

An underwater photograph showing a diver in the center, surrounded by vibrant coral reefs. The water is clear and blue, with sunlight filtering through from above. The diver is wearing a mask and a dark wetsuit. The coral is diverse in shape and color, including branching and table corals.

Reef Restoration and Adaptation Program

T1: STAKEHOLDER, TRADITIONAL OWNER AND COMMUNITY ENGAGEMENT ASSESSMENT

A report provided to the Australian Government by the Reef Restoration and Adaptation Program

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1. PREAMBLE

The Great Barrier Reef

Visible from outer space, the Great Barrier Reef is the world's largest living structure and one of the seven natural wonders of the world, with more than 600 coral species and 1600 types of fish. The Reef is of deep cultural value and an important part of Australia's national identity. It underpins industries such as tourism and fishing, contributing more than \$6B a year to the economy and supporting an estimated 64,000 jobs.

Why does the Reef need help?

Despite being one of the best-managed coral reef ecosystems in the world, there is broad scientific consensus that the long-term survival of the Great Barrier Reef is under threat from climate change. This includes increasing sea temperatures leading to coral bleaching, ocean acidification and increasingly frequent and severe weather events. In addition to strong global action to reduce carbon emissions and continued management of local pressures, bold action is needed. Important decisions need to be made about priorities and acceptable risk. Resulting actions must be understood and co-designed by Traditional Owners, Reef stakeholders and the broader community.

What is the Reef Restoration and Adaptation Program?

The Reef Restoration and Adaptation Program (RRAP) is a collaboration of Australia's leading experts aiming to create a suite of innovative and targeted measures to help preserve and restore the Great Barrier Reef. These interventions must have strong potential for positive impact, be socially and culturally acceptable, ecologically sound, ethical and financially responsible. They would be implemented if, when and where it is decided action is needed and only after rigorous assessment and testing.

RRAP is the largest, most comprehensive program of its type in the world; a collaboration of leading experts in reef ecology, water and land management, engineering, innovation and social sciences, drawing on the full breadth of Australian expertise and that from around the world. It aims to strike a balance between minimising risk and maximising opportunity to save Reef species and values.

RRAP is working with Traditional Owners and groups with a stake in the Reef as well as the general public to discuss why these actions are needed and to better understand how these groups see the risks and benefits of proposed interventions. This will help inform planning and prioritisation to ensure the proposed actions meet community expectations.

Coral bleaching is a global issue. The resulting reef restoration technology could be shared for use in other coral reefs worldwide, helping to build Australia's international reputation for innovation.

The \$6M RRAP Concept Feasibility Study identified and prioritised research and development to begin from 2019. The Australian Government allocated a further \$100M for reef restoration and adaptation science as part of the \$443.3M Reef Trust Partnership, through the Great Barrier Reef Foundation, announced in the 2018 Budget. This funding, over five years, will build on the work of the concept feasibility study. RRAP is being progressed by a partnership that includes the Australian Institute of Marine Science, CSIRO, the Great Barrier Reef Foundation, James Cook University, The University of Queensland, Queensland University of Technology, the Great Barrier Reef Marine Park Authority as well as researchers and experts from other organisations.

2. EXECUTIVE SUMMARY

The feasibility and viability of proposed interventions to help preserve and restore the Great Barrier Reef will depend, to a large extent, on their social and cultural acceptability. Increasingly, the principles of responsible research and innovation are creating a global impetus for greater levels of public participation in technology research, development and assessment (Stilgoe et. al., 2013). When participation builds stakeholder and public trust, understanding, and ownership of an initiative, it can lead to increased success or reduced conflict (Reed, 2009). The Reef Restoration and Adaptation Program (RRAP) will need to adopt engagement processes suited to the general public; to place-based or interest-based stakeholders such as reef communities or reef-dependent industries; and, with Indigenous Traditional Owners as rights-holders in, and custodians of, the Reef.

Critical needs of RRAP include understanding the social acceptability (or otherwise) of proposed interventions or specific technologies; assessing how proposed interventions (or non-intervention) may affect the diverse social and cultural values, uses and benefits associated with the Reef; and, identifying appropriate ways to engage different groups and interests in the co-design, deployment and evaluation of proposed interventions or technologies over time.

A national, representative survey of Australian residents, and residents of the Reef region, was undertaken in the concept feasibility study to explore social acceptability of large-scale restoration and adaptation. The survey found the Reef was highly valued and there was a widely held belief society should intervene to help protect and restore the Reef. Survey results indicated the public trusted the science community and the Great Barrier Reef Marine Park Authority to ensure the health of the Reef. Respondents were largely accepting of the idea of active intervention to help restore the Reef. Approximately half the respondents surveyed indicated they were generally accepting of the technologies being investigated by RRAP. A further one-quarter to one-third indicated they were undecided or unsure about these technologies. It is important to note that attitudes about acceptance of interventions can change over time. The early stage of RRAP; the currently hypothetical standing of some technologies; and the limited information available to survey respondents about those technologies, requires a cautious interpretation of these results and ongoing monitoring.

Twenty-four stakeholders were also interviewed to understand their views on proposed interventions. These included representatives of environmental non-government organisations, tourism organisations and local government. They expressed greater uncertainty and concerns about the technologies and identified several risks. Both stakeholders and Traditional Owners strongly asserted that for risks to be managed, and benefits to be realised, meaningful participation and transparency in decision-making and in the R&D process was required throughout any R&D program. There was a widely held view that restoration-based intervention on the Reef was necessary, however, the future credibility of RRAP also depended on governments addressing direct threats to the Reef, such as climate change.

The Reef stakeholder and Traditional Owner engagement context is complex and will continue to evolve over the life of the second phase of RRAP (research and development). Engagement strategies tailored to RRAP R&D needs will require detailed planning, co-design, coordination

and trials, and development of novel models of engagement and techniques to support participation and improve overall program performance.

3. INTRODUCTION, BACKGROUND AND OBJECTIVES

Intervening to build resilience of the Great Barrier Reef is a highly complex and challenging task in technical terms. It also presents complex social and institutional challenges such as:

- Understanding the social acceptability of proposed interventions or specific technologies among the broader community, key rights-holders, stakeholders and interests.
- Assessing how proposed interventions (or non-intervention) are likely to affect the diverse social and cultural values, uses and benefits those groups associate with the Reef.
- Developing appropriate ways to engage different groups and interests in the design, deployment and evaluation of proposed interventions or technologies over time.

This report presents the methods and findings from social research activity under Sub-project PD2 'Stakeholder Engagement and Social Licence' during the RRAP Concept Feasibility Study between December 2017 and January 2019. The sub-project was structured around three main, interrelated themes of investigation outlined in Section 3.2.

3.1 Why involve the public and stakeholders?

Engagement is a broad term that refers to a set of intentions and approaches that one group or entity uses to structure interaction with others about an issue or proposal that is potentially of mutual concern.

It includes a broad suite of activities along a spectrum of participation that differ both in their objectives (outcomes sought from participation) and the degree of power-sharing. These strategies can range between:

- Keeping the public or stakeholders **informed**.
- **Consulting** and seeking input on proposed actions.
- **Involving** stakeholders in the decision-making process and adaptive learning processes.
- **Collaborating** in co-creating decisions and implementing actions.
- **Empowering** the public or stakeholders to co-create decisions.

Each of these different strategies can be appropriate for different contexts, but it is essential to carefully match the chosen strategy to the needs and purpose of the program—and to understand how these relate to community or stakeholder expectations about both the goals and process of participation.

A key reason for engaging interested parties is to build processes that enhance equity, openness, inclusion, shared value and mutual benefits. The focus of engagement activities in environmental management contexts often focuses on three key types or groups of interested parties including:

- **The general public or citizenry:** who may have views and concerns about a proposed course of action but may not be directly, materially affected. For RRAP this includes Australian citizens, broadly, or residents of the Great Barrier Reef region (including the Great Barrier Reef catchment) who may not have a direct or defined interest in the Reef.

- **Stakeholders:** individuals, place-based communities or interest-based groups, who have a more direct material, social or cultural interest in the proposal or its outcomes due to their geographical proximity, political aims, beliefs or attachment, economic or social dependence on the resource-base, or on-going or historical management responsibilities.
- **Rights-holders and custodians:** individuals or organisations who hold legal or custodial rights and obligations related to the resource or environment in question. Indigenous Traditional Owners are a key example of rights-holders in decisions about the Great Barrier Reef and have a different status to stakeholders.

Essentially there are two broad categories of reasons for public participation in the environmental and natural resource management literature—normative and instrumental (see Reed et al., 2009 for a detailed discussion of these issues):

- **Normative reasons** – stakeholders or the public *should* be involved on the basis of their democratic rights. There is a moral or ethical obligation to involve people in decisions and actions that may affect their livelihoods or well-being, and, in doing so, it contributes to addressing needs of procedural and distributional fairness, justice and inclusion.
- **Instrumental reasons** – where involvement is structured to improve the *performance* or effectiveness of the project or program being considered. These include: accessing proximate, local and specialist knowledge from the community; better tailoring of broad programs to local contexts; accessing stakeholder resources and networks; identifying avenues for co-design through collaborative processes; and, reducing opposition or forming the basis for broader social and/or political support for the intervention (i.e. social licence).

It is important to note that normative reasons for stakeholder or public involvement can lead to instrumental outcomes, that is, where participation builds stakeholder and public trust, understanding and ownership of an initiative, it can lead to increased success or reduced conflict (Reed et. al., 2009).

Increasingly the principles of responsible research and innovation are also creating a global impetus for greater levels of public participation in technology research, development and assessment. These include the role of participation in grappling with questions such as:

- How will the risks and benefits of acting/not acting be distributed?
- Who is taking part?
- Who is in control and taking responsibility?
- Why are we doing this, and, what are the alternatives? (Stilgoe et al., 2013).

3.2 Objectives

3.2.1 Objective 1: understanding the dimensions of social risk and social acceptability

This area of work provides insight into how Reef stakeholders, communities and the broader Australian public perceive risk in relation to proposed restoration and adaptation interventions. It also seeks to understand their views on the acceptability of these interventions. It provides an empirical basis for assessing community sentiment towards the Reef and scientific actions therein, and it identifies factors that appear to influence the social acceptability of reef restoration

and adaptation action, in general, and, in particular, of specific technological interventions. This preliminary assessment of how stakeholders and the broader public perceive risk and acceptability is intended to inform the design and roll-out of RRAP R&D in a manner that is sensitive and responsive to the expectations and concerns of communities and stakeholders in reef restoration. The findings point to how researchers might adopt a posture and practice that promotes socially, culturally and ethically responsible innovation (Owen et al., 2013; Stilgoe et al., 2013).

3.2.2 Objective 2: informing the design of public and stakeholder engagement

This provides a synthesis of the research activity to inform investment in, and planning for, public participation and stakeholder engagement under RRAP. The work presented here provides the rationale, foundational principles and identification of lessons from international experience. It also sought to overview the current engagement environment in the Great Barrier Reef management domain, including existing stakeholders, existing engagement processes and forums and identify opportunities for working through these mechanisms or augmenting them.

3.2.3 Objective 3: informing engagement with Traditional Owners and Indigenous peoples

The third component of scoping issues and needs related to the engagement of Indigenous peoples and Traditional Owners. Importantly Traditional Owners hold special rights, interests and responsibilities, thereby having a different status from 'stakeholders' more generally. For this reason, considerations for engaging with Traditional Owners and Indigenous peoples more broadly are largely discussed separately within this report. This component of the work sought to:

- Identify key rights-holders and stakeholders, their values and concerns related to the Great Barrier Reef and proposed interventions.
- Scope and recommend appropriate models and methods for engagement and participation in RRAP.
- Support RRAP to proceed with international best-practice in socially and ethically responsible interventions for building ecosystem resilience.

The findings from these three main themes of work are presented Section 4. The sections below describe the reasons for seeking involvement of stakeholders and Traditional Owners and provide background to concepts and terminology related to social licence, social risk and acceptability used in the report.

4. INDIGENOUS PEOPLES AND TRADITIONAL OWNERS

4.1.1 Indigenous people and the Great Barrier Reef

Indigenous people have been linked with the Great Barrier Reef since time immemorial (CoA, 2018). They are active custodians of their land and sea country (e.g. Nursey-Bray, 2009; Nursey-Bray and Rist, 2009; Maclean et al., 2013; and others). In contemporary times, there is considerable diversity in how Indigenous people are positioned with respect to the Great Barrier Reef, and by extension RRAP specifically.

The most prominent category of Indigenous people comprises the Traditional Owners who have recognised customary connections to identified areas of the Reef. A second category is Indigenous people who reside on or near, and are consistent users of the Reef, but have their primary cultural and custodial connections elsewhere. A third category is the wider population of Indigenous Australia who do not have direct engagement with the Reef on a regular basis but assign considerable importance to it as a natural and cultural asset that requires effective management and protection. The focus of this discussion paper is the first category, Traditional Owners with formal customary connections.

The initial listing of the Great Barrier Reef on the World Heritage List in 1981 was in part because of the legacy of ongoing Indigenous custodianship:

“Human interaction with the natural environment is illustrated by strong ongoing links between Aboriginal and Torres Strait Islanders and their sea-country and includes numerous shell deposits (middens) and fish traps, plus the application of story places and marine totems” (UNESCO World Heritage Centre, 2018).

The associated establishment of the Great Barrier Reef Marine Park Authority Reef Marine Park Authority provided statutory and management structures for realising some key consequences of this recognition. This also builds on more than 20 years’ effort by Traditional Owners from across the Great Barrier Reef to explore and call for a collective approach to achieving their aspirations for ownership, access to, and involvement in the management of sea country. Despite real progress in recognition of their rights, the development of local capacities to govern and manage their sea country, and good engagement by Australian and state governments, there has been no lasting and continually improving Reef-wide approach to engage Traditional Owners (Dale et al, 2015).

A suite of key documents recognise Traditional Ownership and ongoing Indigenous connections to the land-sea country of the Great Barrier Reef. The recent Reef 2050 strategy explicitly acknowledges “Aboriginal and Torres Strait Islander peoples are the Traditional Owners of the Great Barrier Reef area and have a continuing connection to their land and sea country” (CoA, 2015).

The practices of ‘management’ and ‘governance’ are closely related, but important conceptual distinctions can be drawn (Borrini-Feyerabend and Hill, 2015)¹. It is critical that RRAP recognises the Traditional Owners of the Great Barrier Reef as both governors and managers of the Great Barrier Reef *in their own right* and translates that recognition into wider RRAP processes. The unique status of Great Barrier Reef Traditional Owners as Australia’s First Peoples results in expectations that RRAP should accommodate roles for Traditional Owners that are far more significant than just participants in generalised RRAP stakeholder processes. Recognition of Traditional Owner authority and power, and of associated responsibility and accountability, at the governance level will be expected to be complemented by opportunity at the management and operational level.

¹ Borrini-Feyerabend and Hill (2015:171) identify that management focuses on ‘what is done in pursuit of given objectives’ and governance is about ‘who decides what the objectives are’ as well as how those decisions are made and who is accountable for them.

4.1.2 Indigenous worldviews and custodianship

Indigenous custodianship across Australia is underpinned by a world view that recognises the physical, social and spiritual interdependency of ‘people’, ‘country’ and ‘culture’ (Myers, 1991; Peterson and Langton, 1983; Bird Rose, 2000; Thomson, 1972; Williams, 1986). Kinship systems relate people to tracts of country as well as to each other (Thomson, 1972; Maclean et al., 2013). Interconnected place-based knowledge includes the location of land and sea sacred sites, related ceremonies and behaviour taboos associated with particular places, and species (Thomson, 1972; Smyth, 1995). Indigenous people need to interact with country to care for it (e.g. Zurba and Berkes, 2014). This can encompass everyday practices such as hunting and fishing (Thomson, 1939; Smith, 1989), ‘caring for country’ management activities (including co-research activities), and leadership of and involvement in governance for local and regional decision-making.

Such relationships and practices support, and are supported by, a system of Traditional Owner groups and estates. Many² identified Traditional Owner groups have custodial interests to care for their land-sea country across the length of the Reef including: Darnley Island (Erub), Ugar and Masig groups; Murray Island (Mer) groups; Kaurareg; Gudang; Yadhagana; Wuthathi; Kuuku Ya'u; Kanthanumpun; Uutaalgnunu (Night Island) group; Umpila; Angkum; Lama Lama; Paal Paal; Guugu Yimithirr Warra; Ngulan people; Yuku Baja Muliku; Eastern Kuku Yalanji; Wanyurr Majay; Yirriganydji; Gimuy Yidinji; Gurabana Gunggandji; Guru Gulu Gunggandji; Mandingalbai Yidinji; Lower Coastal Yidinji; Mamu; Djiru; Gulnay; Girramay; Bandjin; Warrgamay; Nywaigi; Manbarra; Wulgurukaba; Bindal; Juru; Gia; Ngaro; Yuibera; Dharumbal; Woppaburra; Taribelang Bunda; Bailai; Gooreng; and Gurang (see GBRMPA, 2018). The traditional estates of many of these coastal groups includes land *and* sea, where the marine environment is not seen as a separate domain, and seasonal movement across country was crucial to traditional life (Thomson, 1939; Border, 1999). Seasonal calendars and indicators continue to play a vital role in Indigenous management of land and sea country (c.f. Woodward, 2010).

Indigenous custodial connections are often framed in consultation, planning, and governance documentation as ‘values’ (e.g. Barber and Jackson, 2011; Lyons and Barber, 2018; Maclean et al., 2013, Smyth, 1995). Inter-related social, cultural, historical, spiritual and economic values connect geographically distinct areas (land, freshwater and saltwater country), and associated resources (Border, 1999; Smith, 1989). Values and caring for country interests can have a temporal and seasonal orientation (e.g. Bohnet and Kinjun, 2009) and/or can relate to particular geographically-mobile/dispersed species of significant totemic or wellbeing importance (Smyth, 1995; Maclean and Bana Yarralji Bubu Inc, 2015). Important economic activities such as subsistence fishing can also be a statement of caring for and belonging to country (Smith 1999, Smyth, 1995). Local histories and important local stories (Maclean and Bana Yarralji Bubu Inc., 2015; Maclean and Robinson, 2011; Smyth, 1995) underpin protection of certain sacred sites and cultural practices that in turn relate to the health of particular species and places (Smyth, 1995).

It is important to note the values Indigenous custodians attribute to the Great Barrier Reef, their unique knowledge about the Reef, and experiences caring for the Reef also influence how they constitute ‘risk’, and what constitutes risk to their sea country.

² The exact number given varies between sources, but the contemporary range for the Great Barrier Reef is approximately 40-70 groups. The variations reflect the fact that Indigenous groups can self-identify at larger scales (through such commonalities as shared language) as well as at more specific scales of clan and family groups. Consultation processes will need to account for this internal cultural and linguistic diversity amongst Great Barrier Reef Traditional Owners.

4.2 What is social risk and social licence

4.2.1 Social risk

Risk is generally defined as an estimate of the likelihood and potential consequences of an adverse event. Understanding risk and the effectiveness of mitigation measures allows society to undertake activities that might otherwise be considered unacceptably dangerous or speculative. The importance of scientific or technical estimates of risk notwithstanding, risk should also be understood as social in several important ways relevant to RRAP. Governments and societies that put in place processes and arrangements to effectively assess and manage risk in uncertain situations can also create value for stakeholders and communities of interest.

First, the *acceptability of risk and of actions to mitigate it are always socially determined*. The large scale of proposed interventions for RRAP, the variety of people involved, and the focus on developing novel intervention technologies raises potential for a range of impacts and concerns to shape perceptions of risk and risk acceptability. These perceptions are influenced by institutional and social behaviour, individual values and sources of information (Renn, 2011).

Second, proponents of large projects often conceive of social risk in relation to the potential for controversy over the acceptability of a proposed activity to *delay implementation and increase costs*, consequently undermining project viability and/or cost-effectiveness. The social realm can thus act as a source of risk.

Third, conversely, *activities may present risks to the social realm*, impacting (both negatively and positively) on specific stakeholders or communities. Such impacts include: the distribution or redistribution of values, benefits or harm (Tuana et al., 2012) and the adequacy of compensatory measures for managing redistributions (Svoboda and Irvine, 2014; Shumway et al., 2018; Maas-Hebner, 2014). Moreover, the potential for negative social impacts is likely to influence perceptions of risk acceptability.

Fourth, peoples' *behaviour in relation to potential hazards has a bearing on the objective level of risk* associated with those hazards. The likelihood and consequences of adverse events can, therefore, be amplified or reduced through risk communication, the interpretation of information and by institutional and societal responses (Renn, 2011). Techniques to reduce risk (and its perception) include: communicating risk and mobilising risk culture, involving stakeholders, developing transparency, designing schemes for accountability, flexibility and adaptability in decision-making, budgeting risk management (Florin, 2014).

4.2.2 Social licence

Alongside these considerations of risk management, the development and implementation of novel technologies to help protect and restore the Great Barrier Reef has been accompanied by the idea that successful deployment of these technologies at scale will require a 'social licence' from the Australian public (Lacey & Taylor, 2018). The term, social licence, is most often used to refer to the broad approval or acceptance that communities, the general public, and other stakeholders afford to the development and management of natural resources (Parsons et al., 2014; Moffat et al., 2016). While the term has most recently been used to examine social acceptance of industrial activities that extract natural resources from the environment such as mining, forestry and fishing, it is increasingly being applied to the acceptability of conservation management activities (Kendal & Ford, 2017; Van Putten et al., 2018).

It is well established that public attitudes can influence the level of support, opposition or even ambivalence towards technologies and environmental management decisions, and the importance of involving the public in environmental decision-making from an early stage is well recognised. This is not only to manage potential social conflict but because the complex and uncertain nature of environmental problems frequently demands transparent decision-making that embraces diverse knowledge and values (Colvin et al., 2015). In proposing a series of technical interventions for large-scale reef restoration, understanding public attitudes is not only a pathway to understanding the broad social acceptability of specific reef restoration interventions, it also unlocks a broader range of perspectives on the case for intervention, the suitability for existing engagement arrangements, and preferences for future engagement.

5. METHODS

5.1 Scoping and assessing engagement approaches

5.1.1 Review of international literature on best practice participation

A systematic review of 485 publications concerned with political, social, technical, and technological dimensions of large-scale restoration and adaptation was undertaken between May and September 2018. Publications relevant to the systematic literature review were identified through both keyword-based database searches and recommendations from researchers participating in RRAP and other experts. These keywords were organised against five provisional themes including risk assessment, public participation, restoration and technology, restoration case studies, and assisted adaptation. This search identified 506 potentially relevant publications. Following the removal of duplicates and inaccessible publications, 347 publications were available for analysis. Consultation with high-profile professionals and academics engaged with this literature and with RRAP initiative contributed an additional 138 publications. Overall, 485 papers were included in the systematic literature review. Findings from the review, in terms of critical lessons and insights from earlier experiences, were then synthesised into a set of best practice principles to inform the RRAP R&D Program strategy.

5.1.2 Review of existing engagement structures in the Great Barrier Reef

The preliminary assessment of existing stakeholder engagement structures identified 119 different mechanisms (forums, entities, processes, committees etc.) relevant to stakeholder and citizen involvement in Great Barrier Reef management, restoration and adaptation. These mechanisms were identified through:

- Expert elicitation.
- An internet keyword search.
- Interviews conducted with key stakeholder representatives (see 4.2.2 below).

Desktop research was then used to describe and document the characteristics, composition, function and authority of each engagement mechanism. Based on these characteristics each mechanism was assigned to a category of livelihood, institutional or civil society focused entity. An appraisal of the suitability of these mechanisms to contribute to RRAP R&D Program was then made.

5.1.3 Review of Traditional Owner engagement context in the Great Barrier Reef

A desktop and expert-informed review of existing published scientific and management literature, policies and planning documents was undertaken as the primary method of scoping issues and needs related to the engagement of Indigenous peoples and Traditional Owners relevant to RRAP and Great Barrier Reef management and governance more broadly. The focus of that review document, (a discussion paper prepared by Maclean and Barber and incorporated within this report) is to support, where appropriate, the translation of lessons, principles, practices and/or information from those initiatives into RRAP design phase to minimise the duplication of effort in both program conceptualisation and in its subsequent practical implementation. A related focus is the articulation between existing dedicated Great Barrier Reef Traditional Owner consultation activities/structures and the potential requirements of RRAP. This includes requirements for effective Traditional Owner involvement in RRAP activities focused on that aspect, and the need for strong Traditional Owner participation in RRAP activities that involve wider set of communities or industry stakeholders. A small number of expert advisors including an Indigenous Reef Advisory Committee member, Great Barrier Reef Marine Park Authority policy staff, and researchers working with Traditional Owners in the Reef were consulted in the process of preparing the review and provided advice and input to that documentation.

5.2 Preliminary risk assessment methods

This preliminary assessment of risk and acceptability draws on three research activities: a national survey of Australian and Great Barrier Reef residents; qualitative interviews with stakeholder representatives and key informants; and a sentiment and textual analysis of social media data. The three methods are described briefly below.

5.2.1 Survey of Australian and Great Barrier Reef residents

The survey study was divided into two sub-groups comprising:

1. An Australia-wide study of residents across all states and territories (national sample)
2. A specific sample of residents located within 50km of the Reef (Great Barrier Reef 50km).

An online survey was distributed via a market research company, Taverner Research, to online panels. The market research company also used a social media technique to increase the response rate for those residents living close to the Great Barrier Reef to encourage a larger sample size. After an initial pilot study, the final survey was launched on 7 August 2018 and remained open until 14 September 2018. The national sample used Australian census data to establish quotas (ABS, 2016), while for the Great Barrier Reef sample soft quotas for Queensland were used as a guide. The respondents of the Australia-wide sample were representative of the Australian population based on gender. A total of 2743 useable responses from the national, and 1293 useable responses from the Great Barrier Reef 50km sample were used for the final analysis. Ethics clearance to conduct this survey was obtained through University of Queensland's Research Ethics Committee (ref: 2018001183) with reciprocal approval granted through CSIRO Social Science and Human Research Ethics Committee (ref: 130/18).

5.2.2 Stakeholder interviews

Twenty-four semi-structured qualitative interviews were undertaken with individuals who could offer stakeholder or community-based perspectives on reef restoration and adaptation. These included Chairs or participants in Great Barrier Reef Marine Park Authority advisory committees (Local Marine Advisory Committee, Indigenous Reef Advisory Committee, Tourism Reef Advisory Committee), senior state government program and policy managers in water quality and fisheries, Great Barrier Reef Marine Park Authority managers, environmental and reef related non-government organisations with interests in conservation and citizen science, tourism—including marine tourism—industry representatives, recreational fishing representatives, marine tourism operators, senior local government staff, elected officials in Reef catchments and peak-body representatives. The interviews were conducted between May and August 2018. Interviews were generally 45-90 minutes long. Audio recordings and handwritten notes were taken during the interviews. These notes and recordings were transcribed, and analysed using a mix of inductive and deductive coding strategies. Ethics clearance to conduct these confidential research interviews was obtained through CSIRO Social Science and Human Research Ethics Committee (ref: 043/18) and reciprocal approval granted through QUT Research Ethics Committee (ref: 1800000362).

5.2.3 Social media sentiment and textual analysis

The social media data was gathered through two sampling processes: first, a global media scrape of tweets and; second, tweets sent from within the Great Barrier Reef region defined by longitude and latitude. Tweets were collected between June 2017 and June 2018. This timeline included a Queensland State government election, on-going restoration projects (non-RRAP related) and the launch of RRAP. Twitter as a social media platform was chosen for three reasons: it is common globally; it is a platform used as part of policy debates, politics and journalism in Australia (Jericho, 2012); and, the open public platform allows for greater data gathering. Data were collected using hashtags #Great Barrier Reef and #GreatBarrierReef, from within the Great Barrier Reef geographical boundaries and globally (n=9,323,946). A set of restoration and adaptation keywords filtered out further tweets. Non-English language tweets and those tweets that carried the hashtag #Great Barrier Reef but were unrelated to Reef issues were excluded. A sentiment analysis using Python-based software Vader was applied. A social network analysis was conducted to identify key drivers and influencers around communicating risk. A final sample of 6244 tweets were usable in the Great Barrier Reef region, and 28,288 tweets from the Great Barrier Reef globally.

6. FINDINGS

6.1 Social risk assessment and social acceptance

6.1.1 Perceptions of Reef value, threats and response options

To understand how Australians view a range of issues pertaining to the Great Barrier Reef in both national and local contexts, survey respondents were asked to rate their level of agreement with a variety of statements about the Reef on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree), with 4 being neutral. The Reef was highly valued by respondents with approximately 89 percent agreeing that it was both an important national asset and provided an important habitat for fish and other species. Further, 89 percent believed the Reef supported a strong tourism industry. These findings are broadly consistent with other recent national surveys assessing public attitudes towards the Reef and its values.

6.1.2 Perceived threats and risks to the Great Barrier Reef

When assessing threats and risks to the Great Barrier Reef, most respondents expressed concern about the current condition of the Reef. The highest overall threats were identified as the impact of environmental pests and climate change. Respondents were also asked to assess the negative impact of industries operating in the region on the health of the Great Barrier Reef. Mining and shipping were identified as having the highest perceived negative impacts on the Great Barrier Reef. A total of 76 percent of the combined samples agreed the loss of the Great Barrier Reef would devastate the national economy.

Small differences were evident between the national and Great Barrier Reef samples. Across all measures of perceived industry impact, for example, the national sample expressed slightly higher levels of concern than the Great Barrier Reef sample. By contrast, the Great Barrier Reef sample rated the threat of environmental pests a little higher than did the national sample. Care should be taken in the interpretation of these differences given their small magnitude and the possibility that further analysis will reveal higher levels of variability within each of the samples than between them.

Approximately 84 percent of respondents agreed that more should be done to save the Reef. Table 1 summarises all perceived threats and risks to the Great Barrier Reef by national and Great Barrier Reef samples, and for the overall Australian population (i.e. combined samples).

Table 1: Mean scores for perceived threats and risks to the Great Barrier Reef in Australia overall, and by geographic samples (local and national).

Perceived threats and risks	National	Great Barrier Reef (50km)	Overall
		4.98	5.03
I am concerned about the environmental condition of the Great Barrier Reef.	5.53	5.44	5.50
Environmental pests are negatively affecting the health of the Great Barrier Reef (i.e. Crown-of-thorns starfish).	5.45	5.57	5.49
The loss of the Great Barrier Reef would devastate the national economy.	5.40	5.53	5.44
I worry that the Great Barrier Reef will cease to exist for future generations.	5.48	5.21	5.39
Climate change is negatively affecting the health of the Great Barrier Reef.	5.37	5.25	5.33
The mining industry is negatively affecting the health of the Great Barrier Reef.	5.20	4.94	5.12
Shipping is negatively affecting the health of the Great Barrier Reef	5.19	4.92	5.11
The agricultural industry is negatively affecting the health of the Great Barrier Reef.	4.91	4.79	4.88
The tourism industry is negatively affecting the health of the Great Barrier Reef.	4.68	4.47	4.61
The declining health of the Great Barrier Reef will negatively impact me.	4.47	4.85	4.59
The community I live in is too dependent on the Great Barrier Reef.	3.16	4.36	3.55
Considering the potential values of and threats to the Great Barrier Reef, more should be done to save it.	5.91	5.69	5.84

Notes: Analysis of variance (ANOVA) was applied to examine whether the means of three or more groups were different. Bolded mean scores are significantly different from other sample with green highlighting high scores. Rated on scale from 1 (strongly disagree) to 7 (strongly agree). Midpoint = 4 (neither agree/disagree).

Interviews with stakeholders highlighted the threat of stressors such as climate change or water quality to the Reef was widely recognised as high or extreme, and the need for urgent action was understood and well accepted. There was less consensus amongst stakeholders on what the priority for action (mitigation or restoration) should be however, or, where on the Reef, and for what purpose restoration should be undertaken. The social media analysis also identified climate change, mining and land clearing as key threats to the Great Barrier Reef. Social media data showed there was a risk and disaster narrative around climate change, bleaching and mining relating to the Reef which is consistent with previous studies that identify media coverage of the environment and the Reef as framed within a disaster discourse. Mentions of climate change and bleaching, and/or climate change and mining had the highest negative sentiment. Where this is linked to mentions about interventions there is also a negative sentiment present. This has potential implications for how information about specific interventions are communicated.

Tweets from within the Great Barrier Reef region focus on the key threats mentioned above and are heavily influenced by negative sentiment. The highest concentration of negative tweets was focusing on bleaching (16.2 percent), lack of government action (including state and federal) 7.9 percent and mining 4.2 percent, and then ecology of corals 3.7 percent. Globally the overall negative sentiment had a much greater focus on ecology with 'corals' 13.4 percent, 'changing

environment' 7.4 percent, climate change 6.8 percent and the iconic visitation value of the Reef of 5.6 percent, and 'dying' at 5.3 percent.

6.1.3 Perceptions about management and research in the Great Barrier Reef

Respondents were asked about current and future management of the Great Barrier Reef. There were a high number of neutral responses (22-24 percent) suggesting a degree of uncertainty or ambivalence about the management of the Reef (i.e. the midpoint of the scale reflects a position of "neither agree nor disagree"). Table 2 shows that respondents within the Reef catchment were, on average, somewhat more satisfied, confident and optimistic about the future of the Reef than the national sample. However, responses for both samples were clustered around the midpoint (4 on the seven-point scale).

These data show that although opinions on the current or future management of the Reef were mixed, overall, respondents felt scientific research could help. These results should be considered in the context of negative media coverage of national funding arrangements for Reef management and research during the data collection period.

Table 2: Mean score about perceptions of Great Barrier Reef management and research in Australia overall, and by geographic samples (local and national).

Management and research in the Great Barrier Reef	National	GBR (50km)	Overall
	4.73	4.93	4.79
I feel confident that the Great Barrier Reef is well managed.	4.12	4.42	4.22
I feel optimistic about the future of the Great Barrier Reef.	4.39	4.75	4.51
I think enough is being done to effectively manage the Great Barrier Reef.	3.60	4.06	3.75
Scientific research can provide solutions to help repair the damage to the Great Barrier Reef.	5.39	5.45	5.41
Scientific research can provide solutions to help prevent damage to the Great Barrier Reef.	5.43	5.47	5.45
More research funding is required to examine solutions to help the Great Barrier Reef.	5.45	5.42	5.44

Notes: Analysis of variance (ANOVA) was applied to examine whether the means of three or more groups were different. Bolded mean scores are significantly different from other sample with green highlighting high scores. Rated on scale from 1 (strongly disagree) to 7 (strongly agree). Midpoint = 4 (neither agree/disagree).

Stakeholder interviews indicated there was strong support for an evidence-based, scientifically informed approach to restoration and adaptation on the Reef. However, stakeholders strongly cautioned against over-emphasis on a costly and misguided 'technical-fix' at the expense of a more holistic (threat reduction) and community-engaged approach. These sentiments about the relative importance of threat reduction (i.e. action on greenhouse gas emissions and marine water quality) compared with large-scale restoration align with the survey results, below.

6.1.4 A role for restoration and adaptation interventions in the Great Barrier Reef

Respondents were asked about the role of human intervention and their beliefs about restoration of the Reef. Table 3 shows the range and scale of interventions that were presented to respondents. Small variations were detected across these general restoration approaches with the prevention of threats to slow the rate of damage and improve the current condition of the Reef rated as slightly higher priorities by respondents. Although large-scale restoration of the Reef

received the lowest support of the range of options presented, it was supported by 71 percent of survey respondents overall. Action to increase the resilience of the Reef to future threats was supported by 79 percent of respondents.

Some differences can be observed between the samples (Table 3), with the Reef sample slightly less supportive of large-scale restoration projects and slightly less opposed to the alternative strategy of doing nothing. Indeed, 69 percent of respondents rejected the sentiment that nothing should be done to repair the Great Barrier Reef.

Table 3: Mean score for beliefs about restoration of the Great Barrier Reef in Australia overall, and by geographic samples (local and national).

	National	GBR (50km)	Overall
Beliefs about intervention	5.48	5.31	5.43
Society should try and prevent threats to the reef in order to slow the rate of damage/degradation.	5.78	5.70	5.76
Society should try and prevent current threats to the reef to improve its current condition.	5.76	5.68	5.73
Society should try and repair the most degraded parts of the Great Barrier Reef through local restoration projects.	5.58	5.43	5.53
Society should try to increase the resilience of the Great Barrier Reef to future threats.	5.53	5.47	5.51
Society should try and repair all of the Great Barrier Reef through large-scale restoration projects.	5.33	5.04	5.24
Society should do nothing: The Great Barrier Reef is a natural system and we should not intervene in any way.	3.10	3.44	3.21

Notes: Analysis of variance (ANOVA) was applied to examine whether the means of three or more groups were different. Bolded mean scores are significantly different from other sample with green highlighting high scores. Rated on scale from 1 (strongly disagree) to 7 (strongly agree). Midpoint = 4 (neither agree/disagree).

Respondents were asked to what extent they would support actions (unspecified) to restore the Great Barrier Reef. The results show respondents were generally accepting of restoration of the Great Barrier Reef (*Mean scores = 5.39-5.44*), with similar patterns in response between the national and Great Barrier Reef 50km sample (*Mean score = 4.95* compared to *Mean score = 4.64*). Figure 1 shows the level of acceptance of general reef restoration of the Reef.

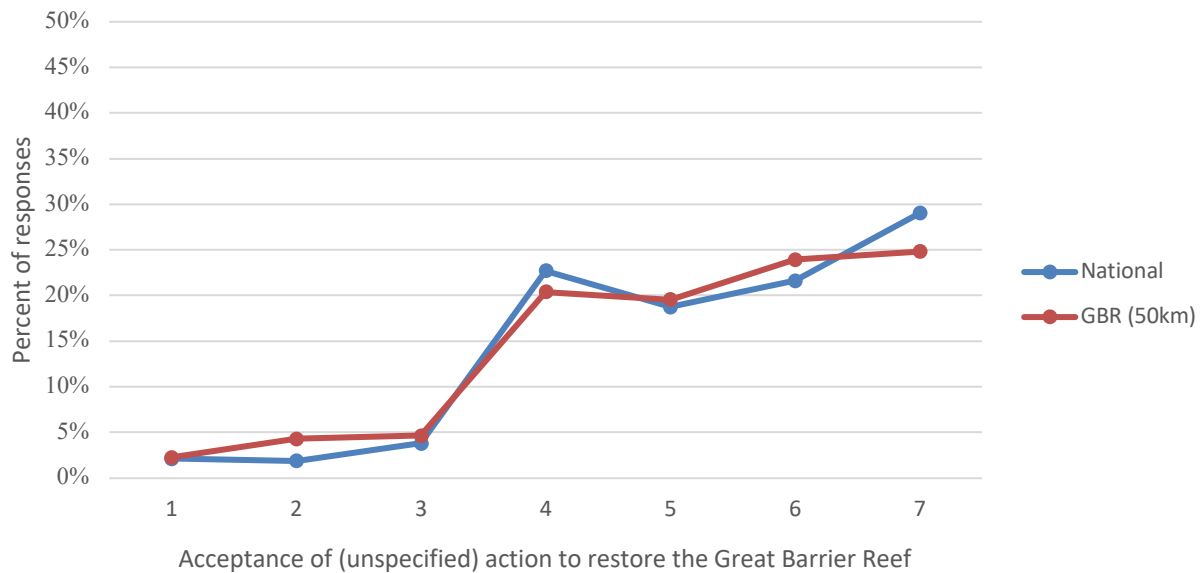


Figure 1: Acceptance of actions to restore the Great Barrier Reef, by geographic samples (Great Barrier Reef and national).

Note: X axis - Level of acceptance (tolerate, accept, approve and embrace) with rated scale from 1 (Not at all) to 7 (Very much so), midpoint (Somewhat) = 4. Y axis: response percentages from each total number of group data (National and Great Barrier Reef 50km).

The analysis of Twitter data (described in 4.2.3) adds some further information towards understanding sentiment towards restoration amongst different populations. That is, tweets outside the Great Barrier Reef region had a positive sentiment towards innovation and restoration science. However, tweets within the Great Barrier Reef region reflect a more negative sentiment, driven by a focus on bleaching and mining. Almost 50 percent of the ‘within Reef region’ tweets referred to bleaching, despite the sample taken outside of the consecutive bleaching of 2016 and 2017 with less focus on restoration and adaption science, and more emphasis on recovery and protection.

The in-depth qualitative interviews (described in 4.2.2) also added another dimension to understanding patterns or issues with broad acceptance of restoration on the Reef. Among stakeholders interviewed, there was generally strong motivation to be engaged in Reef protection or restoration measures, and, a belief that broader public support could be mobilised around these goals. However, this view was counter-balanced by generally low levels of trust in government motives behind RRAP and in the political level decision-making processes. This has created some cynicism towards restoration, which in the early stages of RRAP was compounded by generally low level of awareness (and perceived transparency) of the program and its intentions. Issues around the role of trust in social acceptance are discussed in detail later in the report.

6.1.5 Perceptions of specific reef restoration and adaptation interventions

In order to move beyond generalised beliefs about human intervention in managing the Reef and to better understand the nature of the support that existed for reef restoration, the national survey was designed to explore public attitudes toward more specific restoration and adaptation approaches and technologies.

Eight scenarios were used in the survey to examine if any differences in attitudes and support existed across these eight approaches and technologies. There are relatively few studies that provide such comparison across technologies (Burns et al., 2016) and we were interested to begin to develop a baseline understanding of how the public perceives and responds to a range of reef restoration and adaptation approaches and technologies. The descriptions of each restoration approach tested in the national survey are included as Appendix D. The eight approaches and technologies were:

- Increased shading using surface films.
- Increased shading using cloud brightening.
- Increasing heat resistance of corals using natural breeding techniques.
- Increasing heat resistance of corals using genetic modification.
- Infrastructure solutions such as rubble stabilisation.
- Infrastructure solutions such as human-made reef structures.
- Pest control using biological agents.
- Pest control using manual removal.

Because the survey presented detailed descriptions of a range of technologies to a largely non-scientific audience, we tested for potential bias in our framing. Overall, the majority of respondents indicated that the descriptions were framed neutrally (69.4 percent). However, 23 percent thought the summaries were biased in favour of the approach/technology and 7.4 percent felt they were biased against the approach/technology described. There was no difference in perceived bias across the eight intervention descriptions.

6.1.6 Emotional responses to interventions

Respondents were asked to rate their emotional responses to the single technology scenario they received for a series of positive and negative emotions on a Likert scale from 1 (not at all) to 7 (very much so) with the midpoint of 4 indicating that they “somewhat” experience that emotion when considering the technology. The results in Figure 2 show that overall, positive emotions were stronger than negative emotions. Stronger positive emotions in order of importance were: hopeful, happy and confident. It should be noted that the emotion ‘cautious’ (a fear-based emotion) was rated similarly to positive emotions. Worried and powerless were other salient negative emotions but not as strong as positive emotions.

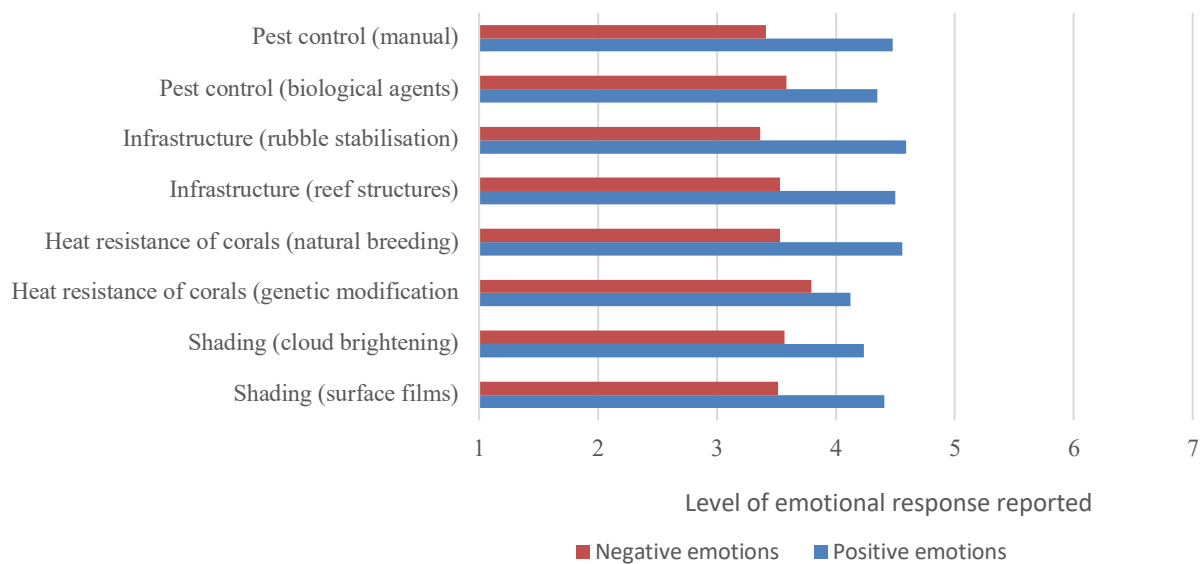


Figure 2: Overall emotional responses to Reef restoration interventions (combined sample).
 Note: x-axis scale (1 = does “not at all” feel a positive/negative emotion, 4 = somewhat feels a positive/negative emotion, and 7 = “Very much” feels a positive/negative emotion).

6.1.7 Acceptance of reef interventions

Respondents were asked to what extent they accepted or rejected the reef restoration and adaptation interventions presented to them. Figure 3 summarises the level of overall acceptance for the eight reef restoration interventions by the national and Great Barrier Reef samples. On this scale, respondents were asked to rate their level of acceptance of a specific proposed intervention (one of the eight scenarios described above and in Appendix D of this report) from 1 (not at all) to 7 (very much so) with the midpoint of 4 indicating they were “somewhat accepting”.

The results across all eight interventions indicated a moderate-strong tendency toward acceptance in both national and Great Barrier Reef populations. However, importantly, many respondents also indicated they were unsure or ambivalent at this stage (with responses clustering around 4 on the scale). Outright rejection for each proposed intervention was low with only 12-14 percent of respondents indicating strong or moderate levels of opposition.

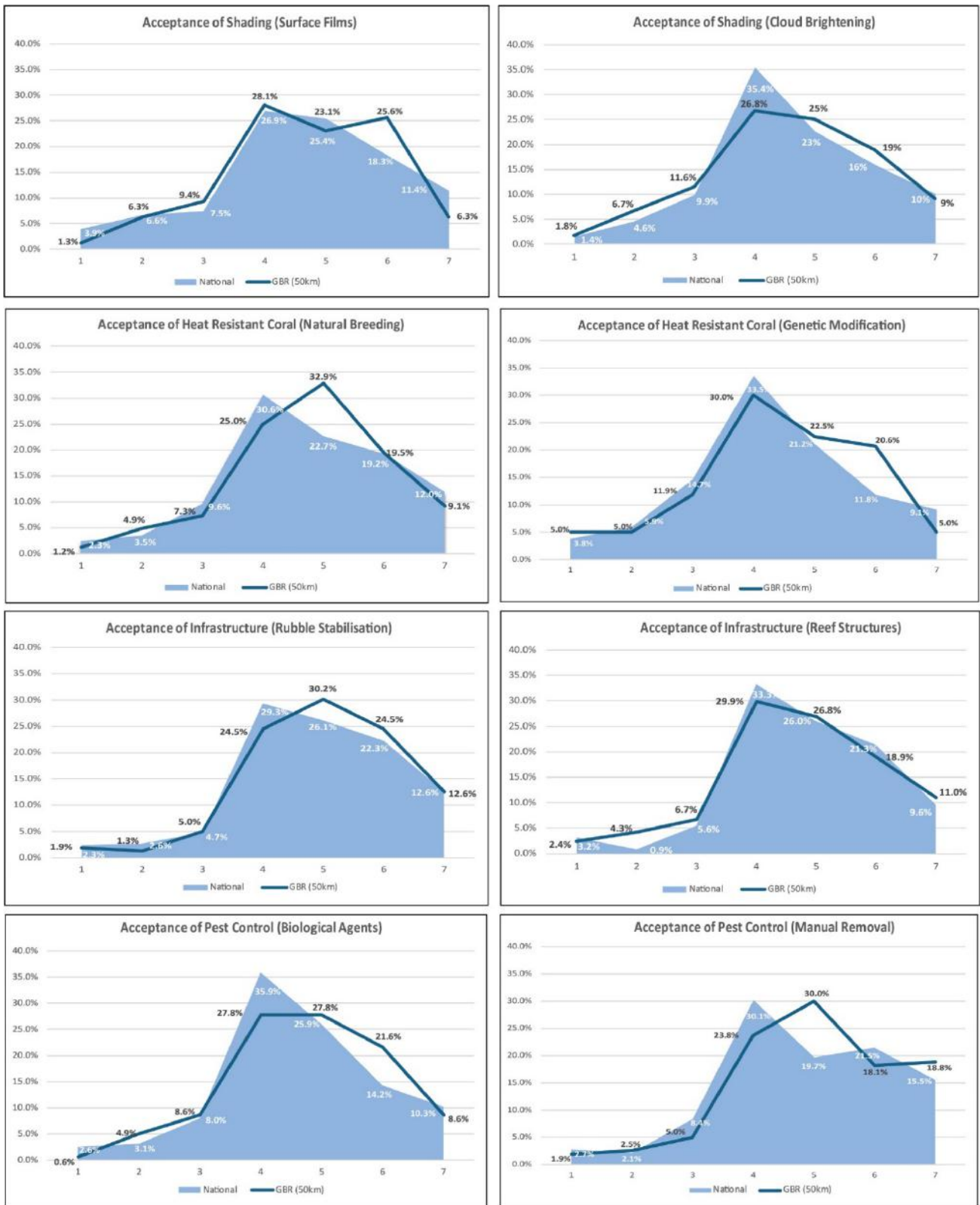
The result of analysis of variance (ANOVA) test demonstrated statistically significant differences between national and Great Barrier Reef samples were evident only in relation to pest control (manual removal) and rubble stabilisation. In both cases, rejection rates were similar but respondents from the Great Barrier Reef sample were less likely to provide a neutral response (neither rejecting nor accepting) compared with the national sample, perhaps due to more familiarity with these interventions.

Across the eight approaches/technologies tested in the survey, genetically modified heat-resistant corals and shading options (cloud brightening and surface films) attracted higher levels of opposition than technologies such as rubble stabilisation and pest control (manual removal). Such variation can likely be explained by the fact manual removal of pests such as crown-of-thorns starfish is an existing and familiar part of the Great Barrier Reef management regime. Rubble stabilisation, meanwhile, may be perceived as less of a threat to the ‘natural’ state of the Reef, easier to understand, and less likely to generate unintended environmental impacts.

However, given that genetic modification and climate geoengineering have generated considerable conflict in other contexts, it is notable that levels of opposition detected in this survey were low – a consequence, perhaps, of the ‘public good’ nature of reef adaptation interventions.

In sum, a range of factors such as familiarity with interventions, their complexity, their perceived naturalness and riskiness, and proposed timelines for deployment may all have an influence on acceptance and on relevant strategies for engagement and communication. The results presented here suggest that while there is no existing or entrenched opposition to these reef restoration interventions currently evident in general national or Great Barrier Reef populations, it will be essential to think about how the planned public and stakeholder engagement can continue to explore issues of acceptance around restoration options.

Results from the survey suggest, at face value, there is strong in-principle public support for science-based action to restore the reef, and on average, cautious support for specific interventions. There are some important caveats. First, from other studies of social acceptance we have learnt that attitudes can and do shift over time as intervention moves from being a hypothetical possibility to a material reality. Second, attitudes can shift as the public learns more about the interventions proposed, and to date, RRAP has undertaken limited public outreach on specific interventions. Third, respondents only had the opportunity to respond to a specific technology (scenario) rather than comparing the full suite of interventions. Last, the analysis to date examines responses from large samples of the general public and reef residents; this may mask the views of specific but important groups in the population such as Indigenous communities or vulnerable communities. Further analysis of the data is planned to address this and other gaps.



X axis: Level of acceptance or rejection with rated scale from 1 (not at all) to 7 (very much so), midpoint = 4.
 Y axis: response percentages from each total number of group data (National and GBR_50km).

Figure 3: Acceptance of specific reef restoration interventions by geographic samples (local and national).

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Respondents were also asked to identify the potential benefits and risks they associated with each of the reef restoration interventions. In making these more detailed assessments, the individual responses show a high level of uncertainty based on the large number of neutral responses provided (between 25 and 36 percent neutrality for each intervention). This indicates that while respondents appeared somewhat accepting of reef restoration interventions at this early stage, their views may change as they become more aware of potential risks and benefits associated with each of those interventions over time, or, as they are exposed to debate over risks and benefits as it emerges in the media or political spheres.

Figure 4 shows the two interventions perceived to have more benefits than risks were infrastructure (rubble stabilisation) and pest control (manual removal), while the three interventions perceived to have more risks than benefits were shading (surface films), shading (cloud brightening) and heat resistance coral (genetic modification). Respondents felt there were more risks associated with using genetic modification to develop heat resistant corals while proposed shading interventions such as surface films and cloud brightening also raised some concerns, although respondents thought negative impacts could be reversed. The three interventions in the centre did not vary much compared with others. Only a small number of differences were found. There was less certainty about potential risks and benefits regarding the naturally heat resistant corals and reef structures. These are very preliminary results and should be regarded as indicative only, subject to further analysis.

While strong and distinct clusters of intervention types did not emerge from this analysis³, the results provide a very preliminary indication of which interventions were perceived to have more benefits, which interventions were perceived to have more risks, and which interventions were perceived not to demonstrate a strong variance toward either risks or benefits at this stage, based on the scenarios presented in the national survey.

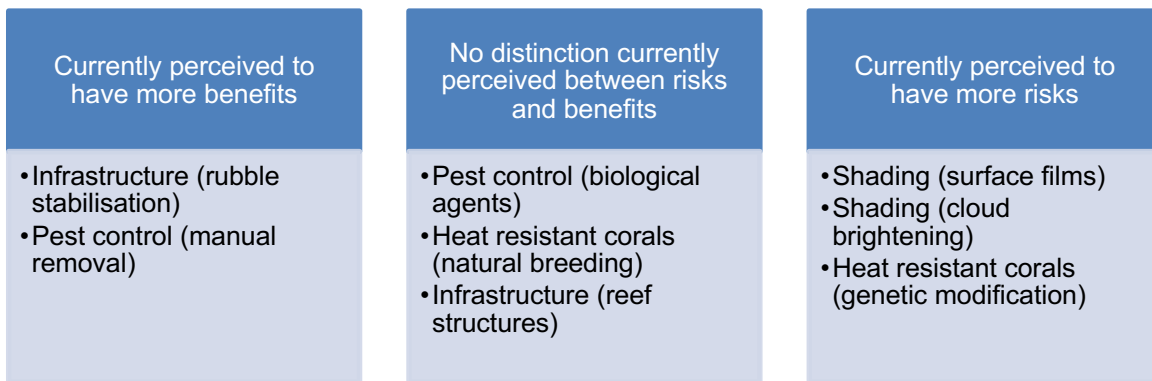


Figure 4: Summary of perceived differences in benefits and risks emerging across the range of reef restoration interventions.

Generally, stakeholders interviewed said they had low, or at best, mixed or partial knowledge about the specific technologies or interventions being scoped in RRAP. As such, their capacity to differentiate between types of interventions (beyond biological and physical/engineering distinctions) or the scales at which these may be deployed (local, Great Barrier Reef-wide) was

³ These differences are from a MANOVA analysis, which allows for the testing of both dependent and independent variables at the same time. This avoids Type 1 errors commonly found in ANOVA tests. Post hoc testing allowed for differences to be identified across intervention types and these differences are summarised in the table.

generally low. Stakeholders also believed the likely effectiveness of many interventions was uncertain or low with considerable scepticism about potential ecological benefits⁴.

Perceptions about specific risks of intervention-types described in the interviews with stakeholders included:

- Ecological risks associated with **coral breeding** and translocation strategies included the inadvertent creation of monocultures (and the possible loss of biodiversity or natural resilience), the potential for creating new pest species, changing patterns of interaction between species, negative consequences for the food web (ecological and human consumption), and, the irreversibility of these changes. This suite of interventions was generally considered high risk/high effectiveness. This strategy raises potentially significant concerns of cultural acceptability for Traditional Owners.
- Concerns about **solar radiation management** type interventions (marine cloud brightening; surface films) included potential for negative changes to local marine-atmosphere (weather) interactions; and 'residues' from surface films in the marine environment. Interviewees generally considered the effectiveness of these interventions to be unknown or low-moderate at best and the perceived severity of risks as unknown. Some interviewees raised concerns about extending the risks from the marine into the atmospheric environment.
- Introduction of **new structures** (for coral substrate or pontoons or structures to support solar radiation management) raised concerns about marine safety (if structures were to detach and move or obstruct use of the marine environment) and aesthetics for dive tour operators. Structures that provide habitat or fish-aggregating functions are likely to be seen favourably by fishers. Other marine tourism operators believed that additional 'gear' in the marine environment would provide positive interpretative opportunities for the industry. Effectiveness of these types of intervention were perceived as low-moderate and risks were seen as localised, generally low or unknown.

Interviews also identified social and psychological risks including concern about potential future distributional outcomes:

- Impacts (positive and negative) of intervention on individual and community **well-being**.
- People expressed **moral confliction** about proposed restoration actions.
- The possibility of **exclusion** from participation and decision-making (among the public, stakeholders and rightsholders, particularly Traditional Owners).
- Low degree of **observability** (of action) and high levels of **uncertainty** (of outcomes).
- Changes to property, **access and use rights and/or benefit flows** from restoration sites and from changed future reef condition.

On the final point above, several reef-dependent industry representatives described the potential for **spatial displacement of economic activity** (tourism, marine tourism, fisheries) at small and larger scales over time as a result of continuing decline of reef health or increase in bleaching events. While local impacts of this scenario were acknowledged, a general view existed that these sectors could be responsive if appropriate institutional conditions (permitting or access arrangements) could be developed to increase flexibility for reef users and dependent industries to deal with potentially increasing **spatial and temporal variability** in Reef condition and values under both intervention and non-intervention futures.

The limited social media data available in the Great Barrier Reef region that specifically related to types of interventions indicated there was negative sentiment associated with surface film (called 'sunscreen') when discussed in the context of beaching (-0.3)⁵ yet without the association with bleaching, the sentiment is positive (e.g. 0.49 and 0.36). 'Genetically modified' had small positive sentiment (average 0.15) outside the Reef region, but a high negative sentiment in the region. Equally, the term 'genetic diversity' had a positive sentiment both inside and outside the Great Barrier Reef, although a low average of 0.05 sentiment.

Sentiment analysis suggested risk perception, as expressed through social media, was lower when the language about interventions was simple, tangible and distant from threats of climate change, bleaching and mining. Where assisted gene flow technologies were described using terms such as 'coral sex', 'coral IVF' and 'coral babies', for example, they attracted positive sentiment (> 0.645). Equally, coral gardening had a positive sentiment of 0.57 in the Reef region. The data showed a large spike in support for assisted gene flow related work in November 2017 during spawning time, but also when Professor Peter Harrison conducted research on Heron Island. Solar radiation management projects such as surface films had a mixed sentiment response: a mix of optimistic caution and some negativity. Coral gardening was seen as a positive action, both inside and outside the Great Barrier Reef.

6.1.8 Factors influencing social acceptance

Previous studies of large-scale development projects involving technologies unfamiliar to the public have identified several factors influential in shaping social acceptance of those technologies. These include: the expected positive and negative impact of the development or action; the level of trust and confidence in regulators and managers to provide oversight; procedural fairness in how decisions are made and how diverse perspectives are represented; and distributional fairness in how risks and benefits are shared across the population and the landscape. Our national survey examined several of these factors relating to the management of the Great Barrier Reef and deploying interventions for reef restoration.

Broad public acceptance of development activities is often linked to the level of public trust and confidence in an organisation's ability to 'do the right thing' (Morrison, 2014; Parsons et al., 2014). We asked respondents to rate their level of trust (on a seven-point Likert scale from strongly disagree to strongly agree) in a range of important organisations involved in managing the Great Barrier Reef and specifically in reef restoration. This included: the federal and Queensland governments, the Great Barrier Reef Marine Park Authority, international agencies (such as UNESCO and United National Environment Programme), non-government organisations (NGOs), and scientific research institutions (such as CSIRO, AIMS and universities). Figure 5 shows public trust in these organisations is variable. Scientific research

⁵ Sentiment scores range from +1.0 to -1.0. Positive scores indicate the strength of the positive sentiment, negative scores the strength of the negative sentiment.

institutions were most trusted, followed by the Great Barrier Reef Marine Park Authority, then Australian non-governmental organisations and international agencies, followed by the Queensland Government and Australian Government.

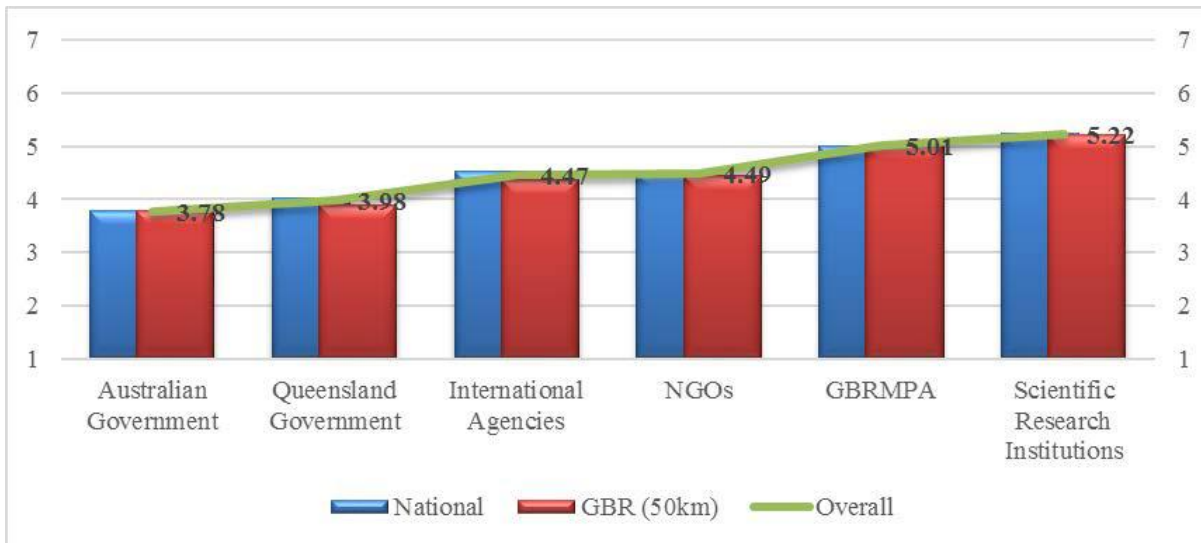


Figure 5: Public trust in relevant Reef-facing organisations.

Note: y-axis scale from 1 (strongly disagree) to 7 (strongly agree), midpoint = 4 (neither agree/disagree).

Respondents were then asked to respond to statements (on a scale of strongly disagree to strongly agree) about whether they were confident a range of organisations (i.e. regulators, authorities and other organisations including research institutions) could ensure the future health of the Great Barrier Reef. Figure 5 presents the mean scores of three different sample groups (national, Great Barrier Reef and total) on level of trust in relevant reef-facing organisations. Figure 6 shows the comparisons of mean scores between perceived institutional efficacy and trust in relevant reef-facing organisations (combined sample). The figure also shows which organisations were perceived differently based on these two aspects (perceived efficacy and trust). It shows high trust in the science community followed by the Great Barrier Reef Marine Park Authority. Respondents rated both the Australian and Queensland Governments' capacity or ability to ensure the future health of the Great Barrier Reef above the trust they placed in these groups to do so. While it is not uncommon to find low levels of trust in governments in Australian surveys of this nature (see Moffat et al., 2014 & Moffat et al., 2017), the higher levels of confidence in institutional efficacy in the government organisations indicates that there is a level of confidence that these organisations are broadly perceived as just and fair institutions. This is important in relation to matters of managing social risk, which is a responsibility that necessarily falls to large societal institutions and the associated decision-making processes that are frequently beyond the remit of individual citizens.

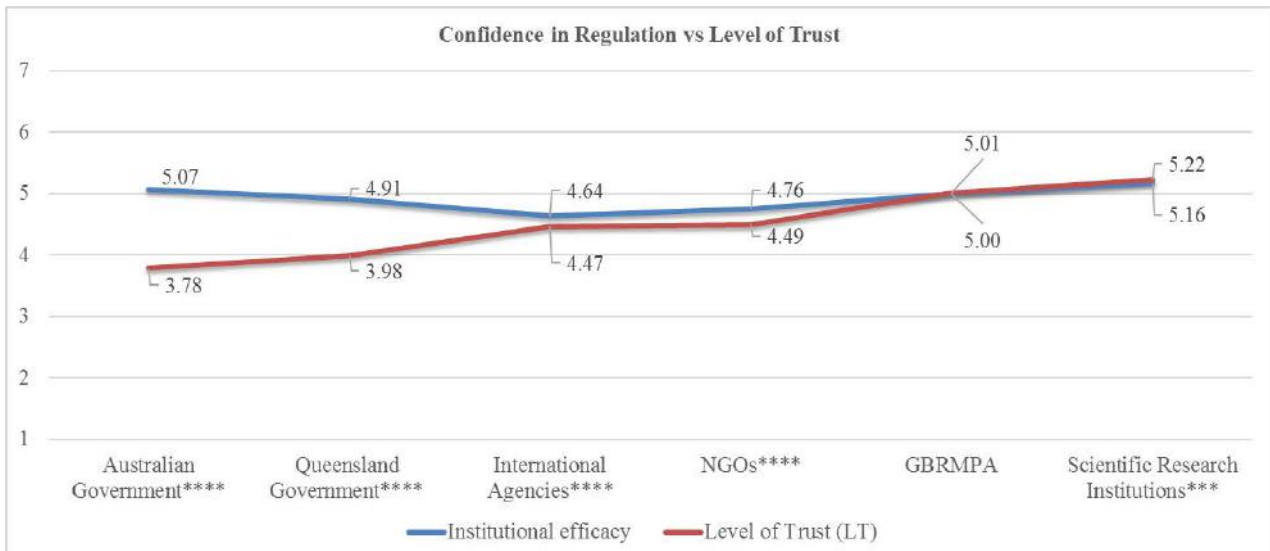
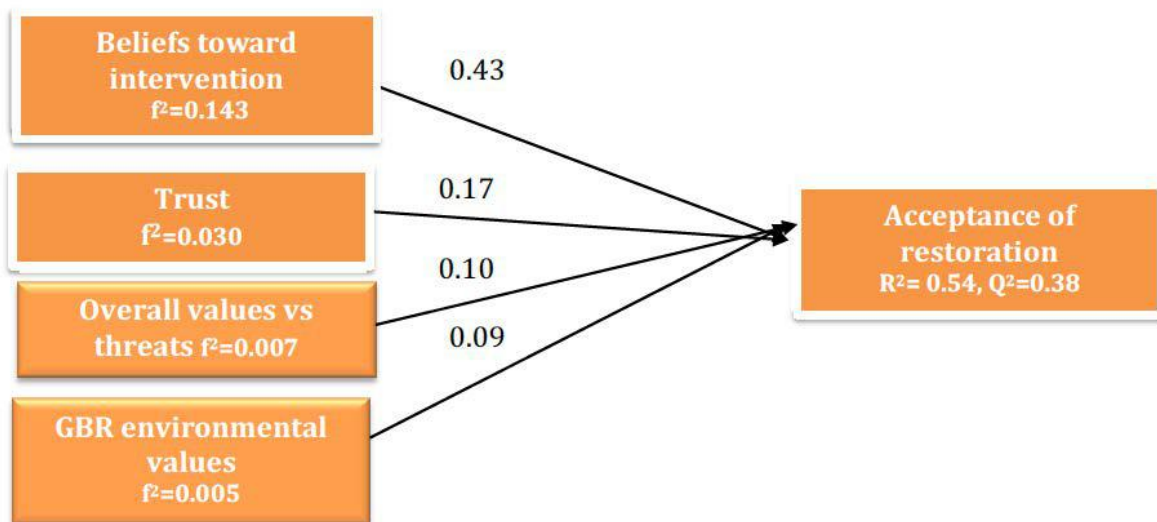


Figure 6: Mean scores for perceived institutional efficacy and trust in relevant reef facing organisations. (**** Statistically different at $p \leq 0.001$, *** Statistically different at $p \leq 0.01$)⁶

A path model was used to test the relationship between a range of factors⁷ and overall acceptance of reef restoration and adaptation. Overall acceptance was rated across four items on a scale from 1 (not at all) to 7 (very much so)⁸. Separate models were run for the Great Barrier Reef and national population samples. Only statistically significant ($p \leq 0.001$) direct effects were presented in Figures 7 and 8. Four factors were found to be direct predictors of acceptance of non-traditional reef restoration for the national population, while two factors were found for the Great Barrier Reef population. These are presented and briefly described below.



⁶ We used paired samples t-test to compare the mean scores between perceived efficacy and trust for each relevant organisation. N (total sample) = 4036, df= 4035 for each relevant organisation except N= 4019, df= 4018 for Marine Park Authority.

⁷ We used $p \leq 0.001$ as the criterion to be reported in this study. Social value was found insignificant ($p > 0.05$), Procedural fairness and Reef management were significant at $p \leq 0.05$ and perceived threats was significant at $p \leq 0.01$

⁸ PLS-SEM (Partial Least Squares – Structural Equation Modelling) was used to examine the direct paths between the factors and overall acceptance. PLS-SEM is a type of variance-based SEM and can use a relatively complex model without requiring the fulfilment of distribution assumptions. Hence, it can handle data of non-normally distributed, which were found in these data. A range of variables were entered into the model.

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Figure 7: Overall acceptance of restoration (national population). Note: Numbers on the path arrows represent beta coefficients (β) and the relative strengths of each relationships. Positive β -values indicate a positive relationship. The paths were significant at $p \leq 0.001$. The effect size value (f^2) of each predictor construct in the model ranged from .005 to .143 which was included in the category small to medium. The Q^2 value for acceptance of restoration was greater than 0, indicating it had good predictive relevance and validity in the model.

Four factors were found to be directly important in predicting the acceptance of direct restoration and adaptation of the Great Barrier Reef among the national population. In order of importance they were:

- **Beliefs toward intervention** related to beliefs about society intervening to repair, restore and build resilience of the Reef. The stronger agreement with this, the more acceptance for direct restoration of the Reef.
- **Trust in organisations** responsible to manage and protect the Reef. The higher the trust in relevant organisations the more accepting people were of restoration and adaptation of the Reef.
- **Overall evaluation of values versus threats.** This was an overall question on whether more needed to be done to save the Reef based on overall weighing up of values and threats to the Great Barrier Reef.
- **Great Barrier Reef environmental values.** The higher the environmental values prescribed to the Reef, the more accepting people were of restoration and adaptation of the Reef.

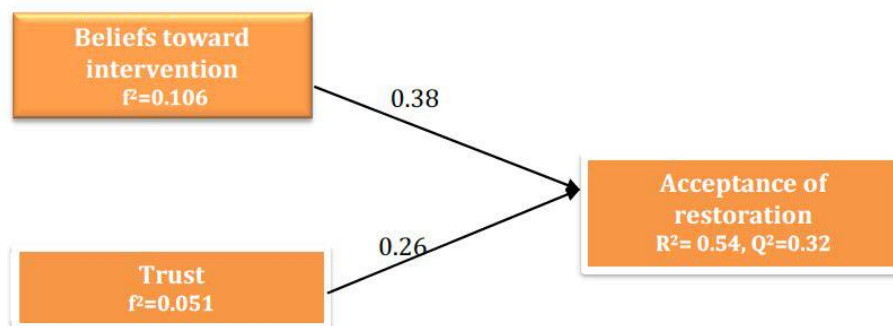


Figure 8: Overall acceptance of restoration (Great Barrier Reef population). Notes: Numbers on the path arrows represent beta coefficients (β) and the relative strengths of each relationships. Positive β -values indicate a positive relationship. The paths were significant at $p \leq 0.001$. The effect size value (f^2) of each predictor construct in the model ranged between .051 and .106 which was included in the category small to medium. The Q^2 value for acceptance of restoration was greater than 0, indicating it had good predictive relevance and validity in the model.

Two factors were found to be directly important in predicting the acceptance of direct restoration and adaptation of the Great Barrier Reef among the Great Barrier Reef population. In order of importance they were:

- **Beliefs toward intervention** related to beliefs about society intervening to repair, restore and build resilience of the Reef. The stronger agreement with this, the more acceptance there was for direct restoration of the Great Barrier Reef.

- **Trust with organisations** responsible to manage and protect the Great Barrier Reef. The higher the trust of relevant organisations, the more accepting people were for restoration of the Reef.

The results show consistency across both survey populations. First, beliefs toward intervention were found to be important for both populations. When beliefs were more positive about direct intervention and its ability to help repair or restore the Reef, it enhanced the likelihood of greater acceptance for non-traditional restoration methods. Second, trust was also important for both populations, although it was more influential for the Reef population. As outlined earlier, trust varied between organisations responsible for managing the Reef – with some trusted less than others. These results suggest that if overall trust is increased, it may help increase overall acceptance of non-traditional reef restoration. For the national population, important factors were environmental values along with an overall assessment that more needed to be done to save the Reef. If the environmental importance of the Reef could be increased, so would acceptance of non-traditional reef restoration methods.

No other factors (other values, threats etc.) were found to directly influence reef restoration acceptance. Some of these other factors may have indirect effects on acceptance. This means they may influence overall acceptance of reef restoration indirectly through other factors in a more complex way. It is recommended that future analysis of the data include indirect (mediation effects) to examine this complexity. Further, as these path models only examine the influence of factors on overall acceptance of reef restoration, it is recommended separate path models are used for each of the eight proposed interventions. In this way, factors that influence each proposed intervention can be examined individually, and patterns can be examined between type of intervention (i.e. shading and pest control). Differences between national and Great Barrier Reef populations can also be examined for each proposed intervention.

6.2 Community and stakeholder engagement

6.2.1 Lessons from large-scale ecological restoration and geoengineering projects

A systematic review of 485 publications was undertaken between May and September 2018. It focused on identifying needs and lessons from previous cases of large-scale ecological restoration initiatives and from public engagement related to geoengineering proposals. Previous cases of large-scale ecological restoration of aquatic environments (such as the Florida Everglades) show the risks of ignoring the entangled structure and network of interactions of and among politicians, public servants, scientists and the community (Borkhataria et al., 2017). Similarly, experiences of assisted forest migration/colonisation outline the struggles and community concerns raised by diverse views around economic and conservation goals (Sansilvestri et al., 2016).

Although RRAP shares similarities with both these types of experiences, this initiative is unprecedented and unique for its scale of intervention, the variety of those directly involved, and the deployment of both untested and state-of-the-art technologies. When all these factors coexist, implementing anticipatory measures raises community concerns around the uncertainty, the cost, and the personal views around the measures to be implemented (Kates et al., 2012).

Rather than attempting to reduce uncertainty, developing risk management is the most effective approach to tackle uncertainty when humans intervene in natural environments (National

Research Council, 2010). In recent decades, risk management frameworks have evolved by including the range of potential impacts of technologies related to genetically-modified organisms, hazardous facilities, and geoengineering (Klinke, 2002).

The interpolation of the political, social, technical, and technological dimensions of RRAP has been investigated in relevant literature to point the importance of:

1. Identifying social contextual factors likely to affect acceptability of large-scale restoration and scientific or engineering programs and tailoring engagement programs around contextual concerns.
2. Employing collaborative governance, learning-based approaches and integrated decision-making approaches to take action in complex social-ecological contexts, specifically large-scale ecological restoration and engineering programs and new science and technology.
3. Using governance models to holistically frame the agenda for community, stakeholder and public involvement in highly uncertain, complex and risky decision-making contexts.
4. Creating opportunities for action through engagement, skilled facilitation, and deliberative decision making.

The systematic review was organised by keyword and theme, and refined based on consultation with key social scientists with expertise in community and stakeholder engagement, social impact assessment, risk governance and participatory technology assessment. Four themes and sets of findings emerged.

Theme 1: Public acceptance and stakeholder engagement in large-scale ecological rehabilitation projects:

- Leadership has an essential role in shaping mechanisms of public engagement, which takes time to be processed by the community (Olsson and Holling, 2006; Heikkila and Gerlak, 2014).
- Social conflicts and tensions arising from alterations in the socio-economic status quo are high priorities (Maas-Hebner, 2014; Shumway et al., 2018; Svoboda and Irvine, 2014; Tuana et al., 2012).
- Social and individual perceptions can be shaped to achieve conditions likely to increase RRAP success, through: increased familiarity with technology (Cummings and Rosenthal, 2018; Burns et al., 2016); focus on benefits and not only on risks (Linnér and Wibeck, 2015); and inclusion of novel solutions in a broader set of less invasive strategies (Shackley et al., 2011).

Theme 2: Models and frameworks for governance of complex and uncertain risks:

- The International Risk Governance Council risk management framework provides terms of reference to select and manage the risk and enhance benefits of new technology deployment (IRGC, 2005).
- Social interactions and decision-making processes impact on public perceptions of risk. Factors that need to be undertaken to understand risk perceptions and managing governance of risk include: cultural backgrounds, social-political institutions, cognitive-affective factors, and information processing (Renn and Benighaus, 2013).
- Techniques to reduce risk (and its perception) and manage uncertainty are: communicating risk and mobilising risk culture, involving stakeholders, developing transparency, designing schemes for accountability, flexibility and adaptability in decision-making, budgeting for risk management (Florin, 2014).

Theme 3: Public involvement and stakeholder engagement in technology assessment:

- Social acceptability of the use of innovative technology can be achieved through public deliberation processes that are inclusive and address personal trust, fairness, equity, personal attitudes, and personal norms (Huijts et al., 2012).
- Steps to achieve social acceptance are: withhold/withdrawal, acceptance, approval, and psychological identification associated with championing in stakeholder behaviour (Franks and Cohen, 2012).
- The public needs to be engaged, recognising several key principles such as right to participation and right to information; free, prior and informed consent (Vanclay, 2017).

Theme 4: Frameworks, tools and strategies for public deliberation in environmental decision (policy) making:

- Different participation formats fit different purposes and stakeholders/community sectors, including: information exchange (public hearings etc.), involvement (citizen panels, etc.), and engagement (summits, etc.) (Paleo, 2008)
- Public deliberation can incur problems when participation is isolated from the policy process, when ‘science’ and ‘the public’ are often seen as two extremes of a continuum, and when participation is only invoked after decisions have been taken (Hagendijk and Irwin, 2006).

Social licence to operate is an ethic/moral mandate given by a community to an organisation/body for a specific purpose. Social licence to operate can be achieved through negotiations, when the community perceives the fairness of the process and the assumption of social responsibility (Moffat et al., 2015; Lacey et al., 2016; Falck, 2016).

6.2.2 Guiding principles for engagement

The literature suggests a range of lessons and models for the management of social dimensions of ecological restoration and adaptation in the Reef, including lessons and models for enhancing the social acceptability of new technology. We have synthesised these into four categories of guiding principles to inform community and stakeholder engagement by scientists and policy makers in designing and implementing reef restoration and adaptation science and policy (Table 4):

1. Engagement programs should address social contextual factors likely to affect the acceptability of large-scale restoration and scientific or engineering programs.
2. Restoration and adaptation action, including R&D, should be guided by collaborative, integrated and learning-based governance processes.
3. Great Barrier Reef restoration science and policy should ensure that community, stakeholders and the public are involved in decision-making and this involvement should be increased in cases of uncertainty, complexity and conflicting values.
4. Great Barrier Reef restoration science and policy should create opportunities for action by community, stakeholders and rightsholders and deliver co-benefits through involvement, skilled facilitation, and deliberative decision making.

Table 4: Guiding principles for community and stakeholder engagement in reef restoration and adaptation.

Principles	Processes and actions	Literature
<p>1. Ensure engagement programs address social contextual factors likely to affect the acceptability of large-scale restoration and scientific or engineering programs.</p>	<ul style="list-style-type: none"> • Systematically document the different attitudes, beliefs and perceptions of risk associated with large-scale scientific and engineering programs in multiple social contexts (the general public, stakeholders and rightsholders). • Ensure diverse values and interests are accounted for when estimating benefits, harms, and compensatory measures for large-scale (scientific and engineering) restoration and adaptation programs. 	<p>(Renn, 2011; Harris et al., 2012; Kates et al., 2012; DiEnno and Thompson, 2013; Renn and Benighaus, 2013; Weng, 2015; Poe et al., 2016).</p>
<p>2. Guide restoration and adaptation action, including R&D, though collaborative, integrated and learning-based governance processes.</p>	<ul style="list-style-type: none"> • Frame restoration and adaptation benefits for community, stakeholders, rightsholders and the general public through collective decision-making and collective experimentation and not exclusively on the basis of techno-scientific promises. Recognise that methodologies for engagement are as valuable as the technologies to be deployed. • Link internal governance and administration processes for restoration and adaptation programs to external communication and engagement processes to promote more effective knowledge building and to guide restoration and adaptation actions. Communicate governance arrangements and opportunities for input to stakeholders and rights-holders. • Use processes of collaboration (with the general public, stakeholders and rightsholders, scientists and policy makers) for collective learning and to shape restoration and adaptation governance processes (strategies, rules, and policies). • Draw on the skills, capabilities and leadership within the Great Barrier Reef system of rightsholders, stakeholders and the broader citizenry to build a shared restoration and adaptation agenda. 	<p>(Olsson et al., 2006; Dengler, 2007; Fleischer and Grunwald, 2008; Frank, 2009; Gerlak and Heikkila, 2011; Heikkila and Gerlak, 2014; Stilgoe, 2016; Asayama et al., 2017; Borkhataria et al., 2017; Curato, 2017; Vanclay, 2017)</p>
<p>3. Increase rightsholder, stakeholder, public involvement and trans-disciplinary scientific involvement in decision-making contexts where these are characterised by uncertainty, complexity and conflicting values.</p>	<ul style="list-style-type: none"> • Involve community, stakeholder and public participation in the assessment of technology and restoration and adaptation risks in the research design, deployment, and management stages. • Ensure science inputs into decision making involving high degrees of uncertainty, complexity, and conflict (e.g. over benefits, risks, ethics) are transdisciplinary. • Balance technical analysis with non-technical inputs when assessing risk and prioritise consultation with the most affected stakeholders. • Empower rightsholders, stakeholders and the public to weigh up uncertainty, complexity, and conflict (e.g. over benefits, risks, values) and 	<p>(Wyant, 1995; IRGC, 2005; Hoegh-Guldberg et al., 2008; Fishkin, 2010; Shrader-Frechette, 2010; Lawler and Olden, 2011; Renn, 2011; Renn et al., 2014; Klenk and Larson, 2013; Renn and Benighaus, 2013; Florin, 2014; Neff and Larson, 2014; Sansilvestri et al., 2015; IRGC, 2017)</p>

4. Create opportunities for consensus and broad social approval of large-scale restoration/adaptation programs and novel technology through engagement, skilled facilitation, and deliberative decision making.

collectively decide the best way forward. (IRGC, 2005)

- Clarify novel science and engineering technologies in terms of accountability, controllability, predictability, naturalness, risks, and implications for future generations.
 - Engage in constant and interactive knowledge exchange (between scientists, rightsholders, stakeholders and citizens) to build familiarity with technology options and to address areas of concern. Maintain interactive knowledge exchange over the life of the programs to promote consensus-building and social approval.
 - Involve stakeholders and rightsholders in the development of an agreed set of principles and procedures for decision making (e.g. about selecting the most suitable technology options, deployment locations, and management measures). Implement these principles and procedures transparently and fairly to build social approval and consensus around action.
 - When exposing people to new information, allow a cooling-off period before making decisions.
 - Engage the general public, stakeholders and rightsholders in the evaluation of restoration and adaptation technology options and establish agreed boundaries for the implementation of these options.
 - Employ different engagement methods appropriate to the goal of decision making, the moment of the decision-making process and the type(s) of organisations, rightsholders and citizens involved (Forester, 1987; Forester, 1999; Fischer, 2003; Paleo, 2008; Forester, 2013). Use engagement techniques that will assist with assessment and decision making such as: restoration and adaptation narratives developed for specific rightsholders and stakeholders, values and interests; scenarios built on models; and methodologies for participatory deliberation and negotiation.
 - Build trust as the basis for achieving broad social acceptance and approval of novel technology by explicitly recognising and addressing rights to - participation; fair treatment; information; free, prior and informed consent; self-determination and social and economic inclusion.
- (Wyant, 1995; Stirling, 2007; Fleischer and Grunwald, 2008; Poumadère et al., 2011; Russell et al., 2011; Franks and Cohen, 2012; Huijts et al., 2012; Pidgeon et al., 2012; Corner et al., 2013; Maas-Hebner and Dunham, 2014; Renn, 2014; Svoboda and Irvine, 2014; Corner, 2015; Gregory, 2015; Sütterlin and Siegrist, 2016; Stilgoe, 2016; Borkhataria et al., 2017; Braun et al., 2017; Asayama et al., 2017; Vanclay, 2017; Carr and Yung, 2018; Shumway et al., 2018; Talberg et al., 2018).

6.2.3 Different types of participants

Broadly, it is possible to group different participants, rightsholders and stakeholders into four main types, though we note that each of these four types have many, diverse sub-groups with differing values and vulnerabilities associated with reef condition, restoration and adaptation:

1. **Traditional Owners** rights and responsibilities mean they have a status distinct from stakeholders, however while a distinct group, they also share characteristics and roles with livelihood, institutional and civil society stakeholders.
2. **Livelihood stakeholders** – this includes reef-*dependent* and reef-*associated* industries, stakeholders and communities in the Great Barrier Reef and catchment (including but not limited to tourism and commercial fishing interests).
3. **Institutional stakeholders** – this includes local, regional, state, national and international governing bodies or organisations with responsibilities and interests in the Great Barrier Reef. These could be based inside or outside the Great Barrier Reef.
4. **Citizens and civil society** – this includes broader public and other interests in the Great Barrier Reef from individuals or groups based inside or outside of the Great Barrier Reef and its catchment.

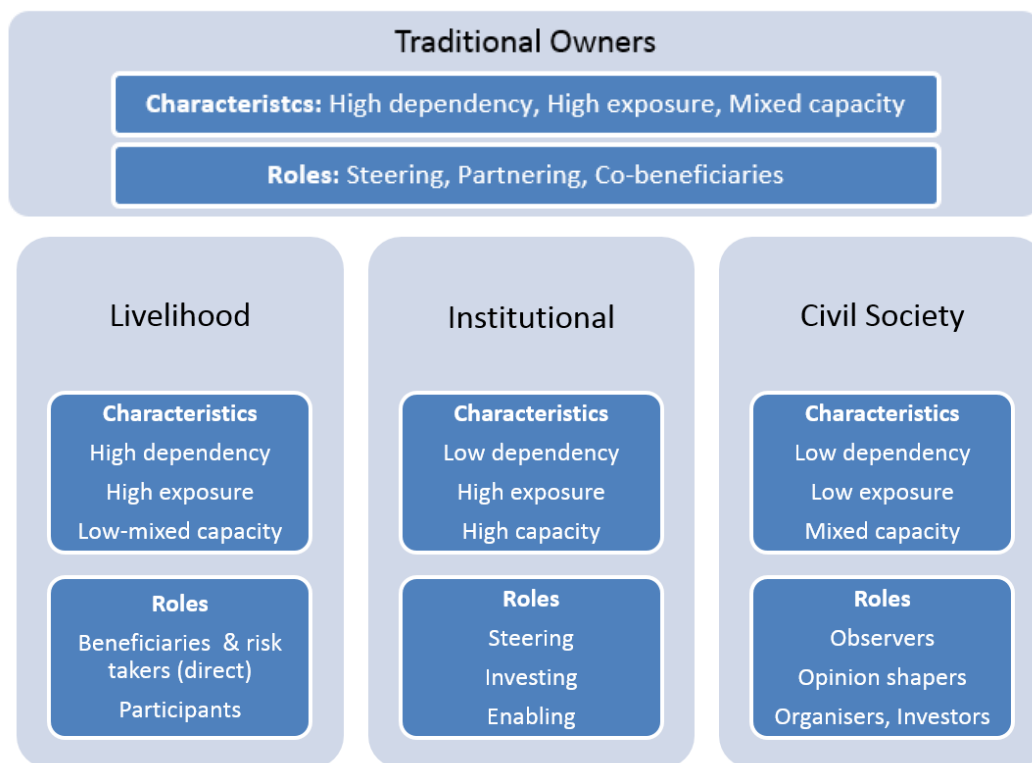


Figure 9: Simplified overview of types of rights-holders and stakeholders: characteristics related to changes in Reef condition and potential roles in RRAP.

Table 5: Organisations, forums and structures for groups that hold rights and interests.

Livelihood stakeholders	Institutional stakeholders
<p>Coastal communities</p> <ul style="list-style-type: none"> – Great Barrier Reef Marine Park Authority Local Marine Advisory Committees (12 in Great Barrier Reef) – Rivers to Reef Report Card Partnerships (5 in Great Barrier Reef) - Healthy Waterways Regional Partnerships <p>Tourism industry</p> <ul style="list-style-type: none"> – Great Barrier Reef Marine Park Authority Tourism Reef Advisory Committee – Association of Marine Park Tourism Operators – Queensland Tourism Industry Council (QTIC) – Cod Hole and Ribbon Reef Operators Association (CHARROA) – Dive Queensland – Whitsunday Charter Boat Industry Association (WCBIA) <p>Industry and business groups</p> <ul style="list-style-type: none"> – AgForce – CANEGROWERS (Queensland Cane Growers Organisation Ltd) – Growcom (Horticulture) – Australian Banana Growers Council – Queensland Farmers Federation (QFF) – Australian cane farmers – Chambers of Commerce – Reef Alliance <p>Voluntary program</p> <ul style="list-style-type: none"> – Reef Guardian Fishers Program <p>Commercial Fishing</p> <ul style="list-style-type: none"> – Queensland Seafood Industry Association – Commercial marine aquarium fish and coral collectors – Commercial line fisheries – Coral Reef Fin Fishery <ul style="list-style-type: none"> - Coral Reef fin fish and Spanish mackerel working group – Tropical Rock Lobster (TRL) Fishery working group – Fisheries working groups – Pro-vision Reef Inc – Commercial crab fisheries – Commercial eel fishery – Commercial harvest fisheries – Commercial trawl fisheries – Commercial net fisheries – Developmental fisheries <p>Recreational Fishers</p> <ul style="list-style-type: none"> – Mackay Recreational Fishing Alliance – Australian National Sportfishing Association (ANSA - QLD) – Sunfish QLD – World Association of Zoos and Aquariums 	<p>Science community</p> <ul style="list-style-type: none"> – Australian Institute of Marine Science (AIMS), CSIRO, Universities – Independent Expert Panel for the Great Barrier Reef – Independent Science Panel for Water Quality in the Great Barrier Reef – Australian Science Communicators National Environment Science Program (NESP) Reef 2050 Integrated Monitoring and Reporting Program – Reef and Rainforest Research Centre National Environment Science Program (NESP) Tropical Water Quality Hub, and Marine Biodiversity Hub <p>Local government</p> <ul style="list-style-type: none"> – Far North Queensland Regional Organisation of Councils (FNQROC) – North Queensland ROC – Whitsunday ROC – Central Queensland ROC – Wide-Bay Burnett ROC – Reef Guardian Councils (17 Local Governments) – Local Govt. Association Queensland - Reef Councils Round table – Indigenous Councils (16) <p>Queensland Government</p> <ul style="list-style-type: none"> – Fisheries Queensland – Tourism and Events Queensland – Queensland Department of National Parks, Sport and Racing – Department of Environment and Science – Office of the Great Barrier Reef – Queensland Government Panel for Fisheries - Available as Sustainable Fisheries Expert Panel – Queensland Department of Agriculture and Fisheries <p>Australian Government</p> <ul style="list-style-type: none"> – Australian Fisheries Management Authority – Australian Department of Agriculture and Water Resources <ul style="list-style-type: none"> - Division of Biosecurity Policy and Implementation Australian Department of Agriculture and Water Resources - Division of Sustainable Agriculture, Fisheries and Forestry – Australian Department of the Environment and Energy

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<ul style="list-style-type: none"> - InfoFish - CAREFISH 	
<p>Indigenous and Traditional Owner entities⁹</p> <ul style="list-style-type: none"> - Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) - Torres Strait Major Infrastructure Programme - Torres Strait Regional Authority (TSRA) - Great Barrier Reef Marine Park Authority - Indigenous Reef Advisory Committee - Traditional Use of Marine Resources Agreements and Land Use Agreements - Land and Sea Country Ranger programs - Reef 2050 Traditional Owners Aspirations Forum - Indigenous Protected Areas - Crown-of-Thorns Starfish Control Program - Native Title Representative Bodies and Service Providers - Commonwealth Indigenous Advisory Committee - RIMReP Indigenous Heritage Expert Group 	<p>Civil society stakeholders</p> <p>Regional arrangements</p> <ul style="list-style-type: none"> - NRM organisations and Traditional Owner reference groups (Indigenous NRM) (5 Regional NRM Bodies in Great Barrier Reef) - Rivers to Reef Report Card Partnerships (5 in Great Barrier Reef) <p>Schools</p> <ul style="list-style-type: none"> - Marine Teacher Association - Reef Guardian Schools (270 Schools) <p>Business community</p> <ul style="list-style-type: none"> - Rotary (multiple, number in Great Barrier Reef unknown) <p>Conservation – Citizen Science</p> <ul style="list-style-type: none"> - Great Barrier Reef Citizen Science Alliance - Reef Check - CoralWatch, Seagrass Watch, Birds Queensland, Ocean Watch, Minke Whale Project, Project Manta, MyWater, One Reef & the Better Earth Volunteer Network-Conservation Volunteers Australia, Creek Watch, Harbor Watch, Shorebird Monitoring, Suntag, Reef Life Survey, Mangrove Watch, Queensland Turtle Research Program, Australian Marine Debris Initiative (ADMI), Tiger shark project <p>Conservation</p> <ul style="list-style-type: none"> - Environmental NGOs – Citizens of the Great Barrier Reef, Great Barrier Reef Legacy, WWF, Greenpeace, ACF, QCC - Conservation Volunteers Australia, Wilderness Society, Green Collar, Sea Shepherd, Greening Australia, Eye of the Reef, Redmap, Fleet: Reef 1, ReefHQ Great Barrier Reef Aquarium - Queensland Conservation Council (QCC), Cairns and Far North Environment Centre (CAFNEC), Cassowary Coast Alliance (CCA), North Queensland Conservation Council (NQCC), Mackay Conservation Group (MCG), Capricorn Conservation Council (CCC), Gladstone Conservation Council (GCC), The Nature Conservancy (TNC), International Coral Reef Initiative (ICRI), Australian Marine Conservation Society (AMCS), World Wildlife Fund (WWF), Australian Conservation Foundation (ACF) - UNESCO - International Union for Conservation of Nature (IUCN)

6.2.4 Opportunities for engaging stakeholders through existing structures

The preliminary assessment of existing stakeholder engagement mechanisms, structures and arrangements identified 119 different types relevant to stakeholder and citizen involvement in restoration and adaptation. These mechanisms were identified through a) an expert elicitation of key mechanisms, b) an internet keyword search, and c) by interview discussions (n=24) which explored engagement processes that could support stakeholder and community involvement in

⁹ A more detailed overview of Traditional Owner and related Indigenous entities is provided in section 5.3.

reef restoration and adaptation. Desktop research was used to elicit key information about each engagement mechanism. Mechanisms were appraised and mapped against a broad stakeholder interests typology of livelihood, institutional and civil society stakeholders.

The 119 main engagement mechanisms included: 35 for livelihood stakeholders, 10 for indigenous and Traditional Owner groups, 48 for citizens and civil society, and 26 for institutional stakeholders (Table 3).

Of the 119 engagement mechanisms, 8 are replicated in regions or communities along the Great Barrier Reef (e.g. Local Marine Advisory Committees (Local marine advisory committees), Report Card Partnerships, Reef Guardian Schools, Local Councils, Indigenous Local Councils, NRM Organisations). When these regional and local mechanisms are counted, the total number is in excess of 380.

Table 6: Summary of key engagement mechanisms for different types of stakeholders and rights-holders.

Stakeholder typology	Engagement structures/types	Characteristics
Livelihood stakeholders.	Thirty-five engagement structures: coastal communities (n=2), tourism (n=6), industry (agriculture/business) (n=7), commercial fisher (n=13), and recreational users (recreational fishing) (n=6) voluntary agreement (n=1)	This group of engagement mechanisms, structures and arrangements have a mix of organisational types. Includes: independent member-based organisations; peak bodies; reef-wide advisory processes; and local community-based organisations. Engagement mechanisms perform either single or multiple roles such as: helping institutions such as Great Barrier Reef Marine Park Authority fulfil their own mandates (e.g. advisory boards); and promoting the interests of particular stakeholders.
Indigenous and Traditional Owner entities.	Ten engagement structures.	This group of engagement mechanisms is mainly involved with facilitating expressions of indigenous legal rights (e.g. Traditional Use of Marine Resources Agreements).
Citizens and civil society.	Forty-eight engagement structures: regional arrangements (n=1), schools (n=2), business community (n=1), conservation through citizen science (n=20), and conservation (24)	This group of engagement mechanisms are largely characterised as not-for-profit organisations operated by voluntary members or through voluntary arrangements. Engagement mechanisms perform either single or multiple roles such as: promoting the interests of particular stakeholders; community engagement, providing education; and providing opportunities for collective action.
Institutional stakeholders.	Twenty-six engagement structures: science community (n=8), local government (n=8), Queensland Government (n=6), Australian Government (n=4)	This group of engagement mechanisms are focused on reef science or reef policy in some way. Engagement mechanisms perform either single or multiple roles such as: helping institutions such as Great Barrier Reef Marine Park Authority/Queensland Government fulfil their mandates (e.g. advisory boards); providing independent advisory services to monitor and evaluate policy action (e.g. Independent Science Panel for water quality in the Great Barrier Reef); and collaborative arrangements to facilitate action by particular stakeholders (e.g. Regional Organisations of Councils, Regional NRM Organisations).

In terms of decision-making function, mechanisms performed either single or multiple roles such as:

- Facilitating expressions of stakeholders' legal rights (e.g. Traditional Use of Marine Resources Agreements).
- Helping institutions such as Great Barrier Reef Marine Park Authority or the Queensland Government fulfil their mandates (e.g. advisory boards).
- Representing and promoting the interests of particular stakeholders.
- Promoting or facilitating community engagement in conservation.
- Providing education and opportunities for collective action.
- Providing independent advisory services to monitor and evaluate policy action (e.g. Independent Science Panel for water quality in the Great Barrier Reef).
- Collaborative arrangements to facilitate action by particular stakeholders (e.g. Regional Organisations of Councils, Regional NRM Organisations).

Livelihood stakeholder engagement mechanisms focus on reef and non-reef matters and have diverse governance arrangements. Some are government managed and tied to Reef policy frameworks (eg. Local marine advisory committees, Reef Advisory Committees) however most are independently run, driven by either members or boards, and focused on advancing particular stakeholder rights and interests. These rights and interests are sometimes, though not always, reef related.

Citizen and civil society mechanisms are the most independent from government. These mechanisms are mostly tied to voluntary or not-for profit organisations. They focus on volunteer involvement in conservation activities, school-based engagement in science and conservation, or advocacy for businesses. They engage with internal and external stakeholders in diverse ways (conservation actions, community capacity building, and marketing) and have different organisational capacities and targets for citizen engagement.

Institutional stakeholder engagement mechanisms are focussed on providing technical advice on reef management, reef science, policy development and implementation. These arrangements occur under the auspices of government policy relating to the environment, Great Barrier Reef or science. They exist to help government fulfil its mandate or establish collaborative arrangements to lobby with government around advancing policy interests.

6.2.5 Assessment of existing mechanisms for RRAP science engagement

Existing mechanisms offer an ability to engage with well-structured advisory processes, access to collaborative mechanisms of decision-making, and access to stakeholder or community networks. The use of existing engagement mechanisms is potentially suitable in the following ways:

- Seeking **expressions of stakeholder interests, rights, knowledge and perspectives** related to restoration and adaptation during the design, testing and deployment of intervention options. This would provide opportunities to understand the how RRAP might affect different stakeholders and to identify processes for stakeholders to negotiate benefits or agreed outcomes and co-create options and solutions.

- **Tapping into well-established and/or trusted networks** already in place and with a history of discussing and advising on reef science and policy for timely engagement. This could help to engage stakeholders and citizens at the early stage of RRAP in fuzzy deliberations about trade-offs, risk and uncertainties associated with technology, costs and benefits, and deployment locations.
- In **framing social benefit and social value narratives** of technology deployment for specific stakeholder rights and interests – for example by working with stakeholders and rightsholders to translate benefits related to coral health and coral cover to a range of social and cultural values.
- **Socialising the restoration and adaptation program** widely with citizens and Great Barrier Reef stakeholders. The Great Barrier Reef is a large and complex social-ecological system. Existing networks could provide avenues to communicate about restoration technologies and processes available to be engaged in deliberations.
- **Alignment of RRAP to processes of government** to: build RRAP knowledge across levels of governance, identify the regulatory and policy alignments or change that might be needed at design and deployment stages and coordinate stakeholder engagement with entities who are responsible for decision-making.

The complex nature of both the social and institutional Reef landscape and the restoration and adaptation program raises questions and uncertainties about how existing mechanisms could be effectively used for RRAP. The key uncertainties relate to:

- **Fit-for-purpose of existing engagement mechanisms for RRAP.** Current mechanisms are framed around existing government mandates, frameworks for establishing and expressing rights or member interests. Even when engagement mechanisms are focused on reef science or policy, they are not currently focused on achieving reef restoration objectives. It is not clear whether these mechanisms can be aligned with reef restoration and negotiating involvement (e.g. with whom) will need to be individually explored with engagement mechanisms. This needs to be further explored in the RRAP R&D Program.
- **Capacity to facilitate engagement, to deliberate trade-offs and support decision making by RRAP.** Even if arrangements are fit-for purpose, they may not have sufficient capacity to meet RRAP's engagement needs. Some engagement mechanisms will need to be supported technically and financially to: explore stakeholder aspirations and how these link to attitudes and perspectives on intervention ideas, explore risks, values trade-offs and uncertainties and operate as communication networks. This is especially relevant for Traditional Owner interest groups. Available and necessary capacities needs to be explored further in RRAP R&D Program.
- **Representational needs, complexity and scaling up to achieve RRAP engagement objectives.** The Reef is a complex social-ecological system and RRAP is a complex program. It may not be necessary to include all existing stakeholder engagement mechanisms at all stages in RRAP. There will be times when targeted involvement is useful (e.g. for understanding emerging stakeholder perspectives on technology options in the design program); times when broad stakeholder and citizen involvement in decision making is needed (e.g. deployment of specific technologies such as cloud brightening, gene manipulation); and there will be times when engagement needs to be specific to

particular rightsholders (eg. Traditional Owners, fishers) or stakeholders/beneficiaries (e.g. tourism operators). Pragmatically, it will be necessary to match engagement mechanisms (existing and new) to the different engagement objectives of RRAP.

Table 7 provides an overall summary of the benefits and uncertainties of using existing mechanisms for reef restoration and adaptation. These opportunities and uncertainties will need to be explored further in the engagement objectives of the next phase of RRAP. A staged engagement plan in the RRAP R&D Program could help clarify which of the existing mechanisms to use, in what way, and to identify areas where augmentation by RRAP is necessary.

Table 7: The suitability of engagement mechanisms for reef restoration and adaptation.

	Potential engagement benefits	Uncertainties to be clarified in RRAP R&D Program
Livelihood stakeholders.	<ul style="list-style-type: none"> Diverse stakeholder knowledge and sectoral expertise. Could help connect RRAP to a broad range of livelihood stakeholders across the Great Barrier Reef. Relatively efficient means of engagement— groups are currently in place and operating. Could be used to craft sector specific narratives to frame RRAP relevant to specific interest groups. A potential network for RRAP to keep peak bodies, reef-wide advisory processes, and local community organisations informed about its activities. 	<ul style="list-style-type: none"> Whether these groups see RRAP engagement as being core to the interests of their members has not been established. Ability of groups to accommodate RRAP engagement requires investigation (e.g. how often do groups meet, for how long, is it possible to secure space on the agenda, what is the process, how much time could be dedicated to RRAP, can these forums spearhead RRAP specific engagement with members?).
Indigenous and Traditional Owner (TO) entities.	<ul style="list-style-type: none"> Knowledge of Indigenous/TO practices (e.g. fishing) that might be affected by RRAP. Inclusion of Indigenous/TO groups to achieve consensus on RRAP intervention. Extension of Indigenous/TO rights and their formalisation/recognition/legalisation (if not already). 	<ul style="list-style-type: none"> Understanding the limitations that Indigenous/TO culture poses to the alteration of existing flora and fauna. Bringing together all Indigenous/TO groups directly or indirectly affected by RRAP. Understanding the level of contribution that each Indigenous/TO group can bring to the several phases of RRAP.
Citizens and civil society.	<ul style="list-style-type: none"> Concerned with reef conservation. Likely to have strong interests in RRAP and ability to reach out to citizens interested in reef science and reef resilience. Could be well placed to socialise RRAP technology and engage citizens in deliberations about technology and interventions. 	<ul style="list-style-type: none"> Capacity constraints likely to be a problem. Strong focus on reef and conservation – not representative of broader citizenry. The outreach of these organisations with citizenry should be explored and what else might be needed to support the engagement needs of RRAP should be identified.
Institutional stakeholders.	<ul style="list-style-type: none"> Could help connect RRAP to a broad range of science and policy expertise relevant to design, deployment, and evaluation of technology and interventions in the Great Barrier Reef. Well established engagement processes. Advantages in building knowledge of RRAP across levels of governance. Potential to identify regulatory and other stakeholder alignments required to allow RRAP activities to proceed in the design and deployment stages. 	<ul style="list-style-type: none"> Despite a relatively common focus on the Reef, the objectives, role, and function of engagement processes is not necessarily fit-for-purpose. The governance of these structures is diverse and alignment to RRAP will need to be negotiated on a case-by-case basis. Tailored exploration of the potential for groups to support RRAP engagement needed – on a case-by-case basis. Does not include engagement structures for novel interventions such as solar radiation management or genetic engineering.

6.2.6 Stakeholder perceptions of benefits from engagement

The stakeholder interviews (n=24) conducted in mid-2018 identified opportunities or benefits that flow to RRAP from stakeholder involvement, and, potentially, to stakeholders and communities from participation (Table 7). Risks or concerns associated with different technologies or intervention strategies raised in the interviews were described in [section 6.1.7](#).

Table 8: Stakeholders views on potential benefits associated with participation in RRAP.

Benefits	Examples of comments from interviews
Improved transparency and trust in science and government.	The widely recognised need for a transparent process that builds trust with general public, government and science was particularly strong among local government and management agency respondents. A strong sense the public and stakeholders want to know what is happening, who is making the decisions and how much say they will have. Related issues included the need to improve trust between management authorities and some key sectors.
Legitimate decisions.	The view was widely held that participation would increase the legitimacy of decisions made in RRAP was widely held, but is especially acute for Traditional Owners and local communities.
Building support and consensus.	While sectors such as marine tourism reported general support for ‘any action’, gaining consensus in other sectors, such as environment and fisheries would be more difficult. Stakeholder support was not a ‘given’, open-ended or unconditional. Participation was seen as critical to encourage community ownership, gain consent and build consensus for action. Strategies identified to do this included undertaking small/immediate and visible action before scaling up to build confidence; connecting early actions to local, special places; individualise stories for specific sectors and communities (including working with local government to build the narrative for community participation); identifying local community restoration champions; and, talking early and planning ahead for R&D and deployment programs. These views were strong among LMAC and local government respondents.
Understanding the regulatory and access implications.	Stakeholders noted that participation of sectors that use and access the Great Barrier Reef and its resources would build understanding of interactions between, for instance, actions to manage fisheries, actions to respond to climate change and generally help consider implications of changes to access, permissions and movement of reef users.
Understanding and influencing goals and scope of RRAP.	Participation was seen as a valuable avenue for stakeholders to better understand, and influence, the vision, plan and timing of the program. Issues consistently raised here included putting RRAP in the context of other responses to manage the Great Barrier Reef (i.e. manage threats and reduce emissions). And that interventions needed to be considered as ‘more than technological’ and include education and capacity-building for communities and sectors.
Prioritisation.	<p>Participation was also seen by many stakeholders to be a vehicle to inform priority setting, such as:</p> <ul style="list-style-type: none"> • Identifying no-regrets options. • Anticipating conflict over spatial prioritisation of interventions between high-value tourism sites, ecologically or, social and culturally-significant locations. • Between inner/outer or northern/central/southern reefs.

Benefits	Examples of comments from interviews
Observability and acceptance.	Multiple interviewees stressed the importance of local-scale or visible restoration activities that engage communities at a scale they relate to and provide a building block towards acceptance of larger-scale interventions. Citizen science was also seen as a critical strategy to promote engagement and built trust.
Knowledge sharing.	Participation was described as providing opportunities to build local knowledge (e.g. dive operators, marine tourism operators, fishers) and Traditional Owner knowledge and experience of decadal change on the Reef into monitoring and evaluation design. Respect for this knowledge was key to meaningful engagement. Sharing of this knowledge between scientists and these groups would lead to better restoration outcomes. And there is also a strong appetite to understand 'the science' but it needs to be shared by experienced, knowledgeable researchers.
Psychological benefits and the 'need to help'.	Active participation was seen to be something of an antidote to feelings of despair and helplessness associated with declining reef condition. Restoration activities were seen to be a focus for innovation, for buying time, and for 'making a difference' with communities and stakeholders wanting to know what action they can take.
Building capacity to engage.	Local government stakeholders described a low level of environmental awareness and concern in their sector and their communities, including awareness about specific interventions. Urban populations were described as disconnected and investment is needed to strengthen the capacity of local communities and local governments to engage – the latter “not knowing how to engage with the Reef” due to the complexity of the bureaucratic and political environment. Engagement would help build capacity for dialogue about Great Barrier Reef management. Current Reef advisory arrangements do not provide opportunities for in-depth discussion of problems or issues. There was also a perception that there is an unevenness of capacity and resources to engage across regions from north to south in the Reef (i.e. some regions better positioned than others) as well as across stakeholder groups.
Identify new industries, services and economic activity.	<p>A recurrent theme across several stakeholders interviewed were the economic, social and cultural opportunities that could arise through engagement, and through the interventions. These included:</p> <ul style="list-style-type: none"> • Economic or educational opportunities for Traditional Owners and Indigenous communities. • Service provision or value-adding through local communities. • Surveillance, monitoring, reporting services for interventions and field trials. • Training, volunteer labour, communication, land and sea based services to support interventions. • New financing models to support restoration.
Improved understanding of uncertainty.	A smaller number of stakeholders emphasised that the level of uncertainty (about effectiveness and about possible risks) needed to be upfront and clear as part of the conversation. Recognition that 'failure' is not necessarily a waste of money if valuable lessons emerge.

6.3 Scoping involvement of Traditional Owners

6.3.1 Traditional Owners in Great Barrier Reef governance and management

Traditional Owners in the Great Barrier Reef continue to use diverse strategies to translate their custodial rights and obligations into sophisticated governance arrangements and management actions that respond to and address the complex contemporary challenges they encounter on their land-sea country (see Hill et al, 2012; Maclean et al., 2013). There has been ever-increasing recognition of the existing rights and interests of Indigenous people for land-sea country in Australia, particularly since the *Native Title Act, 1993*. Native title provides a mechanism for the recognition of a range of non-exclusive rights in sea country, particularly customary usage rights. Some Traditional Owner groups now have recognised native title rights to certain areas of the Great Barrier Reef (e.g. Kuuku Ya'u People determination, 2009), and have negotiated related (marine park) Indigenous Land Use Agreements (e.g. Kuuku Ya'u People, the Queensland Government and Great Barrier Reef Marine Park Authority to protect the Great Barrier Reef Marine Park). Cape York Traditional Owners are currently focused on terrestrial claims, but further native title claims over coastal and sea areas are expected in the future.

Separate to native title processes, Traditional Owners have also entered into co-governance and management arrangements with National and State government agencies (e.g. Great Barrier Reef Marine Park Authority, Wet Tropics Management Authority, Queensland Parks and Wildlife Services). Traditional Owner representatives participate in dedicated Great Barrier Reef Indigenous committee structures, notably the Indigenous Reef Advisory Committee and occupy a seat on the Great Barrier Reef Marine Park Authority Board. At the local Traditional Owner level, Traditional Use of Marine Resources Agreements recognise Indigenous governance and management by the Great Barrier Reef Marine Park Authority. Indigenous Protected Areas in the wet tropics coastal regions are a feature of Great Barrier Reef governance,¹⁰ and active caring for country has been actualised by many of these groups via land and sea country Ranger groups¹¹ managed through designated Land and Sea Management Units of local and regional corporations¹², many of which have also developed country-based, and community-based management plans.

Relevant plans and strategies focused on Traditional Owners and their interests include:

- Great Barrier Reef Marine Park Commonwealth Heritage Listed Places and Prosperities Heritage Strategy, 2018-21.
- Draft Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef Marine Park, 2018.
- Reef 2050 Indigenous Implementation Strategy.
- Great Barrier Reef Marine Park Authority Reconciliation Action Plan¹³.

¹⁰For example: Girringun IPA; Eastern Kuku Yalanji IPA; Warraberalgal and Porumalgal IPA ; Pulu IPA ; Warul Kawa IPA

¹¹For example: Gunggandji Land and Sea Rangers; Girringun land and Sea Rangers; Yirrganydji Indigenous Land and Sea Rangers; Yuku-Baja-Muliku Rangers; Torres Strait Islands Rangers (14 community based ranger groups on 13 island communities)

¹²For example: Girringun Aboriginal Corporation; TSRA; Gunggandji PBC Aboriginal Corporation.

¹³<http://www.gbrmpa.gov.au/managing-the-reef/how-the-reefs-managed/register-of-management-arrangements>

Implementing these plans and strategies entails Traditional Owner involvement in, and empowerment through activities such as:

- Overall Great Barrier Reef and Great Barrier Reef Marine Park Authority governance structures.
- The Reef 2050 initiative, specifically the Reef Integrated Monitoring and Reporting Program (RIMReP).
- Guiding strategies and plans for managing cultural heritage on the Great Barrier Reef
- Developing and enacting:
 - Community-based plans across key Great Barrier Reef contexts¹⁴
 - Marine Park Indigenous Land Use Agreements¹⁵
 - Traditional Marine Resource Use Agreements¹⁶
- Participating in research program advisory arrangements and research projects¹⁷.
- Locally generated restoration and management initiatives.

It is crucial that any new RRAP arrangements intended to involve Traditional Owners are aligned with such existing initiatives and activities.

With respect to Traditional Owner regional governance, collaborative partnerships between Traditional Owner groups were developed along the length of the Great Barrier Reef to discuss ways to secure their interests in their sea country¹⁸ (see Dale et al., 2015). The management and governance aspirations that many of these Traditional Owner groups have for their land-sea country in the Great Barrier Reef have been consistently articulated through cross-Great Barrier Reef processes¹⁹, and collectively expressed most clearly at the local estate (family, clan or tribal) level (see Dale et al., 2015).

These groups may have similar **collective aspirations and interests for the future management of the Great Barrier Reef region** and, at their broadest level, such common aspirations have been summarised as:

1. Recognition and respect for Indigenous aspirations in sea country management.
2. Sustainable resource use management through cooperation.
3. Education.
4. Cultural practice and regeneration.
5. The generation of sustained socio-economic benefits.
6. Individual TO-groups determine and promote their own aspirations at the country-based scale (Dale et al., 2015:11-12).

However, due to their distinct place-based culture, language, knowledge and customary marine estates (Smyth, 1995), Traditional Owner groups recognise that it is up to individual groups to

¹⁴ For example, GRIMPA, 2013-2023; Yirrganydji Sea Country Plan, 2014 http://dawalwuru.com.au/files/4314/0360/2666/Yirrganydji_Plan_Online.pdf

¹⁵ For example, Kuuku Ya'u People's Marine Park ILUA, 2009 <https://www.atns.net.au/agreement.asp?EntityID=5007>

¹⁶ For example, the Gunggandji Agreement, 2016 and the Yirrganydji Agreement, 2014. See <http://www.qbrmpa.gov.au/our-partners/traditional-owners/traditional-use-of-marine-resources-agreement>

¹⁷ For example, those initiated through the National Environmental Science Program and, more recently, the Cooperative Research Centre for Developing Northern Australia

¹⁸ Sea Forum I & II, 1997/98; Queensland Traditional Owner Sea Country Turtle and Dugong Workshop, 2011; Queensland Indigenous Sea Country Management Forum, 2013;

¹⁹ For example the work of the Southern Great Barrier Reef Sea Forum Working Group (1999) and the Cape York Turtle and Dugong Taskforce (2011).

determine, promote and practise their own aspirations at the country-based scale for their customary estates (Dale et al., 2015).

These governance and management aspirations are articulated and enacted through key plans and strategies that align with the main objective of the *Great Barrier Reef Marine Park Act, 1975* “to provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region” (2a(1)). The key plans and strategies include:

1. The *Draft Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef, 2018* outlines identified heritage values; threats to Indigenous heritage values; a set of guiding principles to work with Traditional Owners on heritage matters; a set of outcomes and objectives and an implementation plan²⁰.
2. The *Traditional Owner Heritage Assessment guidelines, 2017* provides guidance on assessing impacts to Traditional Owner heritage values in the Great Barrier Reef and ways to avoid or mitigate impacts.
3. The *Reef 2050 Long-Term Sustainability Plan* sets out how the Australian and Queensland Governments will manage, protect, improve the condition of the Great Barrier Reef into the future. Twenty-three of the 139 actions specifically relate to Traditional Owners, as do many of the targets and objectives (see Appendix A). It also includes a commitment to address the targets and actions in consultation with the community – the *Reef 2050 Indigenous Implementation Plan* is one outcome of this commitment.
4. The *Reef 2050 Indigenous Implementation Plan* is an outcome of the commitments to consultation in the *Reef 2050 Long-Term Sustainability Plan*. Key findings highlight that capacity of Traditional Owners is variable across the region; continued support for existing efforts is important; most Indigenous actions identified in Reef 2050 are linked; future consultations are necessary to inform monitoring and reporting; and implementation should focus on coordination, cultural heritage and business capacity.

The work of the *Indigenous Heritage Expert Group* (created to advise on the design of the Indigenous heritage theme of the *Reef Integrated Monitoring and Reporting Program, 2018*²¹ (see Jarvis et al., 2018), identified the need for future work to provide Traditional Owner-driven objective indicators and support the potential contributions of Traditional Owners to monitoring biophysical aspects of Reef health.

A project focused on Traditional Owner aspirations is currently underway²². The contract between the Reef and Rainforest Research Centre and Australian Government’s Department of Environment and Energy for the Reef 2050 Traditional Owner Aspirations Project includes services to “develop an approach to support Traditional Owner engagement in monitoring, evaluation and reporting activities as part of the Reef 2050 Plan reporting”. The project aims to advise the Australian and Queensland Governments on the most effective delivery arrangements under the Reef 2050 Plan for future policy and programs relevant to Traditional Owners of the

²⁰ This strategy was developed by the Great Barrier Reef Marine Park Authority with guidance from the Indigenous Reef Advisory Committee, contributions made by 80 participants from more than 20 Traditional Owner groups from the Great Barrier Reef region, and contributions from previous engagement processes (see CoA, 2018:9).

²¹ Final Report of the ‘Monitoring Indigenous Heritage within the Reef 2050 Integrated Monitoring and Reporting Program: Final Report of the *Indigenous Heritage Expert Group*’ is soon to be publicly released see Jarvis et al., 2018.

²² <http://rrrc.org.au/reef-2050>.

Great Barrier Reef. It will also work with key partners to create shared understanding of Traditional Owner rights, responsibilities and aspirations represented in the Reef 2050 Plan. A final report was submitted from this project in December 2018 and, at the time of writing, was with government and management agencies for review.

Another project focussed on the development of Data Sharing Agreements (DMS4) between Great Barrier Reef Marine Park Authority and Traditional Owners of the Great Barrier Reef is due for completion soon.

The Great Barrier Reef Foundation will convene a Traditional Owner Working Group (interim) for the Reef Trust Partnership to “keep Country, Culture and Traditional Peoples of the Great Barrier Reef strong and resilient” (see Great Barrier Reef Foundation, 2018).

6.3.2 Indigenous cultural heritage

Indigenous custodial worldviews and values are the foundations of ongoing cultural heritage, and cultural heritage is a focus for the management of Indigenous interests on the Great Barrier Reef. The *Draft Aboriginal and Torres Strait Islander Heritage Strategy for the Great Barrier Reef, 2018* recognises the connectedness between country, people, knowledge, values and management interests. It states (CoA, 2018:10):

“The [Great Barrier Reef Marine Park] Authority applies a broad definition of Indigenous heritage meaning physical (tangible) and non-physical (intangible) expressions of Traditional Owners’ relationships with country, people, beliefs, knowledge, law, language, symbols, ways of living, sea, land and objects. These all arise from Indigenous spirituality, including heritage places (sites) and/or values. The Authority recognises that the environment is inseparable from cultural identity, with cultural practices inextricably linked to plants, animals and the environment.

The Authority’s Traditional Owner Heritage Assessment guidelines outline the importance of Indigenous heritage to individuals, communities, Australia and internationally, and provide many examples of Indigenous heritage components (the things that hold value) within the Reef. The Authority recognises that components can hold many values, including natural heritage value, Indigenous heritage value, historic heritage value and social, economic or aesthetic value.”

Great Barrier Reef cultural heritage can be grouped into four broad categories:

- Sacred sites, sites of particular significance and places important for cultural tradition.
- Structures, technology, tools and archaeology.
- Stories, songlines, totems and languages.
- Cultural practices, observances, customs and lore (see the Great Barrier Reef Marine Park Authority *Traditional Owner Heritage Assessment Guidelines, 2017*).

6.3.3 Threats to Indigenous heritage values

Through consultation with the Great Barrier Reef Marine Park Authority, Traditional Owners from the Great Barrier Reef consistently identified a series of threats to Indigenous heritage values (see CoA, 2016; Traditional owner Heritage Assessment Guidelines, 2017; CoA, 2018) including:

- Physical (e.g. sea level rise, modification of supporting terrestrial habitats).
- Loss of knowledge and difficulty in exercising cultural rights and responsibilities.
- Lack of on-ground management capacity and opportunities for Traditional Owners.
- Limited resources to access places to fulfil cultural responsibilities and caring for country management activities.
- Limited consideration of Indigenous heritage, and Traditional Owner knowledge in past Reef decision-making.
- Poor community awareness and appreciation of heritage values.
- No peak body to represent Aboriginal and Torres Strait Islander peoples in Reef governance and decision-making.

The *Traditional Owner Heritage Assessment guidelines, 2017* (2017:8-9) describes the ‘unique social needs and connections’ of Traditional Owners of the Great Barrier Reef that could be impacted by the proposed activities of any application. This is assessed in relation to several ‘attributes’ of social value that include: aesthetics (e.g. a sense of place, cultural expressions such as storytelling), human health (e.g. access to healthy food and the ability to maintain cultural traditions and strong connect to place), employment and income (e.g. direct and indirect employment arising from the proposed project), personal connection to country and sea country, equity and empowerment, and contributions to Traditional Owner wellbeing and their resource use and dependency.

The *Indigenous Heritage Expert Group (IHEG)* created to advise on the design of the Indigenous heritage theme of the *Reef Integrated Monitoring and Reporting Program, 2018*²³ (see Jarvis et al., 2018), reviewed a series of Traditional Owner-driven monitoring frameworks and determined that most successful frameworks were biocultural – connecting community wellbeing with country wellbeing through stories and statistics. The group developed a unique framework, *Strong Peoples-Strong Country* for Traditional Owners to monitor the Great Barrier Reef and its catchments, and thus track the Traditional Owner perceptions of the status of Indigenous Heritage, and progress on the Traditional Owner objectives, targets and actions in the Reef 2050 Long-term Sustainability Plan. The framework and indicators provide a structure for monitoring the condition of the Indigenous heritage asset, and for monitoring progress on achieving the Reef 2050 Traditional Owner objectives, targets and actions. The Indigenous Heritage Expert Group identified six hubs relevant to *Strong Peoples – Strong Country*: Country health, people’s health, heritage and knowledge, culture and community, education, and empowerment and economics. Together, these hubs encompass Traditional Owners’ understandings of the connections between the people and their Country across, and underpinned by, the Great Barrier Reef region. This recognises Traditional Owners’ connection to land and sea country is viewed as primary to their heritage information. Forty-five factors that influence each of these six hubs were uniquely described using the worldviews of Indigenous peoples in the Great Barrier Reef region. For example, education is learning from elders, training, and a passion to learn; and health includes

²³ Final Report of the ‘Monitoring Indigenous Heritage within the Reef 2050 Integrated Monitoring and Reporting Program: Final Report of the *Indigenous Heritage Expert Group*’ is soon to be publically released (Jarvis et al., 2018).

spirituality, access to traditional medicines, and access to medical services (see Jarvis et al., 2018).

6.3.4 Benefits from custodial connections

Supporting Indigenous peoples to exercise their custodial responsibilities is known to generate significant benefits over and above the immediate benefit from a specific action taken. Often known as co-benefits, there is considerable literature from Indigenous Australian land management about this topic over the past couple of decades (Barber and Jackson, 2017). Co-benefits are a crucial means by which Traditional Owners evaluate the full efficacy of management action. A recent analysis of co-benefit categories (Barber and Jackson 2017) showed they include:

- **Health and wellbeing benefits** (Garnett et al., 2009) including spiritual and physical health gleaned from completion of cultural responsibilities, exercise and improved nutrition.
- *Economic benefits* including revenue generation and job creation derived from natural resource management and research collaborations, career development opportunities, secure income, reduced reliance on welfare and strengthening of local economy (Jarvis et al., 2018a, b).
- **Political benefits** enabling self-determination through from visionary leadership, reconciliation and strategic partnership development (see Maclean et al., 2013), leadership skills, confidence to work with non-indigenous partners, Indigenous knowledge contributions to governance and management of Great Barrier Reef (Hunt et al., 2009).
- **Social benefits** derived from the development of social capital, self-esteem, pride, community harmony, research collaborations, reconciliation, opportunities for women (see Aboriginal Carbon Fund, 2017), increased access to education and training (Hunt et al., 2009).
- **Cultural benefits** derived from meaningful work, protection of heritage, fostering/reinvigorating culture and traditions (Barber, 2015) Indigenous knowledge transmission, reconciliation, retention of language and identity (Aboriginal Carbon Fund, 2017).

6.3.5 Approaches for working with Traditional Owners and their knowledge contributions

There have been significant improvements in mechanisms for Indigenous consultation within the Reef in recent years. In research, project classifications with respect to Indigenous engagement have been improved, and data-sharing agreements and Indigenous engagement research protocols have been generated. Effective research collaborations between Traditional Owners and non-Indigenous researchers and research institutions continue to emerge (e.g. Hill et al., 2013; Maclean and Bana Yarralji Bubu Inc, 2015; Robinson et al., 2016; Woodward and Marrfurra McTaggart, 2016; Austin et al., 2017; Zurba et al., in press). However, the potential contribution of Traditional Owner knowledge and research skills to Reef research overall remains undervalued and underutilised. Participatory methods are now commonly used for generating effective engagement and highlighting innovative community-based knowledge contributions.

Several strategies, guidelines and protocols have been developed to support collaborative research and knowledge management with Indigenous people and Traditional Owners:

- Guidelines for collaborative knowledge work between Indigenous and non-Indigenous people (see Austin et al., 2017).
- NESP TWQ Indigenous Engagement and Participation strategy – to ensure meaningful two-way engagement that recognises the interests, rights and knowledge of Traditional Owners²⁴.
- Reef Integrated Monitoring and Reporting Program Data Sharing Agreements (DMS4) with Traditional Owners of the Reef (under review with Australian Government at time of writing).

In addition to the above there are many specific methods that have been used to include Indigenous people in the co-design, implementation and translation of outcomes of research projects. These are tabled below.

Table 9: Methods for including Indigenous people in co-research.

Examples of methods	Source
Participatory action research: building trust, and connections with people and place.	Woodward and McTaggart, 2016
Weaving Indigenous, scientific and local knowledge: through five key tasks (mobilising, translating, negotiating, synthesise, apply) underpinned by customary institutions and Indigenous leadership.	Tengö et al., 2017
Participatory art to enable Indigenous artists to express values, interests.	Zurba and Berkes, 2014; Robinson et al., 2015
Photovoice: Enabling Indigenous photography to implement and translate research.	Maclean and Woodward, 2013.
Collaborative film production supporting skill building, direct communication of research outcomes within Indigenous communities, and external communication.	Barber and Marawili, 2015; Barber and Creek, 2017
Participatory mapping including: <ul style="list-style-type: none"> • Using painting and drawing to elevate Indigenous voices. • 3D mapping and peer-to-peer exchanges to share stories that connect people, places and country. • Influence mapping to develop Indigenous-led strategies that strengthen regional scale action. • Cultural mapping and cultural ecosystem assessment. 	Robinson et al., 2015 NESP, 2017 NESP, 2018 Barber and Creek, 2017
Developing boundary objects to facilitate boundary work between researchers, Indigenous people and others.	Robinson and Wallington, 2012
Matrices and guides that identify cultural-law risks and enabled commercial assessment of decisions to share knowledge.	Maclean et al., 2015 Zurba et al., in press
The “Walking-Together” Indigenist research approach: research as a respectful, reciprocal exchange between Indigenous peoples involving five steps.	Talbot, 2017

²⁴ See <http://rrrc.org.au/nesp-twq-indigenous-engagement/>

Traditional Owners are increasingly calling for, and taking up, roles of leaders and co-leaders of research agendas and research projects (rather than being participants or subjects of research) (see Zurba et al., in press) Future engagement with Traditional Owners in the Great Barrier Reef will require a combination of participatory methods, respect for and practice of appropriate protocols, as well as articulation with broader research engaging diverse non-Indigenous stakeholder interests.

7. KEY MESSAGES AND IMPLICATIONS

7.1.1 Insights on perceived risks and social acceptance

About the value of the Reef

The Great Barrier Reef is highly valued by the Australian population and Reef residents. Nine out of ten (89 percent) respondents agreed it is an important national asset; provides an important habitat for fish and other species and supports a strong tourism industry.²⁵

The Great Barrier Reef is an asset whose value, and values, is widely recognised by Australians, indicating a significant social return on investment in protection and restoration.

About threats to the Reef

Climate change, environmental pests, mining and shipping are widely seen as the most serious threats to the Reef. Stakeholders identified additional threats such as water quality as significant.

Australians and Great Barrier Reef stakeholders recognise major threats to the Reef are serious and multiple. This means the rationale for the program (to help the Reef) is 'sound' or consistent with public sentiment. Over-emphasis on these threats in communication and engagement about RRAP may be counterproductive. Indications are a solution orientation is likely to be more engaging.

About the need for action

Some 84 percent of survey respondents agreed more should be done to save the Reef. There is strong support for threat reduction, local and large-scale restoration. While 71 percent of people supported large-scale restoration efforts overall, Great Barrier Reef residents tended to be less supportive than other Australians. [Survey data, interviews and social media indicate that reduction of threats to the Reef, particularly emissions, is seen as a more pressing or equally important action compared with restoration].

Without visible commitment to addressing pressures on the reef related to emissions reduction, public, and particularly stakeholder support, for investment in large-scale restoration efforts could be compromised.

²⁵ These findings are broadly consistent with other recent national surveys assessing public attitudes towards the Reef and its values.

About public acceptance

Two conditions are highly influential for gaining and maintaining public acceptance of large-scale restoration. The first is people's *beliefs about the need for direct intervention* to help repair, restore and build the resilience of the Great Barrier Reef. The second is *public trust in reef managers, authorities and research institutions*. Both conditions are strong predictors of acceptance of reef restoration. Trust is more influential in acceptance among Great Barrier Reef residents than nationally. Trust issues become even more acute in the minds of stakeholders with a direct connection to the Reef. Trust varies between organisations. Research organisations, the Great Barrier Reef Marine Park Authority, international and non-government organisations more highly trusted than governments to ensure the health of the Great Barrier Reef.

Maintaining and in some instances improving trust between organisations with responsibilities to manage the Great Barrier Reef and stakeholders and the public will be critical to success of RRAP. This will require meeting different needs at different levels, including but not limited to ensuring observability and transparency of action and decision-making; participation in setting goals, assessing technologies, managing risks, identifying opportunities and benefits for stakeholders; and, good governance and oversight that provides procedural fairness. There appears to be a clear 'proximity' relationship where the closer people are to the Reef environment (e.g. geographically, politically and economically) the greater the perceived risk and the greater the desire for participation.

About the role of science and stakeholders

Australians agreed that science can provide solutions to help prevent damage to, and help repair, the Great Barrier Reef. Reef stakeholders support evidence-based action in the Reef but cautioned about adopting a purely 'technical-fix' approach. Stakeholders are seeking active, meaningful involvement in the program and co-benefits from actions.

Scientific research and the science community are valued as contributors to addressing threats facing the Reef. However, working closely with stakeholders and Great Barrier Reef communities through the design, development and implementation phases of the program will be critical, as will a more comprehensive approach to Reef management beyond technical interventions for restoration.

About specific technologies and interventions

Among Great Barrier Reef and Australian residents, there appears to be no existing or entrenched opposition to any of the kinds of restoration interventions being considered by RRAP. Survey results show most people are either ambivalent (or uncertain) or generally accepting of each of the interventions. Cloud-brightening, surface films and genetic modification of corals are considered riskier than others. Interference with natural processes and irreversibility were common concerns. Stakeholders have limited awareness of specific interventions and hold concerns about efficacy and potential negative consequences.

These views were taken during the very early stages of the study, with limited information available to the public and stakeholders and, as such, are indicative of people's initial response to some general intent around restoration. It will be essential to think about how the planned stakeholder engagement will address the range of restoration options as these views may

change as decisions are made about large-scale deployment and as awareness increases around potential positive and negative implications of action in different places.

About acceptance over time

These interpretations are from data collected during the concept feasibility study of RRAP. This program (from December 2017–November 2018) was characterised by relatively low engagement and public and stakeholder awareness of the planned initiative. The levels of acceptance described in this report are likely to reflect this early stage of program development. As awareness about the program, its intent, the technologies and likely consequences become known, we would expect acceptance levels to change. Greater knowledge about the interventions among the public and/or increased levels of involvement do not necessarily lead to greater levels of acceptance over time.

Having the capacity to monitor changes in public sentiment and acceptance of restoration and specific technologies will be critical in maintaining responsiveness of the program to changes or concerns in the Australian public's attitudes towards a program of work of this scale.

7.1.2 Implications for communication

These findings indicate RRAP is beginning in a positive position, with support for restorative and adaptive actions in the Reef generally, and, a guarded level of support from the community and stakeholder groups for non-traditional Reef interventions. To strengthen community engagement and support we need to ensure:

- Greater information is available about the interventions being investigated, particularly new and challenging concepts – their potential benefits and risks (e.g. a series of short, engaging video infographics, widely distributed, to help increase awareness and knowledge).
- Opportunities for genuine industry and community engagement. Traditional Owners, stakeholder groups and particularly the local community, will need to be aware of the opportunities to provide input into decision-making. Citizen science and demonstration sites will also be important. Engagement (e.g. via the Local Marine Advisory Committees) during early phase investment period will be critical.
- RRAP members from science organisations and Great Barrier Reef Marine Park Authority should continue to lead outreach activities where possible, as public trust is highest in these organisations.
- RRAP messaging should continue to clearly acknowledge that the interventions being investigated will not negate the need for greenhouse gas emissions control. Communication would benefit from using a language of 'prevent', 'protect', taking a solutions-orientation and realistically describing what can hope to be achieved.
- While threats are well understood by the community, and communication should acknowledge impacts of climate change and bleaching, speaking to the strong sentiment among stakeholders and the community to 'help' is likely to be more constructive than focusing solely on threats. International support and interest in restoration and adaptation evident in social media could be drawn on in domestic communication.

- RRAP recognises different parts of the population (e.g. international interests, the scientific community, Australians broadly, Great Barrier Reef residents, traditional owners and stakeholder groups) will perceive benefits and risks differently and are likely to experience the distribution of those benefits and risks differently. Communication and engagement will need to be specifically tailored to these different groups, commensurate with their rights and interests.

The Reef is highly valued. The large number of networks and people with a direct interest in the Reef could be leveraged for positive communications and endorsement. For example, tourism operators could incorporate reef restoration into visitor experiences, Traditional Owners and local communities could showcase their involvement. This would help build a sense of ownership and community: we are all in it together, everyone has a role they can play that will help the Reef. Providing opportunities for people to be involved and participate in guiding the program will be critical. Ensuring transparency in decision-making and observability of action will be central to maintaining trust which is critical for acceptance.

7.1.3 Implications for future monitoring of social acceptance

It is recommended a program be developed to regularly monitor changes in attitudes toward proposed restoration interventions over time. This is especially important as many of these proposed interventions are at an early R&D phase. Studies have found that attitudes toward novel interventions can change over time (Braun et al., 2018). Future monitoring would benefit from the inclusion of several other measures and techniques during the R&D and implementation programs of RRAP:

- Given that industry and community are potentially key implementation partners in the future of RRAP, assessment of the level of trust in these groups would be beneficial.
- The survey focused on several proposed interventions. As the R&D program progresses, and potential restoration interventions are filtered with unfeasible methods eliminated, research could be focused on the more feasible options.
- Further analysis of the existing data, and future survey data could examine differences in attitudes based on factors such as socio-demographics, Reef dependency, and between indigenous/non-indigenous populations. Identifying and profiling parts of the community would support and help tailor engagement and communication activities.
- Communicating complex interventions in a public survey has challenges, especially in the early concept feasibility study. The proposed interventions were presented to survey respondents as text. The use of visual aids alongside text in future surveys would improve understanding of interventions, providing more accurate responses.
- Although survey respondents rated potential risks and benefits of proposed interventions, they were not asked to compare across more than one proposed intervention. Respondents may trade off certain types of risk (i.e. cost and safety) with certain benefits (i.e. scalability and effectiveness), depending on the restoration type. There are research techniques (e.g. choice modelling) that may help understand these trade-offs and allow comparisons across interventions.

7.1.4 Implications for designing engagement processes

To deliver an engagement program that meets stakeholder needs and builds on best-practice experience we recommend that RRAP:

1. Implement engagement programs in the Reef that address the social contextual factors and complexities likely to affect the acceptability of large-scale restoration and scientific or engineering programs by stakeholders, rightsholders, communities and the general public.
2. Use collaborative, integrated and learning-based governance processes that link information gathered through engagement programs to processes of internal and external knowledge-sharing and decision-making.
3. Engage rightsholders, stakeholders, the public and transdisciplinary science in inclusive and just processes of consensus building.
4. Develop a five-year strategic stakeholder and community engagement plan and annual operational plans to help coordinate and prioritise engagement activity to meet the needs of the RRAP R&D Program, affected parties (stakeholders, rightsholders, communities etc), and in consultation with related Reef programs.

These recommendations for the RRAP R&D Program and five-year actions are outlined below.

- 1. Develop and implement engagement programs over the life of the RRAP R&D Program that address the social contextual factors likely to affect the acceptability of large-scale restoration and scientific or engineering programs and the contextual needs of the RRAP R&D Program.**

Proposed activities (RRAP R&D Program):

- Map aspirations, values and estimate impacts of restoration and adaptation programs on values, social (including economic and cultural) benefits and harms and compare this with a 'do nothing' scenario.
- Identify compensatory measures and options.
- Monitor attitudes, beliefs and perceptions of risk in diverse contexts (rightsholders, stakeholders and general public).
- Ensure rightsholders, stakeholders and citizens are involved early in framing risks and benefits.
- Identify early co-benefits from RRAP interventions and develop benefit narratives linking engagement, restoration and adaptation interventions to the interests of communities, stakeholders and rightsholders.

2. Use collaborative, integrated and learning-based governance processes that link information gathered through engagement programs to decision-making processes.

Proposed activities (RRAP R&D Program):

- Refine an overarching model of engagement for RRAP which ties multiple types of deliberative practices and decision-making together to address: risk assessment and management, complex social perceptions of risk and impacts (of technology/intervention) on values, benefits and harms.
- Establish demonstration sites to engage rightsholders, stakeholders and general public to monitor and collectively evaluate technologies and methods of scaling.
- Establish place-based strategies, sector or industry-based strategies, issue or technology-based strategies, Traditional Owner strategies and program- and governance-based strategies to allow rightsholders and stakeholders to meaningfully participate in transdisciplinary R&D and decision making and learning.
- Inform the Australian public about RRAP compared with a 'do nothing' scenario, outlining technologies and actions proposed by RRAP and establish regular opportunities for the public to participate in and influence the R&D direction.
- Establish decision support tools to bring multiple forms of social knowledge and data together with scientific knowledge and reef modelling to establish scenarios (options) and seek stakeholder and community feedback on different options.
- Establish processes to reflect on and improve collaborative and integrated learning-based (internal and external) governance processes.
- Build a shared restoration and adaptation governance system, drawing on existing place-based collaborative decision making arrangements, trusted networks and existing mechanisms for engaging livelihood, civil society and institutional stakeholders where possible, and establishing new processes where necessary.

3. Engage rightsholders, stakeholders, the public and transdisciplinary science in inclusive and just processes of consensus building.

Proposed activities (RRAP R&D Program):

- Establish a two-way communication plan to clarify matters of interest to rightsholders, stakeholders for RRAP for interactive knowledge exchange and mutual learning about technology, aspirations, values and restoration options.
- Use a variety of engagement methods to involve diverse organisations, rightsholders and citizens in RRAP and strategies (deliberation, mediation, and negotiation) to communicate uncertainty and build consensus for action between rightsholders, stakeholders, transdisciplinary science and the public. Build technical and financial capacity in sectors where necessary to communicate, facilitate engagement, negotiate trade-offs and support consensus-based positions for RRAP.

- Build RRAP knowledge across levels of governance, coordinate stakeholder engagement with entities who are responsible for decision-making and identify the regulatory and policy alignments needed at design and deployment stages.
 - Develop principles to underpin decision making and decision processes within RRAP for the development, testing and implementation of restoration and adaptation programs and technology.
 - Ensure engagement in RRAP design, testing and implementation explicitly recognises and addresses rights to: participation, fair treatment, information, free prior and informed consent, self-determination and social and economic inclusion.
 - Establish the agreed boundaries or conditions when consensus or agreement on technology and restoration and adaptation action is reached.
- 4. Develop an operational stakeholder and community engagement plan (2019-2022) to meet the needs of RRAP R&D Program, affected parties (stakeholders, rightsholders, communities etc) in consultation with related Reef programs.**

Proposed activities pre-R&D program (2019):

- Develop an agreed strategic plan (containing objectives, implementation strategies and performance measures for stakeholder engagement) to meet the place-based, issue-based or technology-based engagement needs of the R&D program.
- Develop advice on operational-level capacities and tools (e.g. information packages, use of existing engagement networks, communication strategies, pilot locations) to support the conduct of reef restoration and adaptation science in different engagement contexts over the life of the R&D program (2019-2022).
- Clarify the programmatic and practical links between the stakeholder engagement activities for the RRAP R&D Program and other engagement/stakeholder policy processes in the Great Barrier Reef governance domain. Clarify links between RRAP R&D Program stakeholder engagement and a) the Traditional Owner and Community Partnerships Component of RTP, b) social science data gathering through the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) and c) government and agency stakeholder and community engagement processes.
- Trial and evaluate engagement and communications tools and approaches to engage stakeholders and communities along the Great Barrier Reef in RRAP science. Build on stakeholder and community engagement in the scoping phase and begin socialising the science program, seek early feedback, and outline future engagement processes and opportunities to be involved.

7.1.5 Implications for working with Traditional Owners and Indigenous communities

The discussion above has clear implications for RRAP planning and the subsequent implementation of the R&D program. Traditional Owners of the Great Barrier Reef have a different status from other stakeholders, with a deep and abiding prior claim to ownership that is increasingly recognised in Australian law and in Great Barrier Reef regulatory and governance structures. This First Nations status, and the consequently profound connections between Indigenous people, country, culture, and heritage are crucial considerations in program planning.

In undertaking program activities, RRAP must take into account this longstanding prior claim and the diverse Indigenous values, rights, interests and development aspirations that flow from them. RRAP will also need to be mindful of existing identified threats to these values, and of understanding the relationships between values, rights, aspirations, and threats. This is true at a Great Barrier Reef-wide level but is particularly true with respect to the selection of geographically specific RRAP field trials and management actions. Traditional Owner participation in program governance will need to occur at Great Barrier Reef-wide and Great Barrier Reef regional scales for the scoping of options, followed by specific local-level engagement with the identified Traditional Owner custodians of prospective areas.

Indigenous people have expressed a longstanding desire to work with government agencies, planners, and researchers to generate the enabling information to make informed decisions about the future management of the Great Barrier Reef. Indigenous-led and cooperative processes, co-management and co-research will need to be an important part of meeting this aspiration.

The combination of emerging Indigenous research protocols and partnerships with the increasing sophistication of participatory methods provides an opportunity for RRAP. RRAP can build on the emerging foundations for best-practice Indigenous research engagement within the Great Barrier Reef specifically, and Northern Australia more generally, to create both co-developed and Indigenous-led programs that enable Indigenous knowledge contributions and maximise the community impact of RRAP innovations.

Further, as an environmentally focused program, RRAP is in a strong position to generate long-term social and other co-benefits for Traditional Owners from its activities. Appropriate attention to structural governance arrangements, management, and the capability and procurement aspects of program activities can enable RRAP to enhance local community, wider stakeholder, and client value through co-benefits, with consequent benefits to perceptions of the program.

At a general **governance** level, five key initial implications can be identified as underpinning effective Traditional Owner engagement:

- Traditional Owners are custodians with a longstanding prior claim and emerging legal recognition. Therefore, they should be addressed as leaders of restoration efforts, not solely as 'stakeholders'.
- Traditional Owners should be included in program design from the outset rather than consulted at the draft or consultation stage.
- RRAP Traditional Owner engagement can minimise duplication and associated consultation load by examining how existing or planned engagement structures can be additionally resourced to support RRAP.

- Careful attention will be required to address how Traditional Owner interests are effectively represented in wider multi-stakeholder forums given that it is crucial that they are guides and participants in wider conversations, yet also have a unique status.
- As Traditional Owners knowledge systems are based on unique world views that result in different perspectives about what constitutes a risk, careful attention will need to be paid to perceptions of risk associated with RRAP. This will be a critical focus when engaging with Traditional Owners.
- The Traditional Owner Working Group was established by the Great Barrier Reef Foundation in December 2018 through an open merit selection process. Its role is to ensure the views and knowledge of Great Barrier Reef Traditional Owners are reflected in the development and implementation of the Reef Trust Partnerships, as well as providing advice and guidance to the foundation on culturally appropriate engagement processes with Traditional Owners. While not replacing the need for direct engagement with specific Traditional Owner groups, this working group will help direct the RRAP governance architecture.

At a **program operational level**, it will be crucial to enable Traditional Owners' participation and opportunity. Three key aspects of program operations would be to:

- Ensure resourcing can accommodate effective remuneration for both governance and operational participation.
- Ensure opportunities for Traditional Owner participation, including employment, education and skills development.
- Evaluate how program operations can enable wider co-benefits from environmentally focused program activities.

At a **program communication level**, there are three key implications:

- An extensive communication/education process is needed to raise awareness of RRAP and the potential opportunities for Traditional Owners and Indigenous people of the Great Barrier Reef.
- Communication and engagement will need to encompass multiple scales, with particular attention paid to the local and sub-regional scale which are areas of RRAP activity.
- Ongoing communication can be enabled by specific initiatives, for example the development of an information portal through which Traditional Owners are supported to access information about the program (including past, current, and future activity) to enable understanding of all that is happened across the Great Barrier Reef.

For **research management**, planning and operation, best practice will need to involve:

- Indigenous-led and co-leadership models.
- Prioritisation of research participation opportunities for Traditional Owners.
- Enhancing the role and status of Indigenous and local knowledges to better understand changes in the Reef but also implications of RRAP activities.
- Careful structuring of research and associated management of project permitting to better accommodate increased permitting demands.
- Prompt initiation of early steps such as workshops to 'test' engagement frameworks and enhance opportunities for alignment with other Great Barrier Reef-focused structures and initiatives.

Ultimately, partnerships with Traditional Owners form the crucial foundation for future RRAP legitimisation and growth. Traditional Owner cultural acceptance and participation is a primary component of social acceptance and social participation in RRAP.

It is important to note that progress to date has not been sufficient. There is a need to mainstream involvement of Aboriginal and Torres Strait Islander peoples across RRAP (including engagement activities). There is a need to empower Traditional Owners to exercise their unique rights and responsibilities including Traditional Owner involvement in RRAP governance. This could focus on for example resourcing direct involvement in R&D – co-research and/or subcontracting field research, and, exploring education and accreditation opportunities. There is an imperative also to shift the conversation in the broader RRAP from a focus on ‘avoided loss of cultural heritage’ to realisation of aspirations and social, cultural and economic co-benefits.

On 13-15 May 2019, the Great Barrier Reef Foundation together with its Traditional Owner Working Group, hosted a three-day Traditional Owner workshop at Cape Cleveland, Townsville. The purpose was to seek Traditional Owner input on the development of the Reef Trust Partnership Annual Work Plan for 2019-2020 – with additional forecasting over a five-year program horizon, and a concept for a Reef-wide co-design framework. As part of this workshop there was a dedicated half-day session on exploring issues and opportunities for Traditional Owner engagement in RRAP.

8. INTEGRATION AND LINKS WITH OTHER RRAP ACTIVITIES

There are several critical areas that will require close coordination and integration between engagement activities and other components leading into and during the RRAP R&D Program. These include:

- **Governance:** Establishing a new (or linking existing expertise or representative forum) to provide direct stakeholder and Traditional Owner voice into to the governance arrangements of the RRAP R&D Program (such as a reference or working group).
- **Regulatory design:** Clarifying the relationship between deliberation on technologies in the engagement sphere with deliberations occurring in the formal assessment and approval of activity in the regulatory and permitting system.
- **Co-design of interventions:** Establishing processes by which stakeholders, communities and Traditional Owners are involved in the co-design of the R&D activities with relevant ecological and engineering specialists on technologies or interventions to increase transparency, improve outcomes from, and effectiveness of, interventions [RRAP team members held an initial scoping workshop to identify opportunities for co-design in the R&D program].
- **Economic valuation:** Work closely with the team undertaking the economic assessment of changes to social, cultural and economic values associated with the Great Barrier Reef under different intervention and emissions scenarios.

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APPENDIX A – RRAP DOCUMENT MAP

Reef Restoration and Adaptation Program



Reef Restoration and Adaptation Program, a partnership

APPENDIX B – ENGAGEMENT STRUCTURES IN THE GREAT BARRIER REEF

Supporting technical document available on request - Findings from PD2 Activity 2 - Identify and 'map' significant engagement, advisory or deliberative structures. Last draft 6 November 2018. Vella, K., Taylor, U., Baresi, U., and Lockie, S.

APPENDIX C – SYSTEMATIC REVIEW OF INTERNATIONAL LITERATURE

Supporting technical document available on request - Public participation in large-scale ecosystem restoration and adaptation. Last Draft 7 October 2018. Vella, K., Lockie, S., Taylor, U., and Baresi, U.

APPENDIX D – RESTORATION SCENARIOS USED IN NATIONAL SURVEY

The following short descriptions of eight current and future reef restoration approaches and technologies were designed for use in the national survey. This allowed us to move beyond generalised attitudes toward restoration and start to develop a baseline understanding of how citizens respond to more specific restoration approaches and technologies. Each respondent was presented with only one scenario followed by a series of statements designed to assess their responses to the scenario. The scenarios were designed with input from scientific experts at the Australian Institute of Marine Science (AIMS).

The descriptions of each restoration approach tested in the national survey include:

- Increased shading using surface films.
- Increased shading using cloud brightening.
- Increasing heat resistance of corals using natural breeding techniques.
- Increasing heat resistance of corals using genetic modification.
- Infrastructure solutions such as rubble stabilisation.
- Infrastructure solutions such as human-made reef structures.
- Pest control using biological agents.
- Pest control using manual removal.

Block 1: Shading (Surface films)

One approach aims to **shade** areas of the reef using ultra-thin **surface films**. Surface films contain sand-like calcium grains, which are what corals are made of. These materials occur naturally in marine environments and are biodegradable. When used in this way, they sit on the surface of the seawater above the corals. **Potential benefits** include cooling and shading the reef, which prevents damage to coral and other organisms. Surface films could be deployed when coral bleaching conditions (i.e. extreme heat events) are predicted. **Potential risks** could include over-shading of some light limited coral. Further research is required to understand the effect of surface films in reef environments. Similar methods are currently used to prevent evaporation from reservoirs and dams.

Block 2: Shading (Cloud brightening)

One approach aims to **shade areas** of the reef through **cloud brightening**. Brighter clouds reflect more of the sun's light that reaches the seawater surface. To achieve this, very small seawater droplets are sprayed into the atmosphere using devices similar to snow making cannons placed on boats, pontoons or permanent structures in the marine environment. **Potential benefits** include cooling and shading the reef during stressful conditions that can lead to coral bleaching. Cloud brightening can be used when bleaching conditions are predicted. It can also be used only when it is required (i.e. it can be 'turned off'). **Potential risks** could include small changes to local weather patterns such as altered rainfall. Further research is required to understand the effect of this technology. Similar technologies are currently used to produce hydroelectricity and snow.

Block 3: Heat-resistant corals (Natural breeding)

One approach aims to enhance the heat resistance of corals by encouraging the selective breeding and spread of **naturally more heat resistant corals**. This can help corals become more resilient to ocean warming and improve the overall health of coral reefs. **Potential benefits** include helping corals to become more tolerant to marine heat waves and environmental change. **Potential risks** could include possible changes in local coral structures and species interactions. Further research is required to understand the effect of this technology. This approach may involve breeding corals in land-based nurseries, an approach that is already used in aquaculture.

Block 4: Heat-resistant corals (Genetic modification)

One approach aims to enhance the **heat resistance of corals** using **genetic engineering**. Genetic engineering includes methods that allow very precise changes to be made to the genetic material of corals, or algae that lives in corals, to increase their ability to cope with heat stress. **Potential benefits** include helping corals to resist, repair and recover from bleaching events by improving their tolerance to heat stress. **Potential risks** could include possible disruptions to the ecosystem and spread of modified algae to other organisms. This technology is not yet sufficiently developed to be applied to corals. Further research is required to understand the effect of this technology. Similar methods have been used to genetically modify food crops including maize and canola.

Block 5: Infrastructure (Rubble stabilisation)

One approach aims to help **stabilise dead coral rubble so that new corals can grow**. Mesh structures or the application of binding agents can be used to prevent movement of the coral rubble. New coral can then naturally establish themselves and grow on this material. **Potential benefits** include providing a stable habitat to promote coral settlement and growth. This approach requires minimal human labour to maintain, and would work most effectively at a local scale. **Potential risks** could include changes to natural conditions such as ocean currents, water quality, and impacts on other reef species. Further research is required to understand the effect of this technology. Similar methods are currently used overseas to fix coral reefs damaged by ships.

Block 6: Infrastructure (Reef structures)

One technology aims to create **reef structures**. Reef structures are human-made structures that mimic the features of natural reefs by using rock or other materials. Material would be produced on land and placed into the marine environment using barges. **Potential benefits** include retaining critical herbivorous fish (i.e. species that eat the algae on corals) in the corals, which can increase the rate at which a reef recovers from mass bleaching, cyclones or predator outbreaks. Reef structures would require some large-scale construction and are potentially costly if deployed over large areas of the reef. **Potential risks** could include changes to natural conditions such as ocean currents, water quality, and impacts on other reef species. Further research is required to understand the effect of this technology. These methods are currently used overseas to fix coral reefs damaged by ships.

Block 7: Pest control (Biological agents)

One approach aims to reduce the damage caused by pest species on the reef. Pests can include excess seaweed and algae on corals which can negatively affect coral health. Methods to remove excess seaweed and algae include using biological agents such as fish or sea urchins which eat the seaweed and algae. Pest control is most effective when used in conjunction with other reef restoration approaches. **Potential benefits** include repair of high value reefs with limited human labour required (i.e. reduced manual removal of pest species). **Potential risks** could include the uncertain impact of biological agents, and the removal of algal habitat as a food source for other local species. Further research is required to understand the effect of this technology. These methods are not yet used in reef environments.

Block 8: Pest control (Manual removal)

One approach is controlling coral predators and pests through **pest control**. This includes controlling crown-of-thorns starfish populations which destroy coral when there are too many of them. Methods can include manual removal by divers with tools such as metal spears. Pest control is most effective when used in conjunction with other reef restoration approaches. **Potential benefits** include the repair of high value reefs. **Potential risks** could include damage to coral when the pest is being removed. This method requires significant human labour and is already being deployed in many areas, including at important tourism sites.

APPENDIX E – SOCIAL MEDIA ANALYSIS

The social media study was conducted by Dr Maxine Newlands, and Ms Melusine Martin (James Cook University).

Background and Objectives

Public discussion around the Great Barrier Reef's long-term survival is often couched in terms of doom and gloom (Lankester et. al., 2015). Environmental groups, conservationists, politicians, marine scientists and climate scientists often push a negative discourse when discussing the Great Barrier Reef in public forums. The Great Barrier Reef has even had its own obituary written following a mass bleaching episode – RIP the Great Barrier Reef (October 2016). Posts and public commentary such as this highlight how, many outside the marine science community understand the current health of the Great Barrier Reef.

Since the back-to-back mass coral bleaching events of 2016 and 2017, politicians and journalists have been talking about the Reef in a language of doom and gloom. Disaster discourse frames public debate. Negative terms permeate public sentiment, aided by the mainstream and social media.

To test if public sentiment around interventions being investigated by RRAP were susceptible to similar negativity, we undertook a sentiment and discourse analysis of social media using tweets as our data source. This analysis of how the public discuss reef restoration on social media will inform RRAP's Stakeholder, Traditional Owner and Community Engagement assessment, the Stakeholder R&D plan and the Stakeholder and Regulatory Engagement recommendations reports.

Social media data analysis is an innovative and unique means of research not previously applied to inform reef restoration in large-scale marine park (LSMP) management. Although there have been studies using sentiment analysis from twitter in tourism (Becken, 2017 et al.), applying social media sentiment and discourse analysis to reef restoration is unique. Our innovative approach aimed to measure public sentiment and identify key drivers to inform the social licence research for RRAP.

While some would argue "sentiment on Twitter[...] is not a reliable proxy for public opinion" (Mitchel and Guskin, 2013, p. 3), Becken et al. (2017) study of tourism tweets on the Great Barrier Reef found the "geographical spread of Twitter posts is at least in theory, sufficient to gather collective knowledge" (96). Daume (2016) notes Twitter "is a proven platform for ecological monitoring, acting both as real time data source thus providing early indicators for potential shifts in social licence and public sentiment" (2016, p.81).

Further, our aim is to identify general sentiment and discourse, and not individual stakeholders and drivers of the narrative, therefore our sample excludes any metadata (demographics, biographies of tweeters, age, gender). Future studies would include data and metadata to help identify demographic differences across the Great Barrier Reef catchments.

The **objectives** of this study were to:

1. Establish a systemic approach to gathering social media data, focusing on Twitter as a measure of public sentiment of reef restoration interventions (mapping of the current public sentiment).
2. Identify the language and sentiment used in the story of Great Barrier Reef restoration on social media.
3. Interrogate public perception via social media conversations around reef interventions with an in-depth analysis of public sentiment around reef restoration and intervention projects on the Great Barrier Reef.
4. Establish the implicit and explicit key drivers of risk perception of reef restoration.
5. Provide preliminary advice about:
 - Potential public discourse around RRAP interventions.
 - Identify required capacity (communication staff and strategy) longer-term monitoring and evaluation.
 - Areas of focus for 2019 and beyond.

This study informed the stakeholder engagement work, R&D and communication outreach for RRAP by identifying:

- The extent to which sentiment and discourse analysis can be useful for ecological monitoring in the Great Barrier Reef.
- Ways to monitor and evaluate the extent of public sentiment both inside the Great Barrier Reef region and globally over time.
- Roadblocks that may require education and engagement strategies, such as where public sentiment may be complex and unclear, or uncertainty exists.
- Where RRAP outreach may need to be reformed, tailored or directed.

This report outlines the methodology and explains our approaches to data collection, coding criteria and sentiment analysis. It identifies a typology of reef restoration-related tweets that have been generated by the public in Twitter discussions on restoration. It's important to look at the language people are using over the scientific community as it plays an important role in shaping knowledge and the discourse. We provide an overview of this sentiment and unpack the discourse that shapes public and media sentiment of reef restoration science. The data was coded to align with RRAP's R&D focus and proposed interventions. Data was coded to help unpack how the people on twitter understand the current and potential interventions, by analysing the sentiment and the language (discourse) and overall findings. For simplicity, we discuss our findings in the context of tweets sent inside the Great Barrier Reef region, and reef restoration-related tweets sent from outside the Great Barrier Reef region at a global scale. We chose to have two geographical datasets for the following reasons:

- That any proposed RRAP interventions will be new to the Great Barrier Reef but not necessarily new in other Large-Scale Marine Parks (LSMP) i.e. Florida Keys, Indonesia.
- The Great Barrier Reef community is varied in profession, demographics, stakeholder interest and governance. Identifying public sentiment also helps with understanding

social acceptance of reef restoration science for those living and working in the Great Barrier Reef region.

- By assessing how the public feels via social media will help identify roadblocks for Reef managers, regulators and policy makers at a local and region scale e.g. Environmental Impact Assessments (EIA), permits, guidelines.

Our report concludes with a discussion on risk perception in reef restoration and ways of mitigating risk.

Methodology

We took a mixed-method approach using quantitative and qualitative analysis. Our quantitative data was gathered via a third party (Institute for Integrated and Intelligent Systems, Griffith University) using a Twitter Application Programming Interface ²⁶(API) (c.f. Becken, Stantic, Chen, Alaei and Connolly, 2017). We analysed the quantitative data through a sentiment analysis, which we supplemented with a discourse analysis (qualitative analysis) to explore public sentiment of reef restoration projects.

Tweets with the hastags #coral, #gbr and #greatbarrierreef, were removed from two locations. Twitter data was sourced from tweets sent from both inside and outside the Great Barrier Reef region. Tweets from within the Great Barrier Reef region were taken within the geographical boundaries as defined by longitude and latitude measurements. Globally, tweets were taken the same way, excluding the Great Barrier Reef region. In both scrapes the same hashtags were used to gather the data.

With the exception of the third dataset (#coral) we focused our data analysis on the 12 months between June 2017 and July 2018. This included the Australian summertime (Sept/Oct), a peak tourism period on the Great Barrier Reef, the Queensland State government election, the launch of on-going reef restoration projects (non-RRAP related) and the launch of the Reef Restoration and Adaptation Program.

The data was collated in conjunction with a sentiment analysis scoring system using the python-based computer programming language that creates a Valence Aware Dictionary for sEntiment Reasoning (VADER). The dictionary can then be used in the sentiment analysis allows for large volumes of text-based data. The sentiment analysis was supplemented with a discourse analysis²⁷ to identify both themes and risk appetite (Houlihan and Creamer, 2017) for RRAP and reef restoration more generally. We discuss risk later in the paper.

Key word findings

We identified five key word categories from a desktop literature review:

- **Interventions** both physical and biological (e.g. Assisted evolution, biocontrol).
- **Policy/governance** (e.g. Queensland and Australian governments, UNESCO).

²⁶ Application Programme Interfaces (API) allows for one computer to ask a social media company (such as Twitter) for specific information. For example, you use an API to ask Twitter for any Tweets that include a specific hashtag (#) or twitter account. The API is the connection between you and the social media provider.

²⁷ A discourse analysis looks at the language of a subject to identify what the key themes are, how knowledge or the story of an event is formed, maintained and evolves in the way people understand a subject.

- **Marine life** (e.g. crown-of-thorns starfish, corals, jellyfish, crocodile, octopus, dugong).
- **Descriptors** (e.g. dead, dying, repair, recover, intervene).
- **Climate** (e.g. climate, acidification, warming, adaptation).

Our keywords also included synonyms to ensure a broader range of terminology (see appendix for full list). The list was peer-reviewed by both RRAP team and steering committee members and revised accordingly. Due to the large volume of tweets, we devised a bespoke Excel-based cleaning program to remove any non-Great Barrier Reef and reef restoration-related tweets.

As there was a large volume of non-reef restoration tweets, we devised an exclusion criterion which included any non-English text and tweets with the hashtag #gbr (upper and lower case) yet unrelated to the Great Barrier Reef. For example, hashtag Great Barrier Reef (#GBR) stands for the country Great Britain, the American football team the Nebraska Huskers, and in some cases the #Great Barrier Reef was tagged for commercial products. Furthermore, hashtag #coral also referred to the bookmakers Coral—a national chain of betting shops in the United Kingdom, or the colour coral was often used by jewellery and clothing companies. We also removed aspirational or tourism promotions – e.g. tweets referring to diving the Great Barrier Reef as a ‘bucket list’ achievement. Other non-Great Barrier Reef related tweets include those where the #gbr was linked to get retweets without being connecting to the Great Barrier Reef.

The third dataset hashtag #coral had an additional search using keywords and synonyms around bleaching (bleached, bleach, dead, white) to further extract tweets after exacting great barrier reef, led to n= 64,255 tweets. The data showed that when people talked about the Great Barrier Reef and coral, 51 percent of tweets were related to coral bleaching. Aware that the #coral tweets may skew the data, we focused on datasets one and two and for the reasons given above [Section 1.2].

The keywords led to 278,557 tweets, and unsurprisingly, the majority of tweets were from the Great Barrier Reef Global dataset (n=230,338), while the Great Barrier Reef Region dataset was n=48,219. A final manual cleaning of the two datasets, left us with 34,405 usable tweets, of which 6244 tweets were from the Great Barrier Reef region, and 28,161 from the global dataset. Due to the difference between the two data sets, we chose not to conduct a comparative analysis, instead we focused on the key issues driving the sentiment and discourse.

Quantitative data collection: Sentiment Analysis

Valence Aware Dictionary for sEntiment Reasoning (VADER), [sic] is an open access tailored dictionary that measures words for their positive, neutral or negative sentiment. VADER is a simple rule-based approach that scores aspects of words relative to other parts of speech (Hutton & Gilbert, 2014). Sentiment analysis is the means of measuring language processes to identify mood, sentiment and opinion (Bhadane et al., 2015) within a text. The method is one that combines natural language processing, with text analysis and computational techniques (Hussein et al., 2016). Sentiment analysis allocates a score to text-based language with a range between minus and plus one, with zero being neutral. For

example, the word ‘fantastic’ would have a high positive score, e.g. 0.95, whereas ‘death’ or ‘catastrophic’ would be given a negative score (e.g. -0.999)

With the sentiment analysis data, we were able to construct a coding criterion for the discourse analysis. We found that the general public and the media would interpret the scientific terms into more relatable everyday items. Therefore, we built a typology of reef restoration twitter terms that related to proposed RRAP interventions.

The choice to develop a typology came after we discovered that people on Twitter were creating their own terminology when tweeting about reef restoration science. We developed a classification system of alternative words people were using next to the scientific terms for RRAP science. In classifying twitter words next to the scientific terms in RRAP, we were able to capture all relevant tweets. The typology meant that we can analysing the words and language people are using to describe the science. It also provides the data to interpret how people understand the science, or not in some cases, and their sentiment providing data in how people communicate about reef restoration science.

The thematic analysis aimed to assess the level of risk using the public sentiment to identify key influencers shaping the narrative and identify areas of focus for 2019 and beyond. We found three key themes driving the story of the Great Barrier Reef reef restoration: ‘trust’ (positive and negative), ‘threats’ and ‘knowledge’ were common in all datasets.

We found that there was a whole new set of terms people on Twitter were using over the more scientific language of reef restoration. In correlating the twitter terms, with RRAP scientific terms we discovered a lot of RRAP’s proposed interventions were not in any tweets. Proposed RRAP interventions that were excluded from tweets, were:

- **Reef structures and stabilisation:** the-stabilising of broken and dead unstable coral rubble, and creating artificial reef surfaces and structures.
- **Probiotics and enhanced bleaching survival** - preventing coral stress (which causes coral bleaching) or facilitating recovery following stress. These include manipulating corals’ association with its resident algae, its microbiome, fungi or viruses to enhance survival and growth following stress.

RRAP interventions that people were aware off, or reacted to media reports of were:

- **Shading and cooling:** preventing coral stress by cooling and shading reef waters.
- **Reproduction and recruitment:** targeting reproduction, recruitment, and recruit survival to enhance recovery following a disturbance.
- **Biocontrol:** using bio-control approaches to facilitate reef recovery or maintain reef health, this type of method includes reducing populations of coral predators and competitors.
- **Assisted evolution:** enhancing temperature tolerance, and other desirable coral traits, to facilitate natural populations’ adaptation to environmental change.
- **Synthetic biology and genetic engineering:** enhancing the stress tolerance of the coral animal or symbiotic partners.

Other interventions include coral gardening and the proposal around cloud seeding.

Summary of findings

The social media analysis identified within that the Great Barrier Reef region, the main conversations were dominated by climate change, mining and bleaching as key threats. Mentions of climate change and bleaching, and/or climate change and mining have the highest negative sentiment. The data is consistent with previous studies that identifies media coverage of the environment and the Great Barrier Reef as threatened within a disaster discourse. Where interventions appear in the same tweets as the term's climate change, bleaching or mining (#stopadani) there is also a negative sentiment present. This has implications in framing and communicating information about specific interventions. In summary, we found that:

- People were creating their own terms and language that was more informal than the scientific data
- Framing interventions in relatable terms whilst discussing the significance impacts of climate change and bleaching on the Great Barrier Reef gives a negative sentiment
- Framing RRAP interventions on their own, without any other factors produces a positive sentiment.
- The terms, **protect**, **repair** and **prevent** are key drivers of positive sentiment.
- The more **innovative** the science, the more positive the sentiment in the global data.
- Reproduction and recruitment including assisted evolution has the highest positive sentiment followed by shading and cooling and synthetic biology.

Sentiment analysis findings:

Overall, both datasets showed that climate change, bleaching, and mining dominated the data that produced a negative sentiment about the Great Barrier Reef. In this data, we found reef restoration social media tweets were very limited. Globally and inside the Great Barrier Reef region generally an overall negative sentiment in the public talking about the Great Barrier Reef. The language was dominated by loss of coral rather than recovery.

However, the tweets that were gathered from a global scrap do indicate an underlying positivity and support for innovative solutions such as RRAP. In the #coral dataset (taken from around the world) we found that sentiment shifts from more negative in 2017 to more positive in 2018.

We also found in the global data a strong positive sentiment, but we see more negativity and less neutral tweets. From this we can surmise that of the small number of tweets sent inside the Great Barrier Reef, those that show trust in scientists and innovative methods could explain the turn towards more positive sentiment. However, at a global scale, we suggest there was more conflating of interventions with the larger issues of climate change and bleaching that dominate global discourse and sentiment. Within the Great Barrier Reef region, a positive sentiment of almost 50 percent was recorded, with most tweets either neutral or positive within the Great Barrier Reef region.

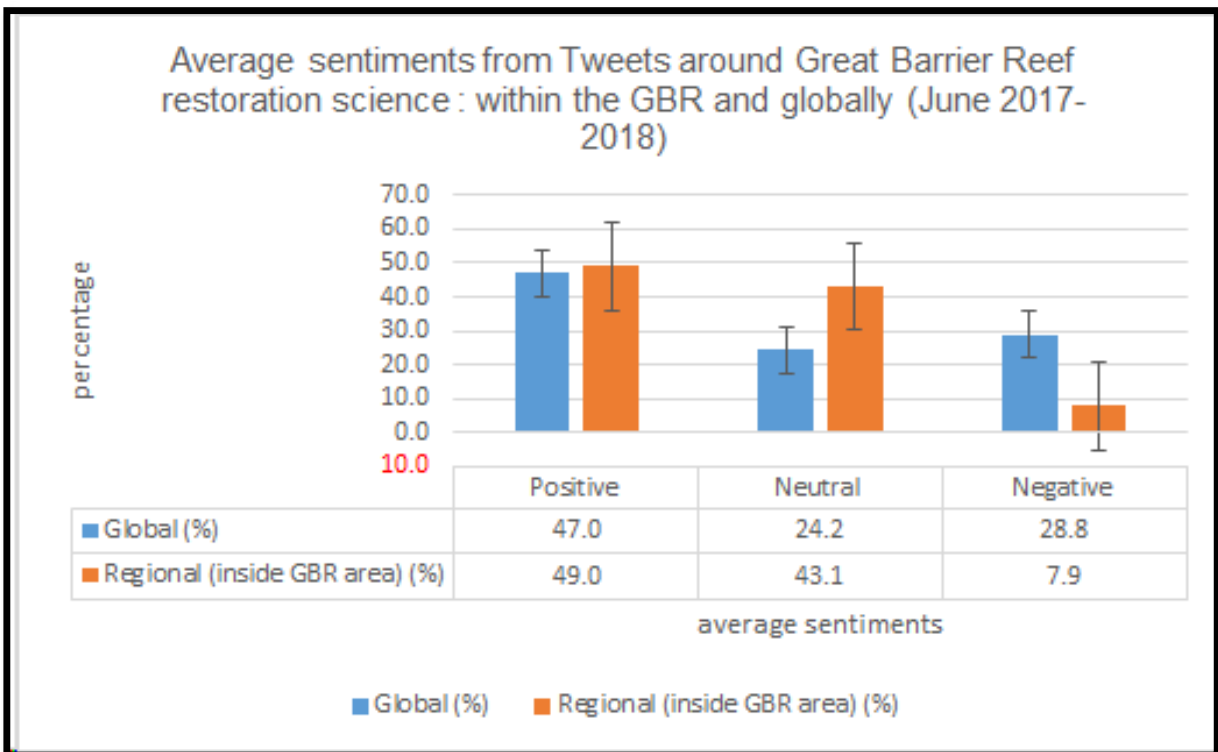


Figure 1: Comparison of average sentiments towards Great Barrier Reef restoration research science both within the region and globally.

The data shows that within the Great Barrier Reef region, the most significantly driver of negative sentiment was mining, driven by tweets from environmental groups and prominent scientists and individuals. In 2016, there was a strong focus on external factors and the future of the fossil fuel industry. A year later, following the back-to-back bleaching, the focus was on negativity and a doom and gloom discourse. By 2018, there were signs of positive sentiment towards coral restoration. Sentiment shifted from dead and dying to protect, prevent and repair. Even though we can track a growing optimism, as far as the future of the reef is concerned, this trend takes place within a dominant trend of perceiving and describing the Great Barrier Reef negatively.

Thus, the data left that specifically related to restoration and adaptation science was very small and reduced further when we discovered that only five of RRAP interventions being considered were registering in Twitter conversations. With the data we did have, overall, our results found positive sentiment in the language around innovative technologies and/ or coral reef restoration research that carried relatable outcomes.

Findings: language, discourse and a typology of reef restoration on Twitter

We found that both inside and outside of the Great Barrier Reef region, the general sentiment and language in the tweets that mention the Great Barrier Reef is mostly negative, due to the prominence of tweets about bleaching, climate change, and regional issues. We identified significant differences in the perception of interventions between those tweeting from within the Great Barrier Reef region and those outside. Inside the Great Barrier Reef region, the narrative is dominated by Queensland and Australian environmental policy and

governance issues over discussion on climate change and the Great Barrier Reef. The majority of the tweets focus on domestic politics (governments, #auspol and federal), and mining also feature prominently in the Great Barrier Reef region, more so than #climatechange and the #greatbarrierreef. The top ten most common terms were: 'bleaching', 'governments', 'stop Adani', followed by 'corals', 'science' and #auspol', #climatechange and #greatbarrierreef and 'risk'.

Outside of the Great Barrier Reef narratives around climate change and the Great Barrier Reef were the main conversations. The table below show the most common words and themes being discussed on tweet inside and outside of the Great Barrier Reef.

Table 1: Coral reef restoration discourse [top ten] inside and outside of the Great Barrier Reef region.

Most common language from tweets sent outside the Great Barrier Reef Region.	Percentage of a word in all global tweets	Most common language from tweets sent inside the Great Barrier Reef Region.	Percentage of a word in all Great Barrier Reef region tweets
corals	13.38	bleaching	16.24
changing	7.43	governments	7.88
climatism ²⁸	6.76	stopadani	4.16
Greatbarrierreef	5.55	corals	3.67
dying	5.31	science	3.40
turtles	4.94	#auspol	3.27
saving	4.67	federal	2.15
bleaching	4.61	#climate change	2.03
giant fans	3.52	#greatbarrierreef	2.00
government	3.25	risk	2.00

The results tell us that inside the Great Barrier Reef community the narrative is driven by scepticism, lack of awareness and a large focus on the external risks of mining, climate change and political point scoring. Federal politics and local issues were given a greater focus than climate change and the Great Barrier Reef itself. Tweets predominantly focused on tourism, aesthetic aspects of the reef, and the cliché – ticking off the bucket list. Tweets barely mentioned ecological concern. The lack of marine environment-related tweets reflected similar data in other studies (Becken et al., 2017). Outside of the Great Barrier Reef the main narrative was around corals the climate and the Great Barrier Reef, with policy and governance less prominent.

Further, with the data we did have, overall, our results found positive sentiment in the language around innovative technologies and/ or coral reef restoration research that carry relatable outcomes. Framing the interventions within a relatable discourse makes it more accessible to the general public. We found that Twitter users were creating their own language and words in place of scientific terminology. In the table below the left-hand column

²⁸ Climatism is an Americanism referring to anthropogenic climate change.

lists RRAP’s scientific terms. The right-hand column is a typology we have developed from how people are defining the innovation on Twitter.

Tweet Typology: Terms the public have used in describing RRAP science, research and restoration.

We found Twitter users were creating their own language and words in place of scientific terminology, much of which was relatable to every item. In the table below the left-hand column lists RRAP’s scientific terms. The right-hand column is a typology of alternative words that are being used in tweets to discuss the various interventions.

Table 2: Public typology of reef restoration and adaptation science on Twitter.

RRAP science and research intervention terminology	Our typology of reef restoration on Twitter: words the public are using to describe the scientific terminology
Reproduction and recruitment and Assisted Evolution: Targeting reproduction, recruitment, enhancing temperature tolerance, and other desirable coral traits, to facilitate natural populations’ adaptation to environmental change.	Of note was RRAP term assisted evolution. Other terms are coral IVF, cutting-edge IVF technology, genetic barcoding, coral sex. Couched in words such as success/successful/hope (positive terms)
Shading and cooling: Preventing coral stress by cooling and shading reef waters.	Cling film, thin film, anti-solar, shield/wrap, floating sunscreen, ultra-fine biodegradable film, sun shield, spray-on umbrella & liquid spray. Additionally, cloud seeding, and brightening were nominally discussed with (n=38 tweets).
Synthetic biology and genetic engineering: Enhancing the stress tolerance of the coral animal or symbiotic partners.	Genetic techniques, genetic variation, altered gene expression, modified genome, assisted evolution, protect, save
Biocontrol: Using bio-control approaches to facilitate reef recovery or maintain reef health, this type of method includes reducing populations of coral predators and competitors	COTS, coral-eating, fight, predator, threatened
Small and local scale existing interventions	Coral gardens

In the typology, we identify that people reactive positively towards the term coral IVF. A popular media-friendly term as people relate to the technology around IVF. Translating the human embryo technique into the marine space is a feasible connection for the public. Likewise, the term ‘sunscreen’ in describing shade and cooling techniques has a positive impact. However, it must be noted that, although not registering in this data, the term sunscreen is unpopular with Reef managers and others because of media reports that that human sunscreen can be damaging to reefs. Further, some countries have banned the use of sunscreen in reef environments. Finally, innovation also registers as positive, particularly with RRAP term assisted evolution in coral reef restoration science.

Much of the language around shading and cooling techniques is positive, we suggest this is because it assimilates with protective measures through the simile of household items. We identified the following list of common terms that people use to describe shading and cooling

interventions - *cling film, thin film, shield/wrap, floating sunscreen, ultra-fine biodegradable film, sun shield, spray-on umbrella* and *liquid spray*.

Examples of shading and cooling tweets (outside the Great Barrier Reef)

- Cling film shield could save Great Barrier Reef
- Great Barrier Reef: promising trials of an anti-solar film to prevent coral bleaching
- Soon, a cling film will wrap the Great Barrier Reef to prevent environmental degradation
- Sun shield trials show promise to prevent coral bleaching on the #GreatBarrierReef

We identified these terms as positive as they were interpreted through a framework of protectiveness. The terms cling film, shields and wrap all infer a means of protecting something. We use cling film to protect our food, we shield our eyes with sunglasses etc. Similarly, we suggest that the terms sun shield and umbrella are positive due to the intonation of coolness. When the discourse is dominated by doom and gloom, people react in a positive way when presented with a language that offers an alternative (counterfactual) position. RRAPs and peoples use of the terms cooling, shading, protecting are all opposite terms to the problem of warming [e.g. global warming, warming oceans]. Finally, the use of ultra-fine and biodegradable in the surface film description puts an emphasis on minimal intervention with a sustainable solution.

Our Twitter typology of **reproductive and recruitment, and assisted evolution** focused on the technical side with terms such as *Coral IVF, cutting-edge IVF technology, genetic barcoding, assisted evolution*. Positive adjectives included: success, successful and hope. **Assisted evolution** also produced positive language. Unlike the shade and cooling, it is the innovative use of technology that produces a positive discourse. Where mentions of **assisted evolution** technologies focused on reproduction over recruitment, the language was simple with terms such as 'coral sex', 'coral IVF' and 'coral babies'. Reproduction attracted a positive sentiment of $n= 0.645$.

Examples of positive reproductive and recruitment tweets from online websites:

- *Scientists Are Breeding Super Coral That Can Survive Climate Change: VIC... via @YouTube (March 2018)*
- *Successful trial of 'Coral IVF' gives hope for Great Barrier Reef @CNN (June 2018)*

Furthermore, the data showed a large spike in support for assisted gene flow-related work during the November 2017 spawning period. The spike correlates with media coverage of Professor Peter Harrison collecting coral spawn on Heron Island.

Synthetic biology and genetic engineering terms focus on genetic techniques. Genetically modified has a positive average sentiment of 0.15 outside of the Great Barrier Reef. The term 'genetic diversity' has a positive sentiment both inside and outside the Great Barrier Reef, more positive ($n=0.88$) outside than inside the Great Barrier Reef region, with genetic diversity in relation to assisted evolution not registering inside the Great Barrier Reef. Other terms that people and the media are using on twitter to describe synthetic biology and genetic engineering are *genetic variation altered gene expression and assisted evolution*.

Scientifically these are very different, which suggests that the public and media are not clear on the different scientific methods. There is, however, a strong theme of trust in the science and scientific work around synthetic biology. Adjectives that describe the techniques include protect, save and shows trust in the science and scientists. We can surmise that synthetic biology and genetic engineering is seen a positive outside of the Great Barrier Reef, especially when connected to a story of protection and trust in the science.

Small and local scale existing interventions (mainly talking about coral gardening) register as a positive action sentiment (n=0.57), both inside and outside the Great Barrier Reef. Although, small and local scale existing interventions (of the six from the seven RRAP interventions being talked about on twitter) is the least discussed. In fact, inside the Great Barrier Reef only 16 percent of the tweets were positive, with zero tweets registered on the negative. In other words, no-one was tweeting about small and local scale existing interventions in a negative way, although that's not to say they only view the science as positive, instead with the low numbers it may indicate a lack of knowledge. Further, there is some concern that despite coral gardening being a community-led event, such as the case in Fiji and the Maldives, it still requires some level of scientific expertise.

- @EPAMaldives Pls ensure coral replanting projects are undertaken within existing regulations!
- This is absurd! Yes, we can do certain things at individual level! However coral planting is a very scientific endeavour! One should look at various biogeophysical oceanographic aspects before planting corals! It's not the same as gardening! Also, EIA must be done! (April 2018).

Our typology shows that people are not using alternate terms to define coral gardening.

Biocontrol (predominantly talking about crown-of-thorns starfish control, and not *Drupella* or algae removal which is in RRAP repertoire) had a negative to neutral sentiment, mainly linked to threat related statements more than sentiment. Examples of biocontrol are mainly negative as crown-of-thorns starfish are very much framed as a threat.

- Great Barrier Reef under threat: Bleaching and ravenous starfish destroying coral
- Crown of Thorns starfish is a big threat to the Great Barrier Reef. Maybe Gina Reinhardt is a bigger threat!
- The Great Barrier Reef is under threat!! One specific problem is crown of thorns! How to test aquatic NDA? [sic]
- Killer starfish threaten Great Barrier Reef. The lack of any alternative synonyms may be more suggestive of limited public knowledge around the techniques and science given there was a slightly more positive response outside the Great Barrier Reef region.

Global Sentiment and Discourse Analysis

Of the interventions, there were three that receive a positive sentiment - reproduction and recruitment, shading and cooling, and assisted evolution. Coral gardening and cloud were the lowest sentiment.

Table 3: Positive and negative sentiment that correlates to each of the talked about RRAP science and innovation on Twitter.

RRAP scientific terms and definitions for the interventions	Outside the Great Barrier Reef		Inside the Great Barrier Reef	
	Positive sentiment [as percent]	Negative sentiment [as percent]	Positive sentiment [as percent]	Negative sentiment [as percent]
Reproduction and recruitment and Assisted Evolution: Targeting reproduction, recruitment, enhancing temperature tolerance, and other desirable coral traits, to facilitate natural populations' adaptation to environmental change.	75	20	5	0
Shading and cooling: Preventing coral stress by cooling and shading reef waters.	73	21	5	0
Synthetic biology and genetic engineering: Enhancing the stress tolerance of the coral animal or symbiotic partners.	69	20	10	0
Biocontrol: Using bio-control approaches to facilitate reef recovery or maintain reef health, this type of method includes reducing populations of coral predators and competitors	60	38	2	0
Small and local scale existing interventions (Coral gardening)	54	31	16	0

We can see from the table that overall there is positive sentiment for the interventions under consideration. Not all RRAP interventions [Reef structures and stabilisation and Probiotics and enhanced bleaching survival] were being discussed on social media during the data collection phase. Therefore, we focus on the five that are in the data. Of the five interventions in the twitter data, Reproduction and recruitment including assisted evolution and shading and cooling had the strongest positive sentiment, followed by synthetic biology and genetic engineering. These three of the six interventions were the most talked about by the public and carried the most variation in the typology we developed.

The three most prominent [of the six] interventions are also those with the most relatable language. Further interventions that have already been made public and discussed in the media and scientific community were positive. Therefore, we suggest a concerted public engagement and communications activities around the new technology (i.e. cloud brightening) highlighting both the technological and conceptual differences in each of the proposed interventions.

Globally, the language of intervention is important for communicating capacity building of science and technology to assist the Great Barrier Reef. Reproduction and recruitment included assisted evolution has the strongest positive sentiment (75 percent), and a negative sentiment of 20 percent which we suggest is due to the alternative language that uses metaphors around protection. Coral sex, coral IVF and coral babies as the reproduction and recruitment intervention also has a stronger positive sentiment than negative. Shading and cooling are also more positive (73 percent) than negative (21 percent), and Synthetic biology and genetic engineering had a positive sentiment (69 percent) and negative (20 percent). Therefore, of the three interventions they average out a similar negative sentiment with people general positive about the interventions that carry a relatable language and/or innovative science. Figures two and three below show the differences in sentiment towards the RRAP interventions from both the global data set and the tweets taken within the Reef region. Figure four compares the two data sets to give an indication of where positive and negative sentiment sits within the Reef restoration space.

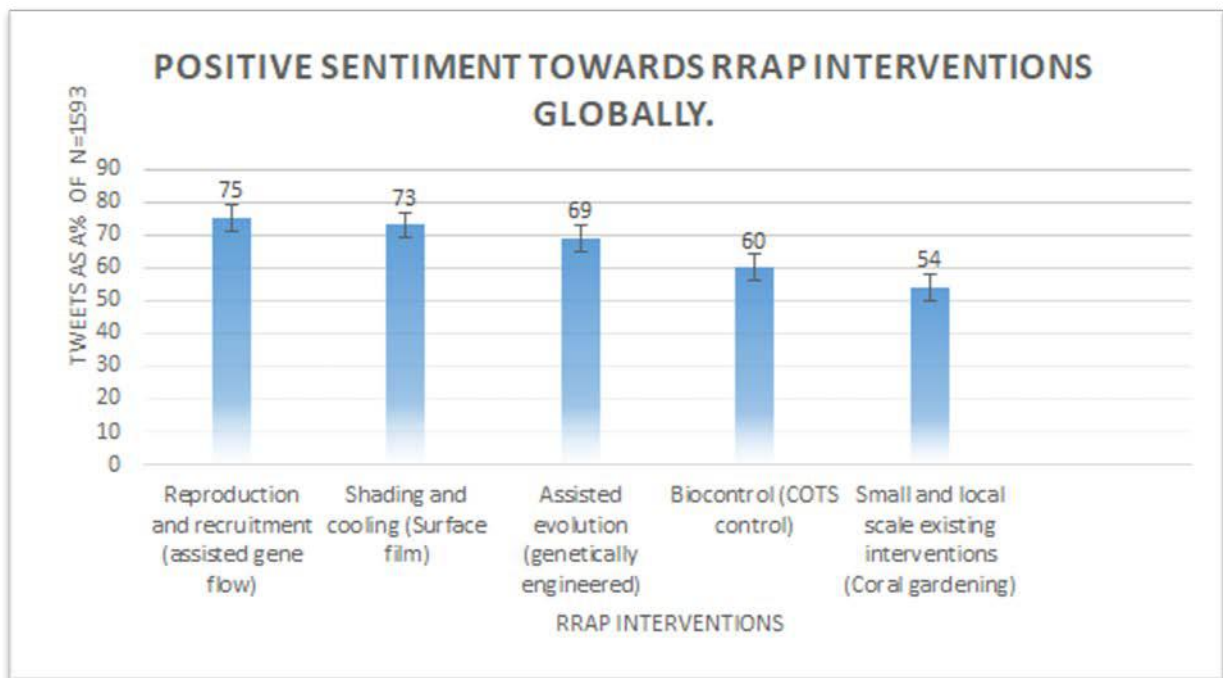


Figure 2: Sentiment analysis to RRAP specific interventions scrapped from a global dataset.

Whereas the story around negative sentiment from the global dataset shows that there is more negativity towards existing interventions and biocontrol.

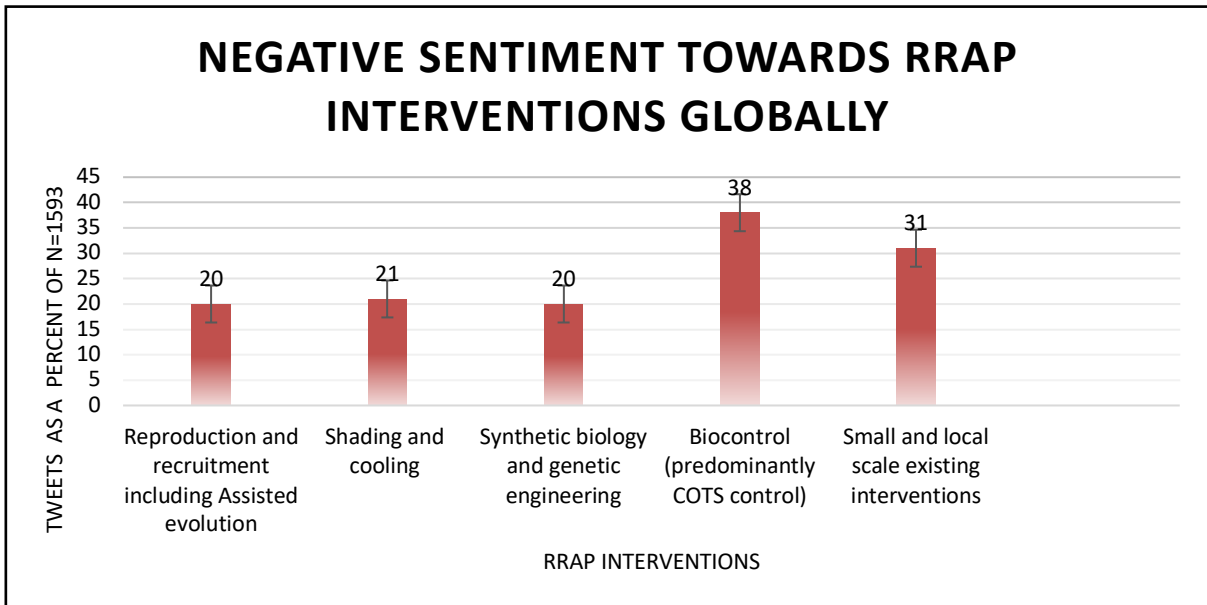


Figure 3: Sentiments analysis to RRAP specific interventions scrapped from the global dataset.

If we combine the two data sets, we see that there is an overall positive sentiment to the proposed interventions. Globally, there a more positive outlook to Reproduction and Shading. Biocontrol and small a local existing intervention receive a mixed sentiment at the global level. Small scale and local is seen as positive within the Reef area, registering the highest percentage (16 percent) of all the sentiment within the Reef area.

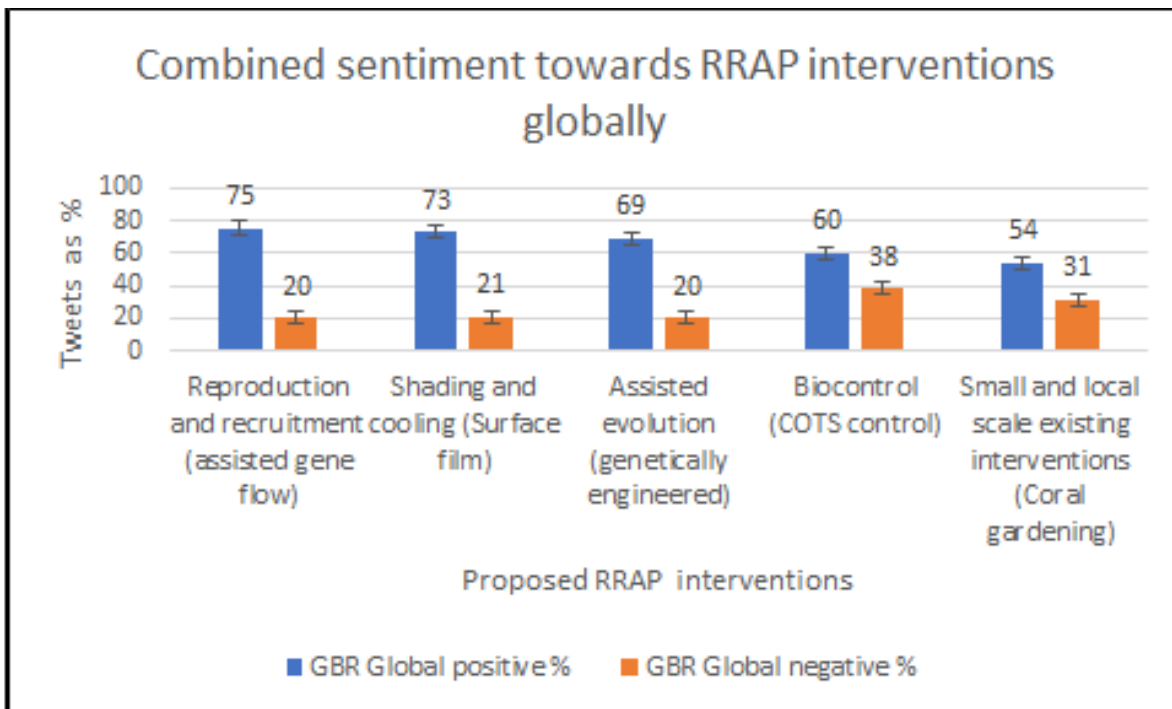


Figure 4: Combined sentiment from tweets taken globally.

We suggest the small number of tweets and difference between positive and negative is due to the public being more aware of the success and failure rates of small-scale interventions that tend to be more community based. For cloud brightening, the small difference between positive and negative (5 percent) was due to a lack of knowledge, uncertainty in the science and close association with cloud seeding. We conclude six key recommendations:

1. Communicating interventions in everyday relatable terms can help generate positive sentiment. The category of **protect** can be added to existing categorisation of interventions using the terms **prevent (active)** measures and **repair** could also generate positive sentiment.
2. Public trust in science and technology can generate positive sentiment, even when the science is unknown. Emphasis on trust, expertise and technology aids positive sentiment.
3. A clear communication and education approach should be developed for those interventions not currently in the general public's knowledge.
4. Framing restoration science as protection, prevention and/or repair links to positive sentiment.
5. Where evidence of success and failure exist in current interventions, sentiment is mixed with positive slightly higher, suggesting that further research is needed to establish any causality.
6. Global sentiment is more positive towards interventions in those living outside of the Great Barrier Reef region, suggesting people are interested in coral reef restoration science.

Inside the Reef – Sentiment and Discourse Analysis results

The limited social media data available inside the Great Barrier Reef region that specifically relates to types of interventions indicates that community-based intervention (i.e. coral gardening) is seen as positive (16 percent) followed by Synthetic Biology and genetic engineering (10 percent)

In contrast to the global sentiment, inside the Great Barrier Reef region Reproduction and recruitment including Assisted evolution has less than 5 percent positive sentiment and (0 percent negative sentiment/ Shading and cooling had the same positive sentiment at 5 percent compared to the 75 percent of the tweets being positive about shading in the global data.

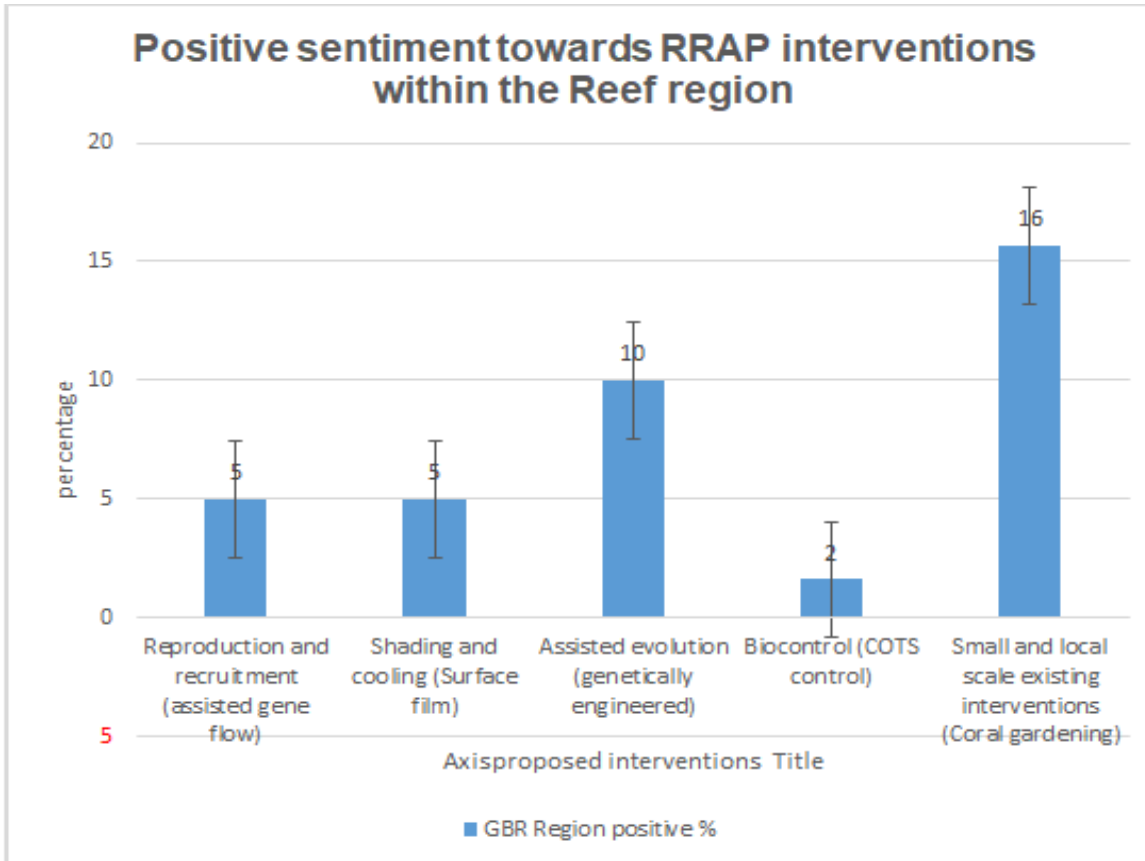


Figure 5: Positive sentiments analysis to RRAP specific interventions from within the Reef region.

Further, Reproduction and recruitment including assisted evolution and shading and cooling carry the most negative sentiment from the limited data available. All negative sentiment is registering as less than zero percent. Table 4 shows the number of negative tweets as a percentage.

Table 4

RRAP intervention terms	Great Barrier Reef Region negative percent
Reproduction and recruitment including Assisted evolution	0.0 percent
Shading and cooling	0.5 percent
Synthetic biology and genetic engineering	0.4 percent
Biocontrol (predominantly crown-of-thorns starfish control)	0.3 percent
Small and local scale existing interventions	0.3 percent

In the following figure [6] we can see that Biocontrol and small scale; existing interventions are seen in a more negative light than the more innovative approaches being considered.

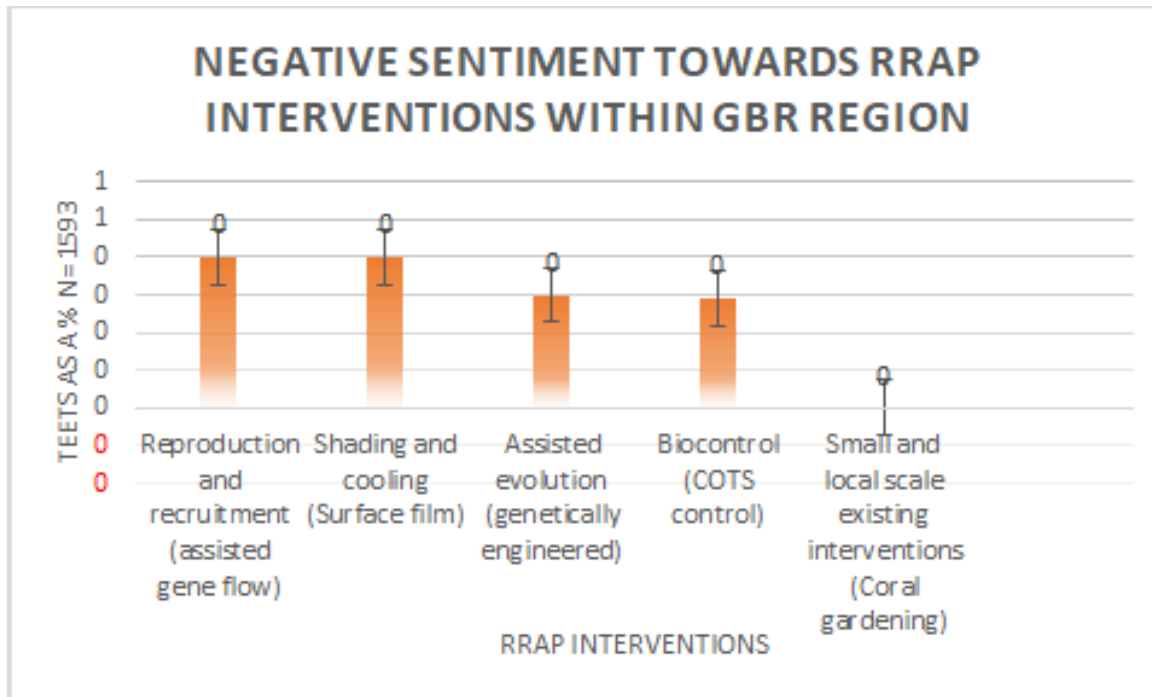


Figure 6: Negative sentiments analysis to RRAP specific interventions scrapped from the sample taken within the Reef area.

If we combine the datasets, (global and within the Reef area) and the sentiments of positive and negative we can see that overall there is a positive sentiment towards the more innovative approaches, and some mixed sentiment between the already existing interventions. Overall, there is a positive sentiment to the different interventions. The data also shows that Reproduction and Recruitment and Assisted Evolution, along with shading and cooling have the most positive sentiment at the global level. Whereas, there is some negativity in biocontrol and existing interventions there is greater positivity in the sentiment within the Reef area.

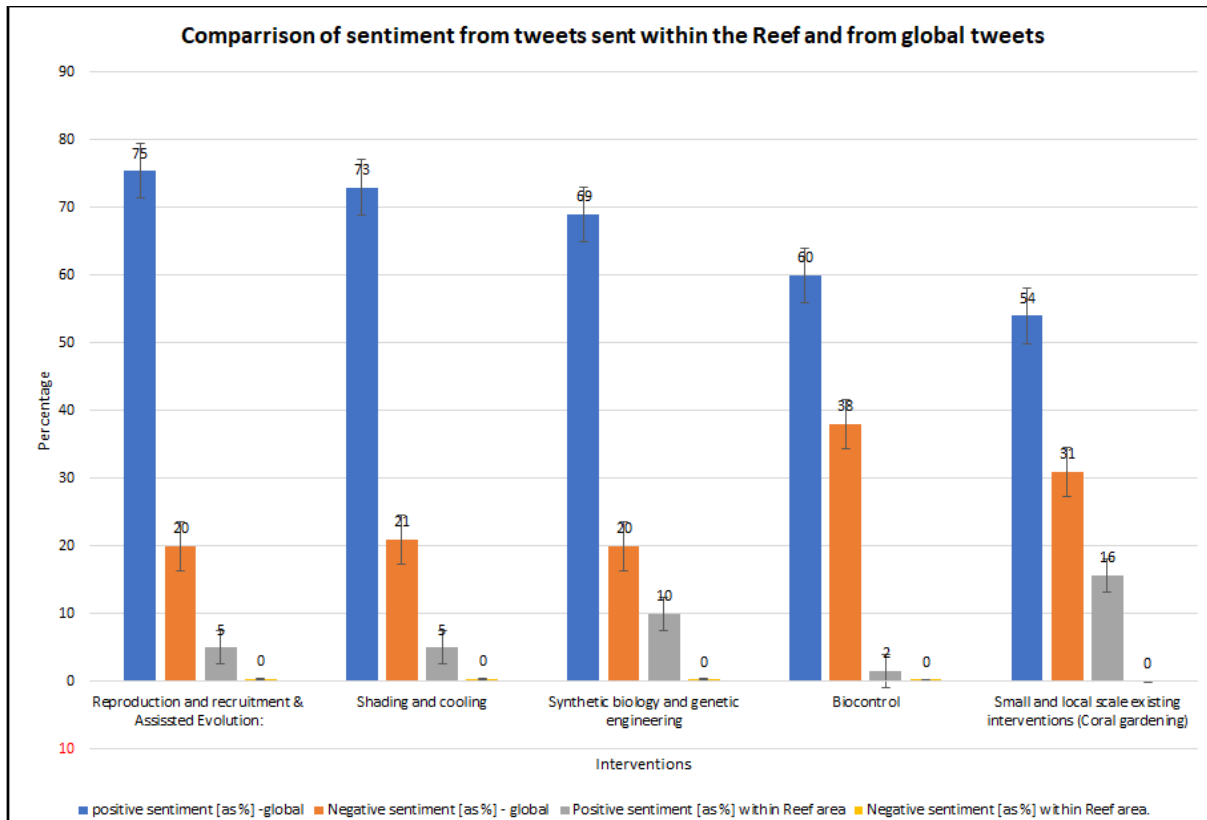


Figure 7: Comparison of sentiment from tweets sent within the Reef and from global tweets.

Sentiment and discourse analysis conclusions:

We conclude the following for the sentiment and discourse analysis for reef restoration inside the Great Barrier Reef region.

1. A need to acknowledge domestic issues in identifying social acceptance and public sentiment.
2. Reproduction and recruitment including assisted evolution, along with shading and cooling and Synthetic biology and genetic engineering have a relatable typology that generates positive sentiment.
3. Whilst typology identified here can be applied both inside and outside of the Great Barrier Reef region, the low level of engagement for coral restoration inside the Great Barrier Reef suggests a need for a different strategy to engage more with stakeholders and the general public living in this region.
4. Education and local community engagement programs could improve knowledge of RRAP and coral restoration science.
5. A reef restoration roadshow would be a way to improve communication and significance of RRAP in the Reef region.

Risk Perception

We now identify the implicit and explicit key drivers of risk perception around coral restoration projects, and the public narrative around risk. We define risk in this context as a socio-cultural process. Not all issues are represented as risks, nor can they be positive. How

the mainstream media covers risk (perceived or not) can destroy or sustain space for policy influence. Risk can also drive explicit and implicit narratives or create complexity through different interpretations of science in risk narratives.

Social media sites present powerful tools and ways to share crucial and up-to-date information during natural disasters. Using social media to communicate research can help alleviate community concerns and mitigate risk. The sentiment and discourse analysis indicate that risk perception, as expressed through social media, is lower when the language about interventions is simple, tangible and distant from threats of climate change, bleaching and mining. In interventions that are either in the concept or early phase there is some uncertainty leading to a high risk of social acceptance.

The data also suggests that risk can be mitigated when people feel they can trust the science and scientists to solve the problem. There were numerous tweets sent by high profile science communicators (namely Professor Terry Hughes, Environmentalists group Sea Shepherd and 350.org's Bill McKibben) that were retweeted the most. The least trusted group for information were the mainstream media.

Further work and recommendations

Our data has shown that RRAP is starting out in a positive position, with support for restorative and adaptive actions in the Great Barrier Reef generally, and with a guarded level of support from the community and stakeholder groups for non-traditional Reef interventions.

Social media has been useful in measuring public sentiment of reef restoration. It can be applied during the future RRAP programs as a monitoring and evaluation tool to identify social acceptance of reef restoration projects. A longer-term study would require a wider study of other social media platforms to be more representative of the wider community. Further evaluation would require the inclusion of metadata to help identify the demographics, locations, stakeholders and influencers driving the Great Barrier Reef narrative.

Globally there was a more positive sentiment for coral restoration research, therefore we recommend closer working partnerships and networking with international partners. International support and interest in coral restoration and adaptation, evident in social media, could be drawn on in domestic communication. Working more closely with key stakeholders outside of the Great Barrier Reef area (such as International Coral Reef Initiative and Coral Reef Consortium) in developing guidelines on reef restoration to could aid clearer understanding for the wider public.

We conclude from the discourse analysis the following:

- RRAP messaging should continue to clearly acknowledge that the interventions being investigated will not negate the need for greenhouse gas emissions control. Adding the language of protect to the existing RRAP framing of 'prevent', 'repair' will aid a solutions-orientation. RRAP should aim to be realistic in its descriptions of what the proposed interventions could achieve.
- If negative sentiment drives a Great Barrier Reef disaster discourse, then positive sentiment comes from relatability and engagement. Conflating disaster with RRAP interventions generates negative sentiment e.g. mentioning climate change

and/bleaching in the same context generates negativity, but neither should it be ignored.

- RRAP language framed in the context of interventions are tools that prevent, repair and protect could counter the disaster discourse.
- Learn from the examples of shading and cooling and reproduction and recruitment when communicating the science
- Build trust between the scientists and wider community, especially within the Great Barrier Reef region, possibly with a roadshow.

To strengthen community engagement and support we need to ensure:

- Where the science is complex and unknown, especially within the Great Barrier Reef region, there is a low risk appetite (e.g. cloud brightening), this suggest a longer-term community engagement and education program will be required.

While threats are well understood by the community, any RRAP communications should acknowledge the impacts of climate change and bleaching, speaking to the strong sentiment amongst stakeholders and the community to 'help' and 'protect'. 'Trust' and 'innovative science' is likely to be more constructive that focusing solely on threats

APPENDIX F – SOCIAL AND CULTURAL VALUES DATA (SELTMP 2017)

Part of understanding the existing stakeholder context in the Great Barrier Reef involves understanding the range of social and cultural values of importance to groups with an interest in the Reef. Some preliminary scoping work was undertaken as part of PD2 sub-project to assess the application of existing social survey data related to social and cultural values in the Reef to RRAP.

The main data set considered here was the Social and Economic Long-term Monitoring Program (SELTMP) survey conducted in 2017 by Marshall et al. (2017) The SELTMP study is a different study independent from the national survey conducted on social acceptance by the PD2 project team and described in the main body of the document. The SELTMP study surveyed the general population in 14 coastal towns in the Great Barrier Reef region; domestic and international tourists in the Great Barrier Reef region in those 14 coastal towns; repeated representative samples of the Australian population using online methods; and samples of Great Barrier Reef commercial fishers and tourism operators. Several segments of this population align strongly to our stakeholder categories. Groups surveyed included livelihood stakeholders such as tourism operators, commercial fishers and Australian citizens who reside in the Great Barrier Reef regions. The survey also include domestic and international tourists, and Australian residents who do not reside within the Great Barrier Reef regions. The SELTMP surveys assessed the relative importance of different values. Table F.1 below describes a sub-set of responses on importance of eight specific values, and Table F.2 (following) presents the means for the respondent scores for the eight values across the six groups surveyed.

Table 5: A selection of social and cultural values assessed through the SELTMP survey (Source: Marshall et. al, 2018)

Values	Description
Identity	The feeling of belonging to a place or social group with its own distinct culture and common social values and beliefs. <i>Survey statement: The Great Barrier Reef is part of my identity.</i>
Pride in resource status	Refers to a satisfied sense of attachment towards a place or its status such as World Heritage Area status. It can be linked to a signal of high social status. <i>Survey statement: I feel proud that the Great Barrier Reef is a World Heritage Area.</i>
Attachment to place	The emotional and physical bond between person and place which is influenced by experiences, emotions, memories and interpretations. It often provides a reason for people to live where they live. <i>Survey statement: I live here because of the Great Barrier Reef.</i>
Aesthetic appreciation	Describes the aesthetic value that an individual attributes to aspects of an ecosystem. Aesthetic responses are linked to both the characteristics of an environment and culturally or personally derived preferences. <i>Survey statement: The aesthetic beauty of the Great Barrier Reef is outstanding.</i>
Appreciation of biodiversity	Describes how people are emotionally inspired by biodiversity and other measures of ecosystem integrity at a particular place. <i>Survey statement: I value the Great Barrier Reef because it supports a variety of life, such as fish and corals.</i>
Lifestyle	The expression of 'visible' culture that has evolved around a natural resource or ecosystem; describes the extent to which people lead their lives around a natural resource and how people interact with it for recreation. <i>Survey statement: I value the Great Barrier Reef because it supports a desirable and active way of life.</i>
Scientific value	The value that people associate with learning opportunities in the past, present and future. The legacy and appreciation of ecosystems and natural resources that have been inherited from the past and their sense of continuity across time. <i>Survey statement: I value the Great Barrier Reef because we can learn about the environment through scientific discoveries.</i>
Wellbeing maintenance	The extent to which individuals are concerned for their own wellbeing if the health of the natural resource were to decline. <i>Survey statement: I would be personally affected if the health of the Great Barrier Reef declined.</i>

Table 6. Mean values (and standard errors) of each held value for each stakeholder group. (Source: Marshall et al., Social and Economic Long Term Monitoring Program, results from 2017 survey) (Marshall et al., 2017)

Value	Great Barrier Reef Residents	Commercial fishers	Tourism operators	Domestic tourists	International tourists	Australians (non-local)
No. of cases	1825	91	94	831	805	1000
Identity	6.64 (.065)	7.19 (.314)	8.12 (.232)	5.78 (.102)	3.51 (.093)	7.34 (.034)
Pride in resource status	9.19* (.037)	7.90 (.252)	9.36 (.161)	9.21* (.059)	8.62 (.071)	8.22 (.028)
Attachment to place	8.85 (.045)	9.42* (.115)	9.57 (.124)	8.09 (.103)	7.74 (.108)	NA
Aesthetic appreciation	9.00 (.037)	8.66 (.223)	8.92 (.155)	8.71 (.070)	8.17 (.080)	8.36* (.059)
Appreciation of Biodiversity	9.18 (.035)	9.17 (.161)	9.80* (.074)	9.16 (.061)	9.07* (.056)	8.28 (.059)
Lifestyle	8.23 (.045)	8.32 (.199)	9.19 (.138)	8.37 (.079)	7.89 (.081)	NA
Scientific value	8.41 (.046)	7.46 (.240)	8.76 (.198)	8.57 (.080)	8.38 (.073)	NA

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Wellbeing maintenance	7.73 (.057)	8.10 (.266)	8.68 (.211)	5.98 (.102)	5.02 (.106)	NA
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*Refers to most highly valued for that stakeholder group

Highest four value means within in each group
Values where there is difference between groups

Some preliminary inferences from the above data that help to profile the relative importance of values across and within the surveyed groups include:

- There are some strongly shared values across the six groups with values of aesthetics, biodiversity and pride in the status of the Great Barrier Reef, all rating highly (with the exception of commercial fishers on pride);
- Livelihood stakeholders such as commercial fishers and tourism operators however rated well-being maintenance, attachment to place and lifestyle as more important (either for higher scores within groups or between groups) than others;
- Tourism operators, more than others, identified personally with Reef, as interestingly did Australian (non Great Barrier Reef) residents. It likely that this association for tourism operators is driven by proximity, and for the latter group, is more of a symbolic identification; and
- While scores across groups on the perceived scientific value the Reef are relatively similar, this value ranked more highly within the list of values for domestic and international tourists.

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