

Why do Great Barrier Reef tourism operators engage in coral restoration?

An exploration of motivations, opportunities, and challenges

Margaux Hein, Maxine Newlands, Alexander Elms, Karen Vella and Ian McLeod



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Cover photographs: (front) Tourism operators transporting coral colonies during a coral restoration workshop in Port Douglas. Photo by Pablo Cogollos; (back) Participants at a coral restoration workshop in Port Douglas. Photo by Wavelength.

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ACRONYMS

GBR	Great Barrier Reef
GBRF	Great Barrier Reef Foundation
GBRMPA	Great Barrier Reef Marine Park Authority
RRAP	Reef Restoration and Adaptation Program

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EXECUTIVE SUMMARY

Active coral restoration is a new endeavour on the Great Barrier Reef (GBR) with the first projects starting in 2017. Methods used in these early projects include coral gardening, direct transplantation, larval enhancement, substrate addition and substrate enhancement. Although many of these projects are led by or involve the tourism industry, there has been little research into the motivations, opportunities, and challenges for the tourism industry associated with their involvement. To address this knowledge gap, we conducted semi-structured interviews with ten tourism industry operators about their motivations to get involved with coral restoration and their experience. Interviews were transcribed and thematically analysed. Although the number of interviewees was small, they represented most of the tourism companies involved in coral restoration in the GBR at the time. Biotic considerations (wanting to improve coral cover and resilience at the tourism sites) were primary motivators for coral restoration by tourism operators. Idealistic motivations (passion for the reef) and an opportunity to use restoration as a way to improve public awareness of current threats to coral reefs were also reported as motivations. One operator identified a pragmatic motivation to use coral restoration as a way to improve the satisfaction of customers. Protecting the reef from increasing pressures was also a common motivation. Three key challenges were identified by tourism operators, (1) regulatory systems and approvals; (2) uncertainties and challenges linked to weather and climate events; and (3) perceived risk that coral restoration may cause more damage to both the reef and their businesses.

This report provides an initial first look at tourism industry motivations and experiences with coral restoration on the GBR as well as insights into how the industry can better be integrated in large-scale efforts supported by the Reef Restoration and Adaptation Program (RRAP) and the Great Barrier Reef Foundation (GBRF). Restoration projects may not be stand-alone activities as they are in other countries. In the GBR they may be integrated with other on-going site stewardship activities such as coral predator and macroalgae control, diver education, pollution reduction and reef monitoring in an attempt to improve the health and aesthetics of the reefs tourist operators use. The tourism industry may offer opportunities to grow the capacity for coral restoration on the GBR. Current challenges to their involvement could be improved through further developing collaborations among restoration practitioners, with regulators, and with the scientific community. A follow-up of their motivations and perspectives, and those of operators not involved in coral restoration activities will be valuable as the coral restoration industry matures.

1.0 INTRODUCTION

As the Great Barrier Reef (GBR) continues to degrade through repeated mass bleaching events, crown-of-thorns starfish outbreaks, and the impacts of intense cyclones, pressure is growing for direct intervention to assist the recovery of reef-building corals. Various types of coral restoration, rehabilitation and assisted recovery projects have been trialled overseas for decades but active intervention strategies represent a new territory for the management of the GBR.

In the last three years, some direct interventions to assist coral recovery have been trialled in Australia. These include direct transplantation of corals, algae removal to promote coral recovery and larval enhancement to increase the levels of coral recruitment on degraded reefs. The large spatial scale of the GBR Marine Park creates lots of challenges for the design and implementation of restoration efforts, which are typically applied at small scale, on specific reef sites. Involving multiple types of stakeholders will likely increase the capacity for implementing such efforts at scale, and for ensuring that interventions are designed to benefit stakeholder groups that directly depend on the reef for their livelihoods. Tourism operators are one of the key group stakeholders leading the way in implementing the very first coral reef restoration on the GBR. In this report, we explore their motivations, as well as key opportunities and challenges associated with their efforts.

1.1 The rise of coral restoration on the GBR

1.1.1 What is ecological restoration?

Ecological restoration is defined by the Society of Ecological Restoration as “the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed” (Gann, 2019). Ecological restoration can include passive and active strategies, passive strategies include management actions to promote natural recovery, such as implementing marine protected areas to reduce damage from fishing or reducing pollution. Active restoration strategies are direct actions to speed up recovery such as coral gardening and transplantation, or substrate modification. This report will focus on active coral restoration strategies (hereafter coral restoration) (Table 1).

1.1.2 Coral restoration on the GBR

Coral restoration has been used in at least 58 coral countries (Boström-Einarsson et al. 2020) and is an accepted management strategy for reef areas such as the Florida Keys, USA (NOAA 2019), or the Belize Barrier Reef (Carne and Kaufman, 2015). Until recently, it was generally thought that the GBR was too large and resilient for restoration to be necessary. This presumption was challenged by large reductions in live coral cover following back-to-back mass coral bleaching in 2016 and 2017 (Hughes et al., 2018), leading to a reduction in capacity for corals to recover naturally (Hughes et al., 2019). Since 2017 there has been increasing interest in and funding for coral restoration and adaptation research and a number of small-scale coral restoration trials.

Table 1: Coral restoration methods mentioned in this report. Definitions from Boström-Einarsson et al. (2020).

Method	Definition	Other common terms
Direct transplantation	Transplanting coral colonies or fragments without intermediate nursery phase	Coral tipping, post-disturbance repair
Coral gardening	Transplanting coral fragments after an intermediate nursery phase	Population enhancement, asexual propagation
Coral gardening - Nursery phase	Transplanting coral fragments with an intermediate nursery phase (used to describe case studies that only detail the nursery phase). Nurseries can be <i>in situ</i> (on the reef) or <i>ex situ</i> (flow through aquaria). Note that following the above definition of restoration, a coral nursery does not constitute restoration, until outplanting has occurred.	
Coral gardening - Transplantation phase	Transplanting coral fragments with an intermediate nursery phase, including outplanting juveniles raised in the nursery (used to describe case studies that only detail the transplantation phase)	Outplanting
Larval enhancement	Using sexually derived coral larvae to release or outplant at a restoration site, after intermediate holding phase which can be <i>in-</i> or <i>ex-situ</i>	Larval propagation, sexual propagation, larval seeding, assisted breeding
Substratum enhancement - electric	Enhancing artificial substrata with an electrical field or direct current	Electrochemically formed structures, mineral accretion, BioRock

1.2 The role of the tourism industry for the protection of the GBR

There are a growing number of reef restoration projects within the GBR, many of these championed by the tourism industry. The GBR generates around \$56 billion dollars of revenue per year and supports more than 64,000 jobs (O'Mahony, 2017). Tourism generated \$27 billion for the Queensland economy over the 2017-18 financial year, with one in five jobs in Cairns and one in three in the Whitsundays in the tourism sector (Australian Government Austrade, 2019). While tourism pressure can negatively affect coral reef by damaging coral or increasing coral disease (e.g. Lamb et al., 2014), tourism also constitutes an important reef ecosystem service with high potential to support local and regional economies, and improve reef protection through education and engagement when managed appropriately (Spalding et al., 2017). Also, with the opportunity to access the reef on a daily basis, and an extensive knowledge of their site history, the tourism industry will likely be integral to how new initiatives can be successfully applied on the GBR.

In this study, we focused on the GBR's two major tourism hubs, the Cairns region in the northern GBR, and the Whitsundays region in central GBR. Coral reef health has declined in both of these regions through recent coral bleaching, cyclone damage, and crown-of-thorns starfish outbreaks (GBRMPA, 2019). These events greatly affected tourism operators, and a growing number of them have expressed interest in becoming more proactive in the protection and conservation of local reef resources (Goldberg et al., 2018). A number of operators are now involved in active reef protection interventions such as reef health monitoring and crown-of-thorn starfish control. Conservation education talks are also given to clients in the majority of operations. However, their motivations for getting involved, the benefits they anticipate, the challenges they experience, and their intentions around longer-term involvement in such projects remains unclear. Addressing this knowledge gap is key to understanding how and how much tourism-led restoration efforts can be scaled across different sites and business models.

Motivations may be linked to attitudes towards the reef and climate change, (as described in Marshall et al., 2019), such as awareness of declines in coral cover, increased vulnerability of their identity, securing income and/or reputation, or more intrinsic values (e.g. it's the right thing to do). Given the critical role that the tourism industry is likely to play in facilitating restoration on the GBR, it is important that the planning of restoration efforts account for their motivations and expectations to 1) mitigate conflict with other stakeholders (managers, scientists etc.), 2) ensure long-term participation and involvement, 3) maximise socio-economic outcomes, 4) identify specific needs and expectations from this industry, and 5) help mitigate against climate change effects on the industry.

1.3 Aims

The aim of this report is to investigate the role and motivations of the tourism industry for getting involved in coral restoration efforts. Specifically, we aim to synthesise 1) who are the key actors involved 2) what their motivations are, and 3) identify key challenges to improving their capacity for long-term and collaborative actions. Better understanding of specific factors motivating tourism operators' involvement in coral restoration activities on the GBR is essential to improve our knowledge of the socio-economic viability of coral restoration efforts in the region. Further, this information will help tailor and align restoration strategies and any future guidelines or standard operating procedures to the needs of the tourism industry.

2.0 METHODOLOGY

We used a semi-structured interview questionnaire approach with ten tourism operators involved or about to be involved in coral restoration efforts in the Cairns and Whitsundays regions. The interviewees represented most of the tourism organisations involved in coral restoration at the time. Operators were identified through the authors' networks and the snowball technique and recruited through invitation emails. Interviews were conducted over the phone. The interview questionnaire included 11 questions (Appendix 1) and lasted between 15 and 70 minutes. Interview questions were mainly qualitative. Some quantitative questions were included to collect demographic information about the sample (Section 1 of interview questions, Appendix 1). Qualitative data were obtained from questions looking at an overview of the restoration activities (Section 2 of interview questions, Appendix 1), and reflections on success and expectations (Section 3 of interview questions, Appendix 1). In particular, participants were asked:



- “What kind of restoration effort is your company involved in/planning to be involved in?” (Question 2)
- “What is your motivation for getting involved in a coral restoration project? (Question 4)
- “What are some challenges that you faced/are facing in this project” (Question 8)
- “What is the capacity of the tourism industry to engage in this type of activity more widely?” (Question 8b)




Responses were de-identified to ensure anonymity. The interviews were audio-recorded and later transcribed. Content-analysis of the transcriptions was performed on NVivo (Version 12, 2018).

2.1 Defining motivations

Clewell and Aronson (2006) described five typical rationales for ecosystem restoration in their paper “*Motivations for the restoration of ecosystems*”. We modified these rationales for this study as follows.

Table 2: Motivation categories used in this report.

Technocratic	Motivation is to satisfy government/legislative order through contracts and permits. Restoration efforts are then typically undertaken by large agencies or institutions. Includes mitigations goals and engineering approach to improve an ecosystem.	
Biotic	Motivation is to preserve biodiversity. Goals are the protection of endangered species, or threatened ecosystems.	

Heuristic	Motivation is to use restoration as experimental ground to further our understanding of ecological functioning. Goal is to get insights into ecological processes and restoration methods.	
Idealistic	Motivation is to restore an area because there is some attachment to it for cultural/social values. Restoration efforts are then typically undertaken by small groups (as opposed to technocratic motivations). Goals are not about ecological outcomes but about cultural values.	
Pragmatic	Motivation is to restore natural capital that is lost due to degradation, negatively impacting well-being. Goals are to restore ecosystem services, and the economic value of an ecosystem.	

These motivations are presented as non-exclusive, usually complementing one another. For example, pragmatic motivations will require technocratic motivations to be implemented at scale, and technocratic motivations will need some idealistic motivations to gather wide support and participation from communities (Clewell and Aronson, 2006). These categories have since been used widely to describe and further the understanding of motivations behind ecosystem restoration (Aradottir et al., 2013; Hager et al., 2017; Bayraktarov et al., 2019). We drew on these studies for our methodological design and coding.

2.2 Restoration methods

We determined the extent and type of restoration efforts that the tourism industry is currently involved in on the GBR by analysing responses for Question #2: “*Can you please describe the type of coral restoration effort you/your company is involved in?*” Responses were coded following restoration methods described in Boström-Einarsson et al. (2020) and categorised as either “on-going” or “in-planning”.

2.3 Motivations of the tourism industry

To characterise the motivations of tourism operators for getting involved in coral restoration efforts, we analysed responses to Question #4: “*What is your motivation for getting involved in a coral restoration project?*” Coding of the responses followed a two-step iterative process. First responses were categorised according to the five key motivations described in Clewell and Aronson (2006), then further categorised into more specific, descriptive categories. We also separated responses as “primary” and “secondary”. Primary motivations being stated as first and foremost, or in direct answer to the prompt: “*What would you say is your primary motivation for getting involved in a coral restoration project?*”, and secondary referring to other motivations mentioned throughout their responses.

2.4 Reflections on success and key challenges

To assess perceptions of project success and identify key challenges we analysed responses to Question #8: “*What are some challenges that you faced/are facing in this project*”, and Question #8b: “*What is the capacity of the tourism industry to engage in this type of activity more widely?*” Responses were coded following commonly identified themes of challenges and perceptions of capacity to engage in restoration more widely.

3.0 RESULTS

3.1 Demographics and restoration methods

3.1.1 Participant demographics

Operators reported that their companies had between 4,000 and 180,000 visitors per year, with an average of 50,000 tourists per company per year in the Cairns region, and 22,000 tourists per company per year in the Whitsundays region. Two operators had been in business for 5-10 years, three operators for 10 to 20 years, and five over 20 years. Tourism activities offered ranged from day trips to the reef where customers can dive and/or snorkel, to overnight charters. Two operators were based on offshore resorts offering a range of in-water activities. All operators mentioned were giving educational talks about the reef as part of their tours.

3.1.2 Restoration methods

Seven operators were currently involved in restoration efforts and all planned to add to their current efforts in the near future. Coral restoration complements the operators existing involvement in “on the reef” actions such as reef health monitoring and targeted control of crown-of-thorns starfish. A larger range of coral restoration methods were used in the Cairns region compared to the Whitsundays region (Figure 1). In the Cairns region, coral gardening including both *in-situ* coral nurseries and transplantation efforts, and larval enhancement were the most widely used methods (Figure 1). One project used a substrate enhancement method where electrified frames were used as substrate for coral transplantation. Another operator was involved in monitoring reef health and the outcomes of their restoration project. In the Whitsundays, the majority of operators reported efforts linked with monitoring and leading restoration committees, hereafter classified as “other”. Coral gardening was used by one Whitsundays operator including *in-situ* and *ex-situ* coral nurseries.

Planned restoration methods among operators and regions included an increase in direct coral transplantation, and projects using substrate addition methods (Figure 1). The planned direct transplantation efforts stem from a collaboration between a range of tourism operators and a research group from the University of Technology Sydney to test and implement a new low-cost, rapid attachment device (Coralclip®) to outplant corals and settlement plates (Suggett et al., 2019, Figure 2g). Projects planning on using substrate addition methods are focusing on dome-shaped steel frames following the “reef star” models developed by MARS Symbioscience (Williams et al., 2019, Figure 2h). The aim of these structures is to provide solid substrata on which to attach coral fragments, added structural complexity, and to stabilise loose rubble fields.

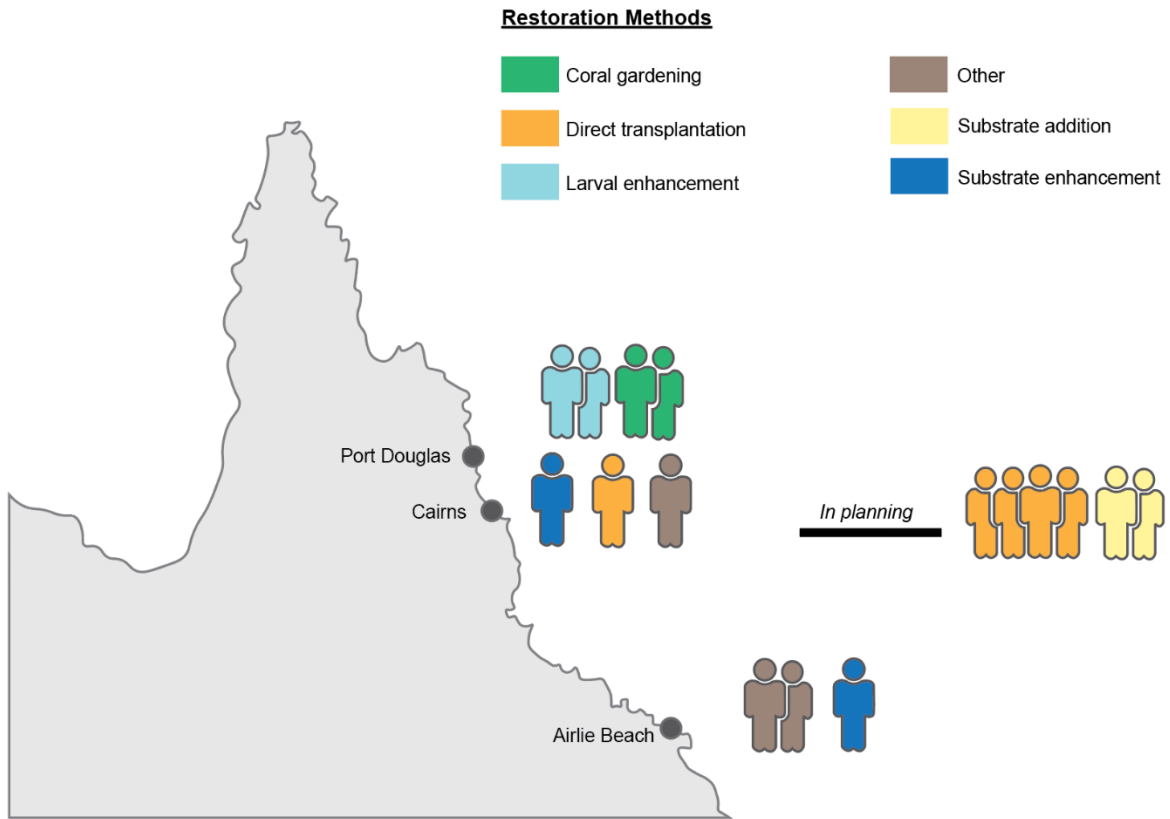


Figure 1: Restoration methods currently used or planned in tourism industry related projects in the Great Barrier Reef

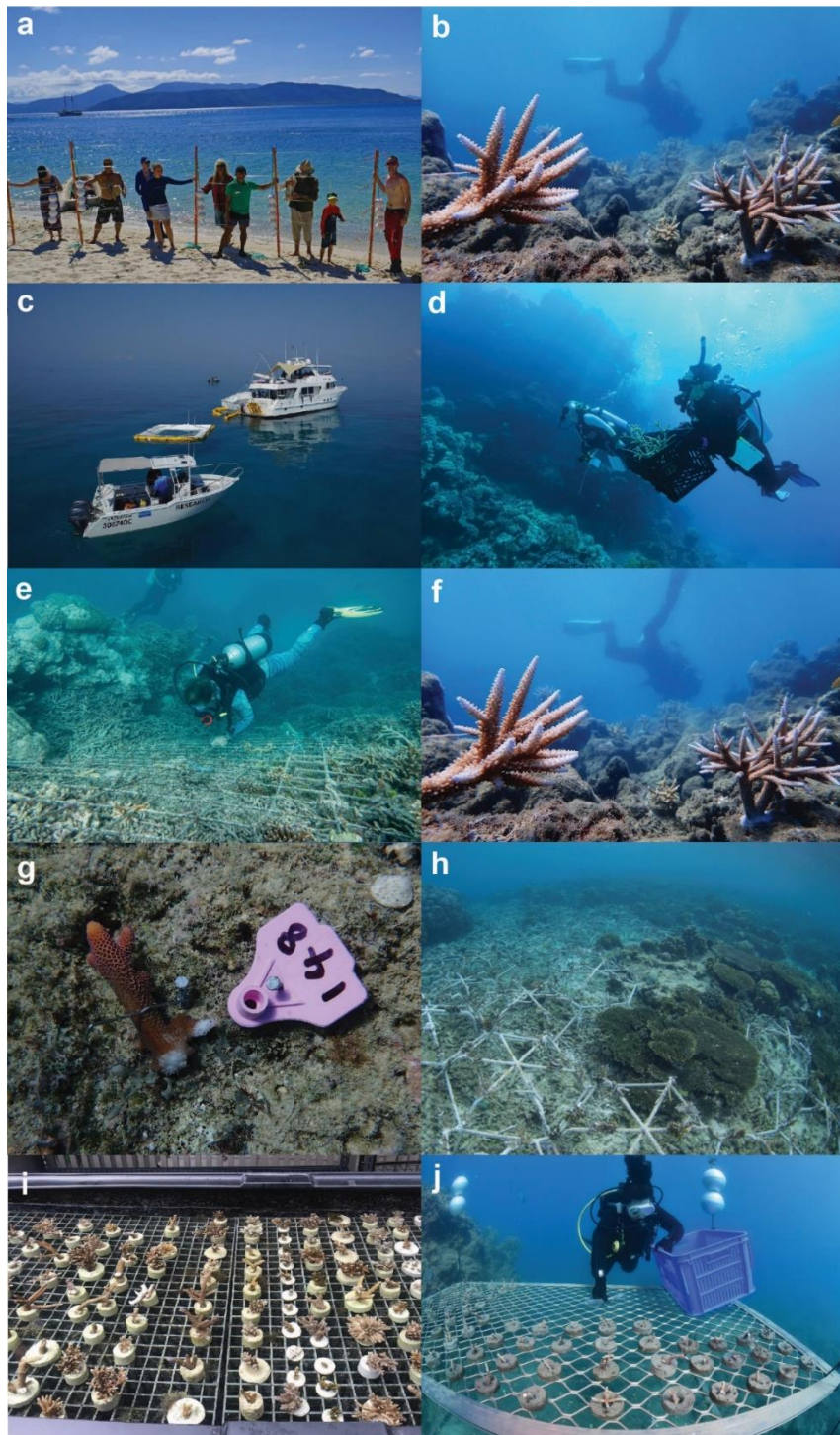


Figure 2: Coral restoration activities associated with the tourism industry in the Great Barrier Reef: (a) Volunteers assisting to set up coral 'tree' nurseries at Fitzroy Island, (b) outplanted coral colonies in the Whitsunday region, (c) collaboration between the tourism industry and scientists during larval enhancement trials at Vlassoff Reef, north Queensland, (d) divers moving coral fragments for transplantation on the reef, (e) electrified frames used as substrate for coral transplantation, (f) coral 'tree' nursery, (g) Coralclip® used to attached a coral fragment to the reef, (h) reef stars used to form a substrate to coral attachment over coral rubble (note, this image is from Indonesia), (i) land-based coral nursery in the Whitsundays region, (j) in-water coral nursery in the Whitsundays region. Photos by Nathan Cook, Pablo Cogollos, Ross Miller, John Edmonson, Ian McLeod, and Johnny Gaskell

3.2 Motivations of the tourism industry

3.2.1 Primary motivations

Primary motivations for getting involved in coral restoration were dominated by biotic considerations to improve coral cover and resilience at tourism sites (Figure 3). Four operators mentioned idealistic motivations associated with their passion for the reef and an opportunity to use restoration as a way to bring awareness to the public (Figure 3). For one operator, the primary motivation was pragmatic, seeing coral restoration as a way to improve the satisfaction of customers (Figure 3).

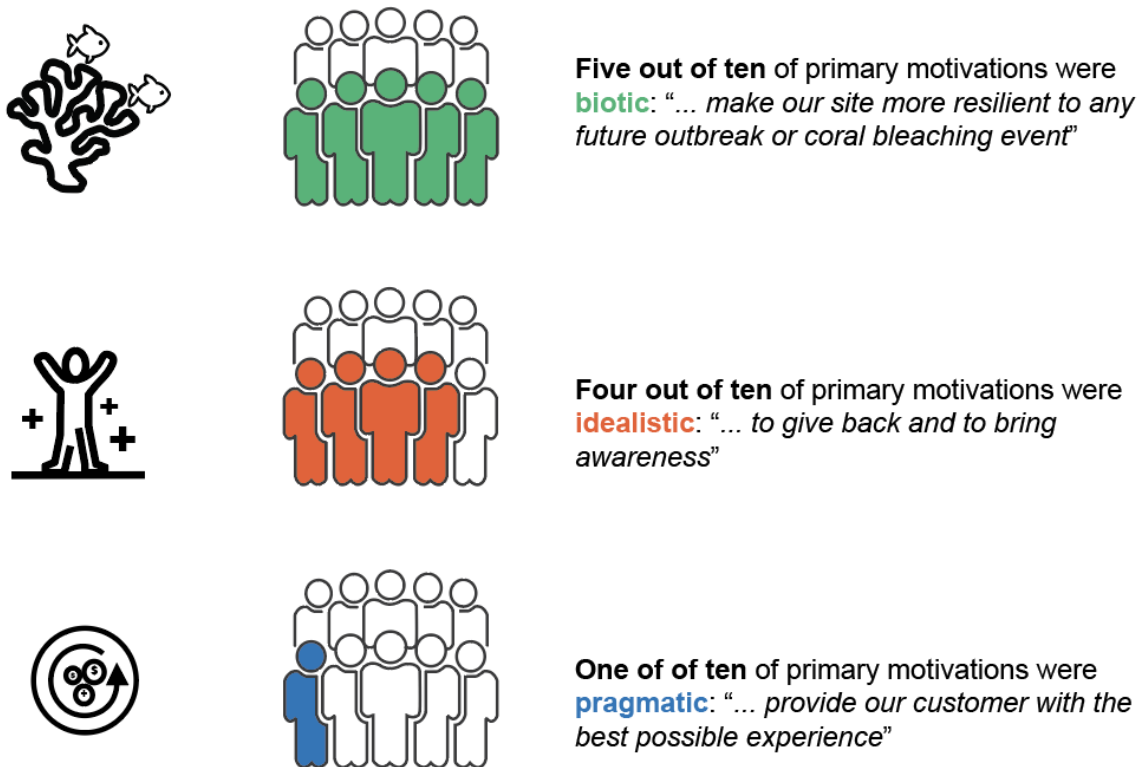


Figure 3: Primary motivations of the ten tourism operators surveyed.

3.2.2 Overall motivations

Overall motivations for getting involved in coral restoration efforts were dominated by idealistic motivations (seven out of ten operators, Figure 4), followed by biotic and pragmatic motivations (five out of ten operators respectively, Figure 4), and heuristic motivations (one operator, Figure 4).

Responses related to idealistic motivations were either linked to the respondents' passion for coral reefs: "We have a sense of not ownership, but for lack of a better word, a sense of looking after the area. So, for me, if I could do something to help, I would."; or their valuing coral restoration as an opportunity for educating the public and fostering awareness: "I'm a big advocate for education and making people appreciate the wild, cause it in turn helps them, motivates them to want to protect it. Then they will know a bit more about it."

Two thirds of responses linked to biotic motivations were related to using coral restoration to improve reef resilience (Figure 4): “...*knowing that a bed of staghorn is going to make so much difference to the communities and anything else that goes on, there is my personal motivation.*” The remaining third of responses focused on coral cover specifically (Figure 4): “*it’s just to improve the live coral cover of the sites we visit*”.

Responses associated with pragmatic motivations were dominated by considerations of the long-term viability of their businesses (Two-third of the operators, Figure 4): “*People come here for nothing else but to swim in the reef, so, if sadly we don’t have the reef here then they would probably lose their business.*”. Other pragmatic considerations included the attractiveness of their business, and the potential to use coral restoration as a way to maximize tourists’ experience: “[*Tourists have*] *High expectations yes. So, we deliver by that*”. Finally, one respondent mentioned heuristic motivations, and the potential to learn from doing and improve the methods used for coral restoration: “...*can also assist with other methods because we are kind of going through all our methods now, we are kind of trying a few things that haven’t been developed before this way*”.

There were no responses correlating to technocratic motivation and only one operator saw coral restoration as heuristic (opportunity for research and experiments).

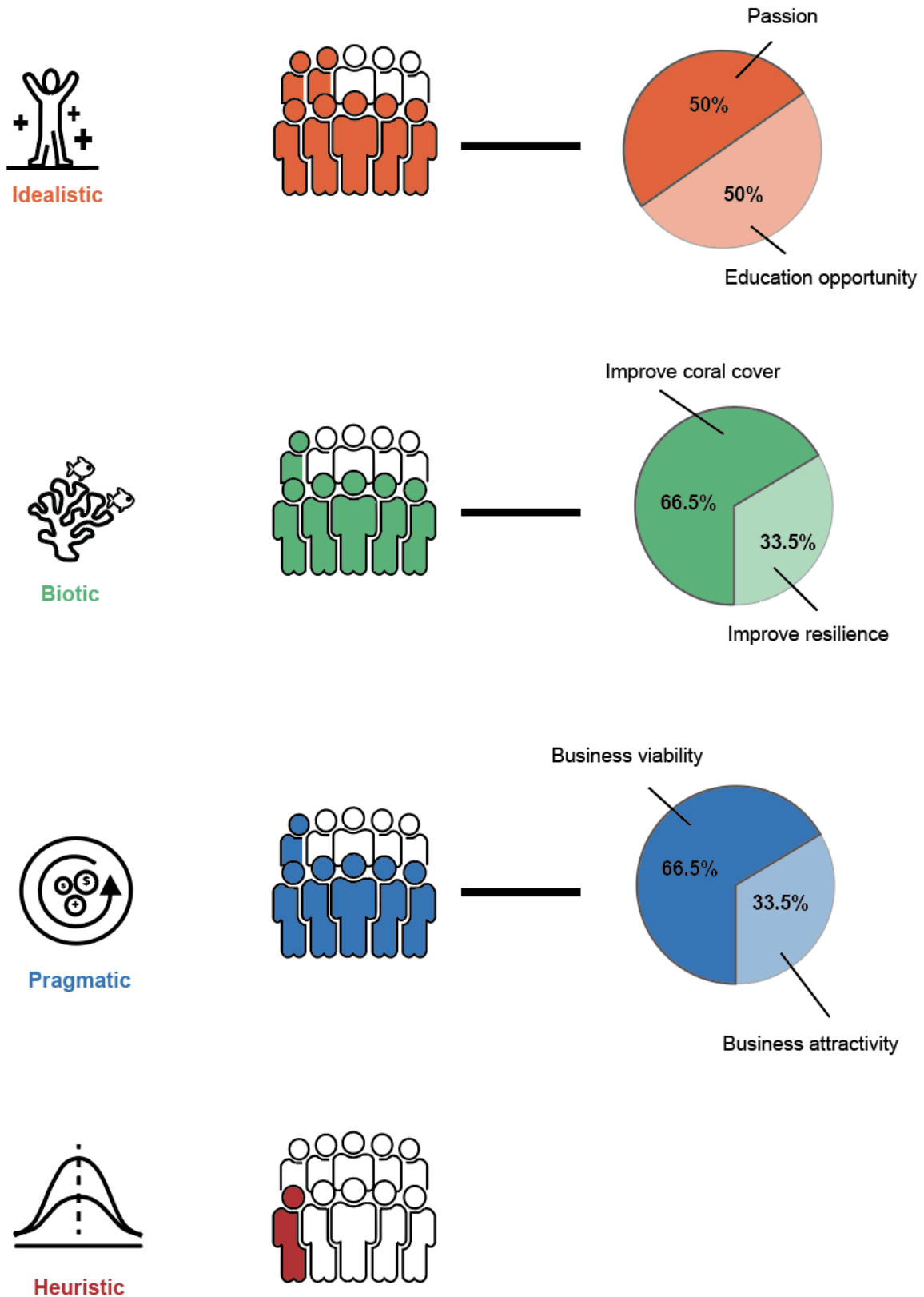


Figure 4: Overall motivations of ten tourism operators on the Great Barrier Reef for getting involved in coral restoration efforts.

3.3 Capacity and key challenges

Tourism operators interviewed for this study brought up three key challenges to implementing coral restoration efforts:

- Regulatory systems and approvals
- Reacting to major weather and climate events
- Risk management and eco-tourism development.

3.3.1 Regulatory challenges

The first key challenge mentioned by the tourism operators was linked to complications arising from the regulatory legislations in the Great Barrier Marine Park. Existing regulatory terms and framework were found to be outdated: *“because [the] marine park authority, the way it’s structured came about in the mid-70s and when it comes to permitting they have a lot of problems changing ...so for this to work GBRMPA has to be on your side and our side, we have to be working in partnership between the managers of the reef, the operators of the reef and the scientists of the reef”*. For some, the time it takes to apply and be granted a permit did not fit well with the demands of the industry and funders. Whilst others saw the existing regulatory and permitting space as overburdened with “red tape”, and others saw the time it takes to get a permit for coral restoration work as too long. Pressures from industry and the regulatory system was a challenge for some of the respondents, with a Cairns tourism operator noting the time pressures on acquiring permits: *“there’s always quite a lot of work in getting permits together so that’s quite challenging”*. Other testimonies reflected on the challenge in balancing the time it took to secure permits and the industry demands for returns on investment. As a Whitsundays’ operator stated *“It takes time to do these things but it’s certainly one of the struggles that we have. Having to get this project up so quickly as well, having that timeframe. If we had two years it would be a lot easier. Other than that, the cost, without the funding I don’t think we would be able to do it”*.

3.3.2 Reacting to major weather and climate events

Of the testimonies given, eight out of the ten operators felt that climate change was a key challenge particularly in connection with the mass bleaching events in 2016 and 2017. Other major weather and climate events such as cyclones or the monsoonal troughs were also mentioned as affecting the capacity of operators to intervene. For example, one operator from the Whitsundays region noted: *“weather was probably the biggest hurdle...Obviously we’ve had a lot of rough weather this year, a few ex-tropical cyclones. Big monsoon up in Townsville that made it quite hard. There were a few days we had planned to go out and we couldn’t get out”*. Similarly, one operator from the Cairns region stated: *“if you have a cyclone come through the area you get a lot of like flipped over coral particularly big plate or tabular corals, and getting back out on the water is also a slow process”*. Uncertainties around the timing and extent of the disturbances was also a challenge affecting their capacity to plan the frequency and success of the interventions. For example, one operator noted: *“you might have years where you don’t get anything for like two or three years and then you have a bleaching event or you have a cyclone and then you’ve got to do a lot”*, and *“you might have another bleaching event in two years and 90% of them [transplanted corals] might die.”*

While climate change was a big concern for many of the operators, it was also presented as an opportunity for tourism operators to discuss the impacts on the ecosystem with tourists.

Dealing with the consequences of climate change on the reef and getting involved with restoration is a way, for some, of facing the key challenge. One operator said that: *“We can eventually create a program where people can actively [be] involved in restoration, they have I guess a sense of belonging and they can probably tackle bigger issues like climate change”*. Similarly, another Cairns operator stated that restoration helped to trigger positive discussion on climate change: *“restoration projects we tend to stick it more towards the end of the day with our little briefs on climate change and how climate change is impacting the reef and we talk about disturbances and resilience and recovery processes and people respond really good”*.

3.3.3 Risk management and eco-tourism development

Risk of damaging the delicate reef ecosystem was another key challenge for many of the operators, whilst acutely aware that any restoration techniques need to be methodologically proven. A Cairns operator said that: *“key challenges with any project is that you don’t want it to be a disturbance itself; you don’t want to impact the ecosystem any more in a negative way. Hopefully your impacts are positive, so that’s always a challenge”*. Operators also noted the need to mitigate risks from restoration, with a few noting that engagement in restoration can be beneficial but also comes with risks of damaging the reef further. Tourism operators were more inclined to be involved when the risk was low and supported by science. For example, one operator noted: *if I think there’s lower environmental risk ...there’s two benefits, one is just to the aesthetics of the site and fish habitats of the site so you get more invertebrates living in live coral, more damselfish, more chromis, more bigger fish because there’s more habitat for the little fish so you get better fish life and better coral”*.

However, the operator warned that too heavy-handed human interaction could be damaging and that although scientists might have a higher risk appetite, the tourism industry was a little more cautious. *“...but the idea is just to have a gentle touch where we do a little bit but work with the natural recovery do it over a very long-term period and we’re doing it at individual sites around the reef and then the connectivity will help, hopefully what we do will help the other areas of the reef by increasing the amount of corals that are actually spawning on that reef”*. Instead of active interventions, some operators felt that eco-responsible tours and education was a better way to go, as one interviewee noted: *“We feel good about doing something useful and our success in the marine park and with our visitation and our eco-tourism it allows us the privilege of trying to do something else locally”*.

Overall, managing risks associated with the active intervention and the potential to further damage both the reef and their businesses were identified as key challenges to implementing coral restoration efforts on the GBR. While operators are motivated to work on projects that are more small scale and related to localised eco-tourism, they seem to push responsibilities for mitigating risks associated with climate change, restoration science and restoration regulations to other groups such as government and the scientific community. Increased collaboration with other groups of stakeholders such as the scientific community or Traditional Owners may spread the risks around and improve the tourism industry’s capacity to further engage in active intervention.

4.0 CONCLUSION AND RECOMMENDATIONS

The involvement of tourism operators in restoration efforts presents a new avenue for increasing the capacity of active intervention on the GBR, as well as a fantastic opportunity to further empower the tourism industry in reef stewardship. Even if the restoration methods described in this study are mostly small-scale and positive impacts are likely to be restricted to each target reef site, these projects represent an important move beyond purely academic-driven projects and an opportunity to collaborate across different stakeholder groups. The ten tourism operators we surveyed engage up to 368,500 visitors a year, representing nearly 20% of all visitors and creating a unique opportunity to engage the general public in active reef stewardship in restoration initiatives and discussions about threats to coral reef ecosystems. It is likely that tourism operators will become key players in improving the capacity for active reef intervention efforts on the GBR.

4.1 Motivations are driven by passion and necessity

Our study found that four main factors drive the involvement in coral restoration:

- Passion for the reef;
- An opportunity to use restoration as an educational tool to communicate about the importance and fragility of the Great Barrier Reef;
- A recognition that coral reef ecosystems are threatened, and that coral restoration can improve coral cover and reef resilience;
- The link between the health of the reef and their business. Tourism operators see restoration as a way to maintain business viability in the future by maximising tourism experiences in the face of past, present and future degradation.

These results strengthen the key role that tourism operators have to play in the recovery of degraded reefs on the GBR. The emphasis on biotic consideration for primary motivations confirms that tourism operators are aware of pressures to the reef and are deeply motivated to actively participate in its protection (Goldberg et al., 2016, Marshall et al. 2017), despite the widely publicised polarised arguments with scientists about the state of the Great Barrier Reef following the two back to back bleaching events in 2016 and 2017 (Hughes et al., 2017; “The Guardian, 2018”). Motivations to use coral restoration as a vector for educating the general public also suggest that the involvement of the tourism industry will facilitate means for implementing societal behavioural changes, strengthen stewardship of reef resources and enhance coral conservation management strategies altogether (Hein et al., 2019). Finally, pragmatic motivations linked to the viability and attractiveness the operators’ businesses further highlight that the success of these restoration efforts is directly linked to their livelihoods. This group of stakeholders is at the frontline of negative impacts to the reef and their engagement in coral restoration efforts is critical to their ability as stakeholders to adapt to how changing climate is re-shaping the GBR, and thus stay afloat and secure their business in the future.

While motivations for setting up coral restoration efforts in Australia would be broadly categorised as “technocratic” with large-scale, multi-agency programs in place such as the Reef Restoration and Adaptation Program (McLeod et al., 2020), tourism operators appeared more focused on setting up their own small-scale projects highlighting a misalignment that may

need to be addressed to better engage stakeholders. Research opportunities, and the potential to improve on existing coral restoration methods was only mentioned by one respondent, highlighting a disconnect between the tourism industry and the scientific community for whom motivations behind coral restoration are still largely experimental (Bayraktarov et al., 2019). As coral restoration efforts ramp up on the GBR, improved collaborations between academics and the tourism industry will be important to increase the efficiency and effectiveness of the methods applied.

4.2 Key challenges need to be addressed

Three key challenges were highlighted by respondents:

- Regulatory systems and approvals
- Uncertainties and challenges linked to weather and climate events, and;
- Risks of doing more damage to both the reef and their businesses.

Challenges linked to regulatory systems and approvals are being addressed by GBRMPA in different stages since 2017. Firstly, the publication of their 'Reef Blueprint' (GBRMPA, 2017) embodied their change of attitude towards active intervention by including specific plans to support active, localised restoration. These were followed by a set of guidelines under the 'Applications for restoration/adaptation projects to improve resilience of habitats in the Great Barrier Reef Marine Park' (October 2018) to provide guidance for coral restoration permit applications (GBRMPA, 2018). More recently, GBRMPA has drafted a new restoration policy for public comment on coral restoration, which is likely to streamline the process of issuing permits for coral restoration projects. Finally, some coral restoration efforts are being spearheaded by GBRMPA itself such as macroalgae removal at Magnetic Island (Ceccarelli *et al.* 2018) and redeploying coral bommies that had been moved into the intertidal environment by extreme weather (McLeod *et al.* 2019). These efforts provide critical risk-analysis opportunities for GBRMPA to further develop guidelines and permitting around restoration.

Other challenges linked to weather and climate events and managing risks are not specific to the tourism industry and overcoming them will be key to improving broader implementations of active intervention strategies on the GBR. In particular, notions of risks linked to uncertainties from future weather and climate events provide opportunities for the scientific community to strengthen their collaborations with tourism operators, and improve the reporting and framing of the goals and expected successes of coral restoration efforts. Strengthening the collaboration between operators and the scientific community would also allow to develop restoration efforts that are based on the best-available science, optimising efficiency and efficacy, therefore reducing the risk of failure. For example, projects more focused on rebuilding reef resilience rather than just repairing damage will likely provide a better return on investment in the future.

4.3 Next steps and recommendations

This study represents a snapshot of attitudes and motivations at the early stages of coral restoration by the tourism industry on the GBR. While there is a huge scope for tourist operators to drive restoration activities, key challenges still need to be overcome to improve their engagement and capacity to intervene. The following recommendations are likely to

improve the capacity of tourism operators to engage in restoration activities as part of local reef stewardship.

- Responsible operators could be formally recognised as stewards and given more support to grow their capacity to intervene. For example, allowing them to control coral predators (crown-of-thorns starfish, or *Drupella sp.*), macroalgae, and marine debris, and restore corals, could further empower them to protect the reefs they use. Support could include intervention training, and research partnerships.
- The permit application process for activities aimed at improving reef health could be streamlined. Once restoration activities have been shown to be low risk they could have a fast-track permitting process. The benefits of activities and the risks of not taking action should be considered during the permit approval process, which has traditionally focused on reducing potential impacts. The monitoring requirements of permit application could be more explicit, with some metrics required for all projects allowing for more direct comparisons of success and unexpected outcomes.
- Further collaborations should be developed between tourist operators, regulators, Traditional Owners and the scientific community. Tourist operators are key players of reef stewardship and are highly motivated to actively intervene to protect the reef in the face of rising pressures. Traditional Owners are key stewards of the GBR and their integration into active intervention strategies such as coral restoration will only strengthen the capacity to address the many threats to the GBR and ensure the integration of local traditional knowledge in project design. Finally, partnering with research would allow a better verification of their impacts as well as the integration of best-available science to maximise efficiency and efficacy of the restoration activities.
- The capacity and needs of the tourism industry should be taken into account when planning large-scale research programs such as the Reef Restoration and Adaptation Program and include the tourism industry in the co-design of intervention strategies when appropriate. Creating a platform of dialogue to better integrate tourist operators in the national and international coral restoration community could be valuable. The newly-formed Coral Restoration Consortium regional group in Australian could provide such a platform.
- Sustainable funding is one of the most common challenges for conservation and restoration projects. New funding models could be explored to further support operators' motivations to intervene without creating further risks to the viability of their business in the future.
- A follow-up of tourism operators' motivations and perspectives will be valuable as the coral restoration industry matures. Understanding the perspectives of operators that do not want to be involved in active intervention would also be valuable.

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APPENDIX 1: INTERVIEW QUESTIONNAIRE

Why do tourism operators become involved in coral restoration activities?

You are invited to take part in a research project about why tourism operators become involved in coral restoration activities. The study is being conducted by TropWATER Researchers and will contribute to the National Environmental Science Program looking at coral restoration's best-practice for the Great Barrier Reef. The aim of the project is to better understand the tourism industry's needs and interests for coral restoration activities. This project does not constitute an audit of the industry's efforts.

You are being invited as you have been identified as a known leader associated with coral restoration projects in the Cairns and Whitsundays regions. You are invited to take part in a research project about why tourism operators become involved in coral restoration activities. The study is being conducted by TropWATER Researchers and will contribute to the National Environmental Science Program looking at coral restoration's best-practice for the Great Barrier Reef. The aim of the project is to better understand the tourism industry's needs and interests for coral restoration activities. This project does not constitute an audit of the industry's efforts.

You are being invited as you have been identified as a known leader associated with coral restoration projects in the Cairns and Whitsundays regions. If you agree to be involved in the study, you will be invited to be interviewed about your views around tourism and restoration efforts. The interview, with your consent, will be audio-taped, and should only take approximately 30min of your time. The interview will be conducted over the phone or through video meetings.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice. Your responses and contact details will be strictly confidential/anonymous. The data from the study will be used in research publications and reports. You will not be identified in any way in these publications. If you know of others that might be interested in this study, can you please pass on this information sheet to them so they may contact us to volunteer for the study.

Interview questionnaire

Section 1: Demographics and background

1. Could you please give me the name of your company and a little bit of background as to what tourism activities you engage in?

Prompts: How long has the company been involved in tourism activities on the GBR? How big is the company (staff, boat, # of tourists/day or year)?

Section 2: Restoration activities

2. What kind of restoration efforts is your company involved in/planning to be involved in?
3. How did that come about? How did you learn about restoration projects on the reef? Were there any other alternatives?
4. What is your motivation for getting involved in a coral restoration project?

Prompt: If more than one motivation are mentioned get them to let you know the primary motivation.

5. In general, can you give me an indication of how the restoration efforts are being funded?

Prompt: Do you receive funding from a government grant, peak body, university collaboration, private or philanthropic funding?

Section 3: Reflections on success and expectations

6. What do you expect from your project/ potential project? What would success look like to you?

Prompt: Can you describe what you see as some of the likely outcomes that you expect from your involvement in reef restoration? Either personally, or for your business, or for the reef?

- 6a. What timeframe are you thinking at for your project to be successful?

7. Alternatively, what would failure would look like to you?

8. What are some challenges you faced in this project?

Prompts: What is the capacity of the tourism industry to engage in this type of activity more widely? Big picture or small scale.

9. How do you think tourists will react/have reacted to reef restoration?

10. What advice or experience would you share with other operators considering this type of work?

11. Finally as a last big picture question- What do you think is going to be the role of reef restoration for the GBR in the next five years?

Prompts/follow up: What would your business, industry, the reef look like in five years without this kind of project?

Ok, I think we have covered everything. Is there anything else you would like to tell me that I haven't covered?

Thank you again for your time and insights. Don't hesitate to get in touch if you have any more questions or thoughts on this subject. Don't hesitate to also let me know if you change your mind and decide that you do not want to be part of this study.

