovered quantitative perceptions regarding proportions of gender and Q15 proportions of nationality within the MMRP workforce, with the majority of interviewees (78%) believing they worked with more females than males and another that their co-workers were short-term residents (78%). For detailed results see Table 5.

Table 3. Interview questions with comment totals colour coded by theme. Interview questions were devised with particular themes in mind, however, given the conversational nature of the interviews, comments were ultimately coded by relevance rather than pre-ordained allocation, with the possibility for any comment to be coded at multiple nodes.

	Theme (Perceptions of)	Question	Comment Totals	Percentage
D1	Quantitative	Age		
D2	Quantitative	Gender		
D3	Quantitative	Nationality		
D4	Quantitative	Maldivian Living Status		
D5	Quantitative	Education		
D6	Quantitative	How long have you been involved with manta ray conservation?		
D7	Quantitative	How long have you/ did you work for the MMRP?		
Q1	Participation	How did you hear about MMRP before your employment? Have you been tracking the work of the MMRP following employment?	20	2.48%
Q2	MR Conservation	How has Manta ray Conservation changed in your living or working memory?	19	2.36%
Q3	Participation	Could you please personally evaluate the work you did at the MMRP?	25	3.10%
Q4	Skills/ Enablers	What enabled you to personally enter into manta ray conservation?	39	4.84%
Q5	Local Impact and Engagement	In your opinion how does manta ray conservation influence the local economy and local community?	35	4.34%
Q6	Participation	There has been a steady increase in yearly contributions to the MMRP dataset from 1987 until now, what do you think has enabled this?	39	4.84%
	Participation	Are there still barriers to wider participation, and if so, what might they be? How could they be overcome ?	45	5.50%
Q7	When	Peak months for contributions appear to be August – October – can you think why this would be?	31	3.84%
Q8	When	April and May have the least contributions overall, given what you know of the Maldives, can you think why this would be?	22	2.72%
Q9	Where	I have seen that Baa, Ari and North Male Atolls are the most contributed to Sub-Regions – in your opinion, what are the factors responsible for this?	33	4.09%
Q10	Where	The MMRP dataset has the least contributions from Fuvahmulah, Gaafu and Dhaalu atolls – what factors do you believe are responsible for this?	29	3.59%
Q11	Participation	Do you believe there is potential or necessity to expand or minimise contributions in these areas? How might this be achieved?	38	4.71%
Q12	Participation	Who do you think contributes the most to the database? And how do you think interest and involvement of other DSTs could be increased?	34	4.21%
Q13	Inclusivity and Accessibility	Overall, how effective and inclusive do you think this model is for manta ray conservation??	29	3.59%
Q14	Quantitative	In your role with the Manta Trust what proportion of the workforce were; local (nationals); long-term residents (greater than 5 years); short-term residents (less than 5 years); seasonal and temporary workers?		
Q15	Quantitative	Of the people you previously worked with, approximately how many identify as; female; male (or other)?Of the people you previously worked with, approximately how many identify as; female; male (or other)?		
Q16	Gender	It seems you work predominantly with ….Is there a reason for this that you would be able to share with me?	24	2.97%
Q17	Local Impact and Engagement	Do you see any advantages or disadvantages for manta ray conservation of including more locals (nationals) in your day to day work? What are the barriers to achieving this? Do you have any suggestions about how to overcome these barriers?	104	12.90%
Q18	Gender	Do you see any advantages or disadvantages for manta ray conservation of including more women in your day to day work?	34	4.21%
Q19	Local Impact and Engagement	What are your personal thoughts or observations regarding local and female engagement in the Maldives' Manta Trust conservation activities?	29	3.59%
Q20	Skills/ Enablers	What skills do you believe are most valuable for enabling contribution to the MMRP program?	67	8.31%
Q21	Skills/ Enablers	How would you describe the ability of the MT's MMRP program and affiliated organisations to build skills within the local community?	28	3.47%
Q22	Skills/ Enablers	What factors do you think currently enable or prevent skill building within the community?	36	4.46%
Q23	COVID	How do you think the COVID-19 pandemic will affect local Maldivian communities and their engagement with marine conservation efforts over the next few years?	46	5.70%
Q24	MR Conservation	What is your vision for manta trust conservation and tourism in the next 5-10 years?		
			806	99.82%

Table 4. Demographic data collated from interview participants. Categories include age, gender, nationality, education, Maldivian living status, time spent in manta ray conservation and time spent at the MMRP. Answers are provided as percentages with comparisons between those of all participants, present and past.

Category	All Participants (n=18)	Present Participants (n=8)	Past Participants (n=10)
Age			
20 - 29	61%	75%	50%
30 - 39	33%	25%	40%
40 - 49	6%		10%
Average	30	25.4	31.5
Gender			
Male	39%	25%	50%
Female	61%	75%	50%
Nationality			
British	50%	38%	60%
Swiss	6%	13%	
German	6%		10%
South African	6%	13%	
American	11%	13%	10%
Maldivian	11%	25%	
Italian	6%		10%
Austrian	6%		10%
Education			
Secondary	6%	13%	
Bachelors	33%	50%	20%
Masters	56%	38%	70%
PhD	6%		10%
Maldivian Living Status			
N/A	67%	25%	100%
Work Visa	22%	50%	
Citizen	11%	25%	
Time Spent in Manta ray Conservation			
6 months - 1 year	17%	13%	20%
1 - 3 years	50%	63%	40%
4 - 6 years	11%		20%
7 - 9 years	6%	25%	
10 - 12 years	6%		10%
13 - 15 years			
16+ years	6%		10%
Average (years)	4.4	3.6	5
Time Spent in MMRP	28%	25%	30%
6 months - 1 year	50%	50%	50%
1 - 3 years	11%	13%	10%
4 - 6 years	6%	13%	
7 - 9 years			
10 - 12 years			
13 - 15 years			10%
16+ years			
Average (years)	3.1	2.7	3.2

Table 5. Participant perceptions regarding the proportions of gender, citizenship and length of stay of MMRP staff, presented as percentages with comparisons between all participants, present and past staff members.

Categories	All Participants (n=18)	Present Participants (n=8)	Past Participants (n=10)
Gender Proportions			
Majority Female	78%	88%	70%
50/50	11%	13%	10%
Majority Male	11%		20%
Staff Citizenship			
Majority Expat	89%	88%	90%
50/50	6%	13%	
Majority Citizens	6%		10%
Staff Length of Stay			
Majority Short Term (1 - 5 years)	78%	88%	70%
50/50	6%	13%	10%
Majority Long Term (5+ years)	11%		20%

5.2.2. Qualitative Analysis

Perceptions of Where

Q9 addressed peaks for spatial contributions, with 69% (n=20) of comments regarding tourism. Lows (Q10) were also mostly attributed to tourism with 59% (n=17) by 14 participants.

Perceptions of When

Q7 addressed temporal peaks for contributions, 64% (n=18) were attributed to manta ray and monsoon season by 14 participants, followed by tourism with 39% (n=11). Lows were addressed in Q8 resulting in 61% (n=14) of comments relating to monsoon and manta ray season and 52% (n=12) of comments to tourism.

Perceptions of Manta Ray Conservation Participation

Questions 1, 3, 6, 11 and 12 addressed wider participation in manta ray conservation (comments per question can be seen in Table 3). Responses were sorted into enablers (Fig 4), barriers and overcoming barriers with similar themes recurring throughout. 72% (n=13) of participants mentioned having a background in marine biology or diving, *'I've got quite a few years of marine field data collection experience, also a dive instructor…that definitely helped, academic background helped for sure'* (IT16).

In terms of overcoming barriers, 94% (n=17) of participants mentioned awareness raising, either in person or online *'I think if we could get there and speak to people the sightings and submissions would go up for sure'* (IT8).
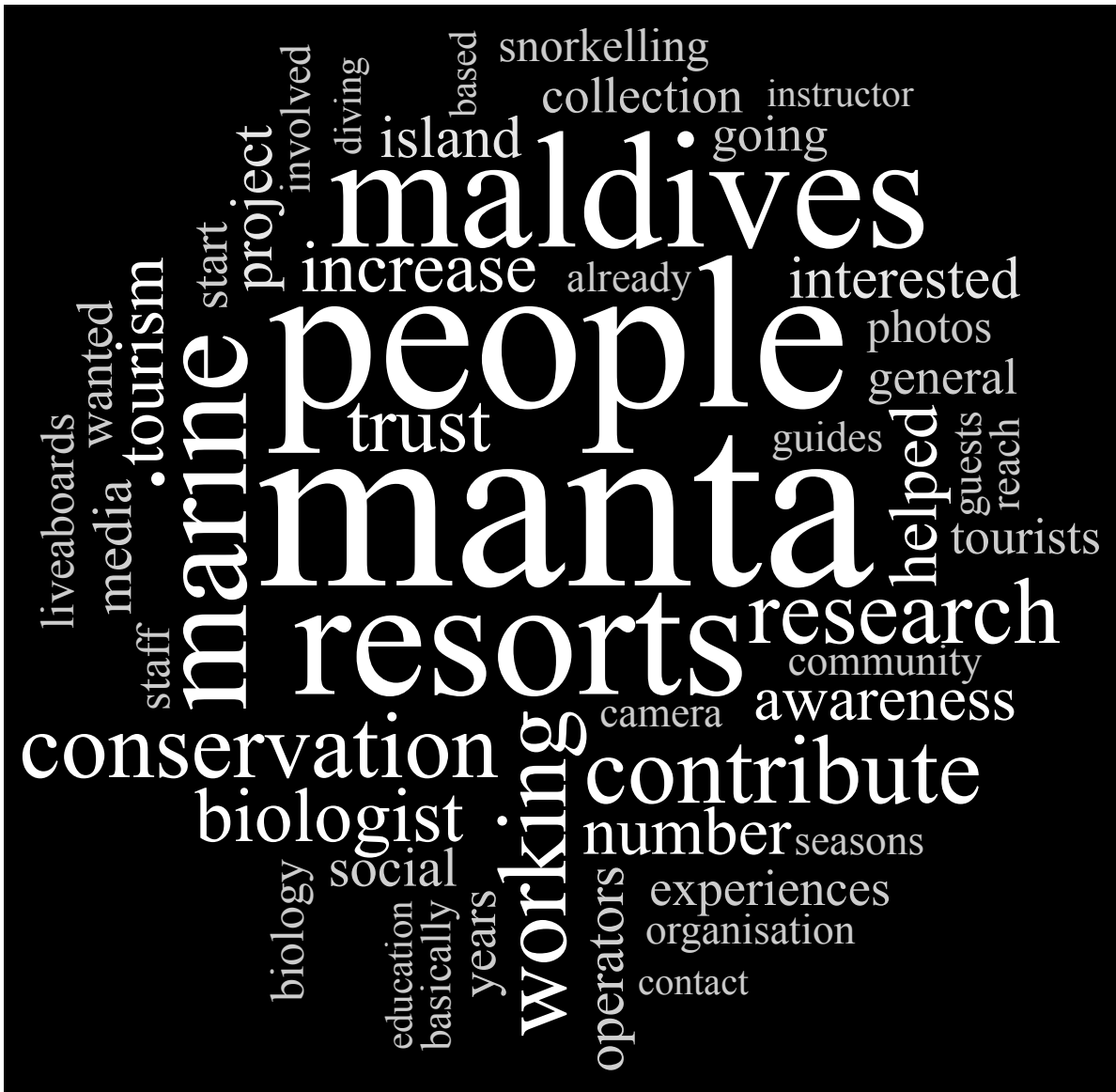
Fig, 4. Word cloud depicting most commonly used, stemmed words for coding category; Manta Ray Conservation Participation Enablers. Size of word indicates frequency of use.

94% (n=17) of interviewees noted successes of the MMRP, '*no one really knew much about manta rays 5-10 years ago and so building the research and building that awareness, I think has changed people's perception*' (IT13). Very few issues were mentioned forming only 12% (n=6) of comments regarding successes and issues, they included community engagement, MMRP integration and research impediments, '*the service for five star guests is a huge priority, guests always come first and then the research will come second*' (IT16).

Perceptions of Local Impact and Engagement

Responses were sorted into advantages and disadvantages, enablers, barriers and overcoming barriers. Advantages were mentioned by all participants forming 86% (n=31) of comments, '*the benefits are subtle but important when we're out in our research boat having Yani there who can talk to other Maldivians… and tell them what we're up to in Dhivehi, even though everyone speaks very good English, it's very important, having that representation*' (IT6). Only 5 disadvantages were mentioned by 3 participants.

72% (n=13) of participants perceived barriers to local engagement to be cultural (Fig 5), '*most of the*

Fig 5. Word cloud depicting most used words for the coding category Barriers to Local Engagement, including stemmed words. Size of word indicates frequency of use.

parents won't let their children be dive masters because of incidents that happened to the fishermen who are in no way qualified to be diving' (IT10). Education was also mentioned by 72% (n=13) of participants, *'we're trying to involve more [locals sic]… and modify our internship phase to include more [locals sic] because a couple of our requirements don't really fit what the Maldivians have'* (IT7), and *'There's, no higher education for marine conservation or marine science in the Maldives…I think they've started a marine science degree now but there wasn't previously'* (IT1).

Enablers and overcoming barriers had similar comments with 51% (n=63) focussing on education and internships, *'we want to try and make 50% of our intern roles local only…I think offering positions that allow training before they're taken on full time'* (IT8) and *'there's been some really good outreach programs running where it's like a marine course'* (IT13).

Perceptions regarding Gender Engagement

Q16 and 18 investigated participants belief that there was a majority of women within the MMRP. There were no predominant reasons mentioned, though 61% (n=11) of participant's attitudes were positive, *'MMRP is really girl power, which is great'* (IT5) with some, 72% (n=13), more neutral or advocating gender equity *'we can be doing the same work if we have a woman or man, so I would be pretty neutral about it'* (IT10).

Perceptions of gender inclusion reversed in regards to Maldivians, with all participants mentioning a lack of Maldivian female participation. 62% (n=32) of reasons were attributed to culture, *'cultural hesitation, particularly with parents about wanting a daughter to leave their home island to get further education & things. As well there's just fewer females who know how to swim'* (IT9). All participants held positive attitudes in regard to Maldivian female participation.

Perceptions regarding Skills

Q20-22 addressed skills believed valuable for MMRP contribution and employment. 30% (n=25) of comments, by 14 participants, pertained to scientific background, *'data analysis or [scientific] writing is hugely beneficial' (IT1)*. Diving, including swimming and freediving, followed with 21% (n=17) from 11 participants, *'mostly swimming based and being able to dive down that little bit to get underneath the manta'* (IT13). Half the participants (17% of comments) mentioned the importance of social skills, *'Being gregarious…a lot of the work we have to do involves having not only to work with team members, but they have to be constantly interacting with members of the public, with guests, resort staff, members of the local communities, so they have to be a good people person'* (IT14).

Perceptions of Inclusivity and Accessibility

Comments were sorted into positives and negatives, they were mostly balanced with 48% (n=30) positive, and 52% (n=33) negative. Some comments, such as ones regarding technology applied to both, *'I think it's [MMRP] quite effective and inclusive to be fair. I realise that the inclusivity of it will change with aspects of income and ability to travel and have an underwater camera'* (IT18).

Perceptions regarding Outreach

94% (n=17) of participants mentioned education as a primary outreach method, *'education is starting to become such a big thing, and the resorts are proud of educating the local communities'* (IT8). In regards to impacts of COVID, 61% (n=11) mentioned existing or future impacts on community engagement and education initiatives.

Table 6. Frequencies and percentages regarding skills interviewees regarded as necessary for contribution to, and employment within, the MMRP. Science or having a scientific background rank highest. Skills that were mentioned, though not as frequently have also been included.

Skills Mentioned	No. of Comments	Comment Percentage	No. of Participants
Science / Scientific Background	**25**	**30**	**14**
Diving (inc. swimming)	17	21	11
Social	14	17	9
Passion	5	6	5
Dedication	2	2	2
Media	1	1	1
Language	2	2	2
Organisation	2	2	2

6. Discussion

Analysis of the MMRP dataset and interviews illuminated hotspots and gaps towards MMRP engagements and factors that enable or prevent participation, with MMRP analysis revealing most contributions to come from Baa, Ari and North Malé atolls, and most contributions occurring from August to October, the least from April to May. Women were believed to be the majority of employees within the MMRP, however, this belief regarding gender involvement was reversed in regard to Maldivians. Interview participants displayed open attitudes to MMRP inclusivity, however 30% of participant comments regarding skills pertained to science and 21% to diving or swimming. The high esteem placed on these skills could act as a barrier to wider involvement, including that of Maldivian's, despite all participants mentioning advantages to Maldivian engagement. Education was also mentioned as a primary outreach method by 94% of participants.

When and Where

August to October are peak contribution months with April and May having the least overall, though differences can occur between atolls, this was largely attributed to the monsoon season in the Maldives (Anderson, Adam and Goes, 2011; Harris *et al.*, 2020; *Maldivian Manta Ray Project*, 2020) which makes excursions difficult and dangerous at certain times of year. These months were also concurrent with European holiday seasons (*International Tourism, Number of Arrivals - Maldives*, 2021; Matthews, 2020) which allows more opportunity for citizen science and researchers to spend time on the water.

The MMRP data itself revealed the geography of the Maldives to have a significant impact on contributions, which was verified by the interview process, illuminating the means by which atoll formations affect access for both tourists and MMRP staff. This is mostly due to the development of the Maldives as a tourist destination, which grew around the only airport, centrally located in Malé (Maloney, 1976). Interviews have indicated this has a knock on effect as excursions to northern or southern atolls are very much restricted due to difficulty and travel expense.

Gender Equity in Conservation

It is widely agreed that women are underrepresented in science (Williams and Ceci, 2015; Williams, 2018), however, there is evidence to suggest that women's roles worldwide are increasing (Wuhib, Dotger and Ieee, 2014), particularly within the realm of conservation. Whilst the MMRP dataset revealed a majority of male contributions throughout the entire dataset, including the Researcher category, the majorities remained small with 55% (n=41671) and 54% (n=1874) respectively, with women holding a high majority (76%, n=6423) within the Marine Biologist category. Furthermore, 61% of all staff interviewed were female (rising to 75% for present staff), supporting evidence of an increase in female participation.

Conversely, as inferred by prior literature (Barraud, 2017), Maldivian females were considered mostly absent from MMRP initiatives, with reasons attributed to culture, *'sometimes the family doesn't like them working at resorts, I believe also on the whole there's very traditional order, very traditional. Women get married very early, women should stay at home'* (IT15).

The empowerment of women worldwide is a critical and extolled issue, gaining traction through the UN's Sustainable Development Goal Five (UN, 2021) and with female liberty increasingly considered a facilitator

to conservation (Sodhi, Davidar and Rao, 2010). However, the circumstances surrounding creation of equity are not straightforward (Moon, Adams and Cooke, 2019) and are influenced by the many cultural landscapes within which conservation actions occur (Bennett *et al.*, 2021), requiring particular sensitivity from organisations working withing these realms.

Nevertheless, it is gender equity which is ultimately the most significant factor as different genders each bring varying benefits, knowledge, skills and community to any project (Radel, 2012), an understanding consistently reflected in the perspectives offered by MMRP interviewees.

It is important to note, not all MMRP employees were interviewed for this research, nor were any contributors outside the MMRP. In future interviews should be conducted with wider groups and communities to reduce the potential for bias and increase understanding. Furthermore, demographic information should be incorporated into the '*IDtheManta*' platform to increase data and reduce uncertainty, providing increased insight, not only into gender, but age, nationality and ethnicity of participants. This will help hone comprehension of hotspots and gaps regarding contributors, and how culture may shape the participation of different genders, and changes to this over time.

Skills and Opportunity

MMRP staff members held a predominantly open and inclusive attitude towards contributors and members. However, a background in biology or diving were nonetheless the most frequently mentioned skills considered beneficial for inclusion within the MMRP. As aforementioned, there are a number of specialisations involved with marine citizen science that make opportunity to develop these skills inherently inequitable (Cigliano and Ballard, 2018). Regular contributors to citizen science tend to be older, better educated and wealthier than the average person (Maund *et al.*, 2020). Whilst the MMRP is likely to benefit from 35% of tourists visiting the Maldives to dive (Kitchen-Wheeler, 2010), Maldivian communities are unlikely to substantially benefit from this activity with most profit generated given to internationally run resorts (Moorthy, 2010).

Whilst tourism can be beneficial, such as via the partnership between the MMRP and the Four Seasons, which enables capacity building by sponsoring apprenticeships and internships (Barraud, 2017), investment in conservation projects (Cigliano and Ridlon, 2018) and opportunity for local communities to participate may still be limited.

Wider barriers to STEM have been noted to include racial discrimination, limited career options and education, as well as low fiscal state (Morales and Jacobson, 2019). It is likely at least some of these factors are at play in regard to Maldivian involvement. Only two of the 18 people interviewed were Maldivian, and education was frequently mentioned as a barrier to Maldivian involvement. The lack of universities, biology-based programmes and segregation of local from resort islands within the Maldives (Maloney, 1976; Sathiendrakumar and Tisdell, 1989) make capacity building and accessibility within these communities all the more challenging and necessary.

Concerted efforts and considered mitigation are necessary for fostering inclusivity as the ecotourism and volunteer tourism models can deeper engrain issues regarding privilege in conservation (Brown, Kamath and Rubega, 2017), entrenching fiscal as well as cultural divisions, such as fear of the sea (Barraud, 2017) which was also mentioned in interviews.

The interviews revealed the MMRP already has a strong focus on capacity building, in future, schemes focussing on increasing equal opportunity could be established, for instance where essential equipment like Go Pros can be signed out from resorts to increase participation for local or low income peoples including fishermen, resort staff or dive masters.

Beyond Natural Science

Conservation is dominated by natural sciences (Bennett et al., 2017), however, in recent years there has been more focus on incorporating social science, particularly as appreciation of the value of human effort towards conservation success grows. Half the participants interviewed mentioned the importance of social skills to the MMRP's work and past research has stated that the legitimacy of a project improves with greater collaboration and inclusion (Bennett and Dearden, 2014). Moreover, collaboration can overcome limitations associated with 'expert' centred scientific research (Delevaux et al., 2018), incorporating social science is advantageous (Moon et al., 2021) in order to broaden perspectives and improve the social integration that makes conservation truly successful (Bennett *et al.*, 2017).

Funding for conservation work, and in particular for work that integrates natural and social sciences is known to be a challenge (McKinley, Acott and Yates, 2020; Bennett et al., 2021), a factor frequently mentioned throughout the interviews as a barrier. Whilst problematic, given the segregated geographic and economic landscape of the Maldives, research projects that aim to understand and integrate the impact of human activity to achieve conservation actions on small and large scales are all the more valuable.

Human practices are ultimately the foundation of all conservation action (Fox *et al.*, 2006; Mascia *et al.*, 2003) and it is essential to combine social science approaches alongside those of the natural sciences to ensure conservation is enacted in a culturally appropriate and just manner (Bennett, 2016; Berkes, 2021; Nuna *et al.*, 2021). Greater integration of the two allows NGOs to fulfil obligations to the local community whilst succeeding in their biological objectives (Bennett *et al.*, 2021).

Beyond Education

Education programs for youths have great potential to further citizen science efforts (Wasser, 2018). One of the great successes of the MMRP, besides the extensive database of manta ray research, is the education program run in conjunction with MMRP activities, its achievements being repeatedly mentioned by interview participants with 94% mentioning education as a primary outreach method, *'by the end of the program you've got at least one or two that are super passionate about marine biology'* (IT6).

Capacity building is a necessary priority for Maldivian biodiversity protection which involves making education resources widely available in an easily accessible way, such as translation into Dhivehi (Jameel, 2002), as some MMRP interviewees recognised and noted as something to build towards.

However, a key issue raised by MMRP employees was lack of motivation both from locals and some tourists in either learning about or participating in the MMRP program. Lack of interaction with the sea has been attributed to lack of affinity to it (Sakurai and Uehara, 2020) which could be the case in the Maldives. Whilst education is clearly a significant factor in building essential skills for Maldivians and any long term MMRP contributors, knowledge is not necessarily enough to alter attitudes or behaviour (Akintunde, 2017; Schultz, 2011), with previous studies finding contribution to conservation efforts has more to do with

fondness and attachment to place than knowledge (Sakurai and Uehara, 2020; Charles, Keenleyside and Chapple, 2018; Bennett, 2016). Many interviewees spoke of experiences first seeing a manta ray, or in their youth, that shaped their desire to work in conservation which is concurrent with research that suggests such positive experiences allow one to view themselves as a part of nature, encouraging pro-environmental behaviour (Crompton and Kasser, 2009; McKinley, Acott and Yates, 2020; Sowman *et al.*, 2021). The Manta Trust is in a strong position, with its environmental initiatives founded around a charismatic species, to incorporate positive marine experiences into its model. This seems to already exist for tourists and interns, but could be increasingly implemented within Maldivian communities.

Furthermore, unification of science and arts can play a crucial role in strengthening collaboration and integration (Costanza, 2014) by development of culturally relevant, non-education focussed experiences that provide space for western conservationists to listen to local attitudes (De Groot and Zwaal, 2007). With use of storytelling (Mony and Satria, 2021; Fernández-Llamazares and Cabeza, 2018; De Groot and Zwaal, 2007) as well as focus on integrating conservation ideals with local culture (Muswar and Satria, 2021) proving successful elsewhere. In Bali, Indonesia, successful conservation initiatives were introduced to the local fishing community by aligning the conservation actions with intrinsic elements of their religious and cultural belief, karma (Charles and Berkes, 2021b), demonstrating the importance and significance of adopting a cross-cultural approach, particularly for western-led conservation organisations.

7. Conclusion / Recommendations

The MMRP has been widely successful with 85,706 sighting records gathered from many Maldivian atolls over the last 35 years. In order to expand contributions and increase equity the MMRP should further develop mechanisms for understanding the social aspect of contributions, by incorporating a social element to the MMRP platform which will allow collection of demographic data such as gender and nationality, allowing the MMRP to have more awareness of engagement gaps and appropriate channels for outreach effort.

Following this, incorporating diverse outreach methods, that go beyond 'pure' education into fostering affinity, reframing narratives and using humanities-based approaches alongside scientifically founded ones is recommended to allow greater cultural cohesion and inspire the Maldivian community into conservation action that stems from their language, history, cultural and spiritual heritage, making way for bottom-up as well as top-down conservation approaches.

WORD COUNT: 4995

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