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Changes among Great Barrier Reef commercial fishers from 2013 to 2017

a report from the Social and Economic Long-Term Monitoring Program (SELTMP)

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Important disclaimer

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Contents

Executive summary

The Social and Economic Long Term Monitoring Program (SELTMP) forms an integral part of the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP), providing primary data for a range of human dimension indicators that are necessary to evaluate progress towards the objectives of four themes within the *Reef 2050 Long Term Sustainability Plan* (Commonwealth of Australia 2015; 2018). The purpose of this report is to present the differences in the responses of local commercial fishers within the Great Barrier Reef (GBR) to survey questions presented to them in 2013 and 2017.

The report forms part of a series, describing and comparing the state of key characteristics of GBR-dependent industries and communities within the Great Barrier Reef region (defined as the GBR World Heritage Area and Marine Park, together with the GBR catchment, bounded by Bundaberg in the south, Cape York in the north and the Great Dividing Range in the west), including local residents, commercial fishers, tourists, and marine tourism operators.

In this report, only a limited number of survey questions are directly compared between sampling periods, due to 2017 survey questions being refined to address future reporting needs of the *Reef 2050 Long Term Sustainability Plan*. It is anticipated that more comparisons and longitudinal insights will be possible in the next reporting period. The complete results (mean scores ± standard error for all survey questions, including both 2013 and 2017 surveys) are summarised in tabular form in Appendix A, and these indicators will form the basis for future longitudinal trend analyses.

Results in this report (and the report series) should be considered in the context of key events (environmental, social and economic) that occurred over the 2013-2017 period. Notably, between these sampling points, unprecedented coral bleaching events over the summers of both 2016 and 2017 affected much of the northern half of the GBR Marine Park (Great Barrier Reef Marine Park Authority 2017a; 2018). In addition, in March 2017, Severe Tropical Cyclone Debbie impacted built infrastructure, islands and coral reef habitats in the Whitsundays region (Great Barrier Reef Marine Park Authority 2018). Media reports associated with these events was sensationalised and extensive (Eagle et al., 2018), and combined with the personal experiences of local communities, will undoubtedly have had some influence on the responses of SELMTP survey participants.

In early 2018, the RIMReP Human Dimensions Expert Group, proposed that indicators for monitoring the human dimension of the region be organised into five clusters: Aspirations, Capacity and Stewardship, Community Vitality, Culture and Heritage, Economic Values and Governance (Gooch et al., 2018). Within this framework, key findings from this report include:

- **Aspirations, capacity and stewardship**. The major change that occurred among commercial fishers was an increased proportion in 2017 (27%) indicating belief that "climate change is an immediate threat requiring action" (up from 16% of fishers surveyed in 2013). We note that this proportion remains substantially lower than that for other groups reported in this SELTMP report series (e.g. international tourists 78%; GBR region residents 68%; domestic tourists 67%; Marine Park tourism operators 63%). Perceptions of

the major threats to the GBR have also changed among commercial fishers. In 2013 coastal development, water quality and shipping were the three most frequently identified threats to the GBR by commercial fishers, whilst in 2017 the most frequently identified threats were fishing (encompassing illegal fishing, recreational fishing, and over-fishing), water quality and climate change. Among the stewardship indicators, fishers continued to report a strong sense of responsibility for protecting the GBR, as well as a willingness and capacity to take protective actions.

- **Community vitality**. Commercial fishers remained a community with strong identity and dependence associated with the GBR. Fishers continued to feel that they would be personally affected if the GBR health declines. In other SELTMP survey groups (reported in Marshall et al., 2019; and Curnock et al., in review), we identified a negative affective (i.e. emotional) response associated with the 2016-2017 mass coral bleaching events. We did not detect a similar response among commercial fishers, which may be due to a more pragmatic relationship with the GBR held by members of this community.
- **Culture and heritage**. Commercial fishers provided consistently high ratings in both 2013 and 2017 for GBR values, including biodiversity, economic, lifestyle, identity, and to a lesser extent scientific heritage value. There were notable increases in ratings for the GBR's international icon value, as well as for pride in the GBR's world heritage status (though the latter increase was not statistically significant), suggesting an increased awareness of the GBR's significance and status beyond that of local and Australian stakeholders – potentially influenced by the extensive media coverage associated by the coral bleaching events.
- **Economic values**. Commercial fishers were significantly more optimistic about their business in the GBR in 2017 than they were in 2013, even though a larger proportion indicated that their business had not performed as well in 2017 than it had in the previous 12 months.
- **Governance**. Respondents gave higher ratings of trust in 2017 for GBR information provided by scientists and by GBRMPA; however, overall levels of trust in various information sources remained lower than that for other SELTMP survey groups. There were notable (but not statistically significant) increases in ratings for confidence in GBR management, and for support of regulations affecting access and use of the GBR.

We broadly conclude that while substantial changes occurred among many other GBR stakeholder groups between 2013 and 2017 (cf. Marshall and Curnock 2019; Curnock & Marshall 2019), only minimal social and cultural changes were observed among commercial fishers over this period. While the absence of statistically significant changes may be partly attributable to the smaller sample achieved in 2017, previous studies have shown that commercial fishers are generally more conservative in their responses to environmental and societal change (e.g. Marshall et al., 2010; Sutton & Tobin 2009). Nonetheless, these data provide important insights for understanding the state and trends in values, perceptions, attitudes and resource dependency of commercial fishers in the GBR, and future iterations of data collection will become increasingly valuable for Reef managers and decision makers, as this important industry responds and adapts to environmental and societal change.

Introduction

The need to incorporate social and economic data into environmental management is well established. This is particularly pertinent where natural resources are degrading and the role of natural resource managers is broadening to include managing for human wellbeing. The Great Barrier Reef (GBR) is one such example; it is heavily depended upon by people for a range of benefits, yet it is experiencing concerning ecological declines (Great Barrier Reef Marine Park Authority 2009; 2014a). Since the last decade the GBR is threatened most significantly by climate change, poor water quality from land-based runoff, coastal development, and some remaining impacts from fishing (Great Barrier Reef Marine Park Authority 2009; 2014a). Over the summers of 2016 and 2017, the GBR experienced sequential mass coral bleaching events at an unprecedented scale, leaving a substantial impact on coral communities across the northern half of the Marine Park (Great Barrier Reef Marine Park Authority 2017a; 2018). In addition, in March 2017, Severe Tropical Cyclone Debbie impacted built infrastructure, islands and coral reef habitats in the Whitsundays region (Great Barrier Reef Marine Park Authority 2018). Despite these impacts, the GBR remains one of best managed, most intact and resilient coral reef ecosystems on the planet (Great Barrier Reef Marine Park Authority 2017b). Understanding the responses of reef-dependent communities and industries to these events, and more broadly understanding the dynamic relationship that individual users have with the GBR is critical if coral reef managers are to ensure that the GBR continues providing essential ecosystem and cultural services.

The recent development of the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP) provides the unprecedented opportunity to integrate human dimensions with other monitoring in the GBR, to enhance our system understanding and guide tactical and strategic management decisions in an era of rapid environmental and societal change. The Social and Economic Long-Term Monitoring Program (SELTMP) for the GBR describes some of the conditions and trends of the human dimension of the GBR social-ecological system. Designed for long-term monitoring of key indicators relevant to the *Reef 2050 Long-Term Sustainability Plan* (Commonwealth of Australia 2015), SELTMP provides insights to assist day-to-day management of the GBR, as well as for planning for the future of GBR-dependent and GBR-associated industries and communities in the face of environmental and societal challenges and drivers of change. These drivers, which include climate change, population and economic growth, technological development, societal attitudes and governance, have direct and indirect effects on human activities and pressures exerted on the GBR (Great Barrier Reef Marine Park Authority 2014b). The state of the GBR, in turn, directly and indirectly affects the wellbeing of people and communities who depend on it, or are associated with it, and/or value it (Marshall et al., 2016; 2017).

This report forms part of series that builds on the baseline of SELTMP reports over 2011-2014, available at https://seltmp.eatlas.org.au/seltmp, which provided the first quantitative snapshots describing how people interact with the GBR, how they value it, perceive it and are likely to respond to environmental and social changes. Following an extensive consultative process to identify knowledge gaps and prioritise human dimension monitoring needs (outlined in Marshall et al., 2014) the first iteration of SELTMP primary data collection commenced in 2013. The large-scale surveys were conducted at 14 coastal centres along the GBR coast, from Cooktown to

Bundaberg, and involved more than 6,300 participants, including commercial fishers, tourism operators, tourists and local residents of the GBR coastal region. In addition 2,000 Australian residents were surveyed online as part of a geographically and demographically representative sample of the Australian population. Our second sampling period occurred in mid-2017, involving more than 3,900 participants across the GBR region representing the same groups.

Recommendations from the RIMReP Human Dimensions Expert Group included biennial SELTMP sampling (Gooch et al., 2018), which would enable correlations and potentially predictive modelling of human-environment responses to significant environmental and/or societal events (e.g. major disturbances like a mass coral bleaching event) through detailed analyses and synthesis in alternate years.

A number of peer-reviewed scientific papers using SELTMP data are currently available, which validate SELTMP's conceptual design (e.g. Marshall et al., 2016; Marshall et al., 2018b; Gooch et al., 2017) and reveal new insights into people's values and attachment to the GBR (e.g. Goldberg et al., 2016; Gurney et al., 2017, Marshall et al. 2018b), their perceptions of its management and institutional trust (e.g. Turner et al., 2016; MacKeracher et al., 2018), their vulnerability and dependence on the GBR (e.g. Marshall et al., 2017), and responses to climate change (e.g. Goldberg et al., 2018; Marshall et al., 2019; Curnock et al., in review). As longer-term data and knowledge are accumulated over time, the value of SELTMP to GBR managers and the Australian public will grow.

Survey data from SELTMP are made publicly available online via https://doi.org/10.25919/5c74c7a7965dc and can be analysed for myriad purposes. SELTMP 2017 data can also be interrogated through several PowerBI™ online dashboards (https://research.csiro.au/seltmp/).

Methods

Commercial fishers who operated in the GBR Marine Park were interview by telephone between June and December 2017. The survey questions are presented in Appendix A, and a detailed description of the survey design (as well as data collection methods) is reported in the SELTMP 2017 Final Report to GBRMPA (Marshall et al., 2018a), as well as in the SELTMP 2014 report on commercial fishing in the GBR (Tobin et al., 2014). We adopted the same method for data collection in 2017 as employed in 2013. In 2013, a total of 210 commercial fishers were interviewed, and in 2017 we had 91 respondents. We were able to access these stakeholders through our own contacts databases, publicly available data, and personal contacts. We attribute the smaller sample in 2017 (at least in part) to the disconnection of many landline telephone numbers among commercial fishers.

The approach taken to make comparisons across years included providing the means and standard errors of resident responses to each survey question in both 2013 and 2017. Where possible, statistical tests to compare the distribution and/or means of rating scale responses were conducted to determine the significance of any observed changes in responses between 2013 and 2017. While the smaller sample size (cf. coastal residents, tourists) limits the statistical power of comparative tests between years, the involvement of repeat respondents and the participation by a significant proportion of the industry suggest that any substantive changes in responses to interview questions between years should be considered noteworthy, even if not statistically significant.

Analysis and presentation of results

Numeric data were analysed using MS Excel and SPSS statistics software. Most of the results below show comparisons of mean ratings from scaled response questions (i.e. respondents were asked to give a rating from 1 to 10 indicating their level of disagreement/agreement with a statement). Statistical tests comparing mean rating scores between years included non-parametric Mann-Whitney U Tests, and Spearman's Rho tests were used to identify the strength and significance of correlations between particular questions. Responses to the open-ended question "what do you think are the three (3) most serious threats to the Great Barrier Reef" were coded thematically via qualitative content analysis, to produce frequencies of different major threat themes as they occurred (e.g. climate change, pollution, fishing, and tourism).

Results are presented according to the Gooch et al. (2018) framework and survey questions (indicators) are categorised as: (i) aspirations, capacities and stewardship, (ii) community vitality, (iii) culture and heritage, (iv) economic value, and (v) governance. In Appendix A, a table is provided summarising the mean rating scores for all survey questions in both 2013 and 2017. This table indicates significant differences (where applicable) from 2013, the direction of change (higher or lower), and the relevance of each question to the RIMReP human dimension indicator clusters and attributes proposed by Gooch et al. (2018).

To compare general sentiment associated with the GBR among commercial fishers, we analysed text responses to the open-ended question: “what are the first words that come to mind when you think of the Great Barrier Reef?” Using the word-sentiment analysis plugin (EmoLex^{TM}) in R software, we compared of the relative frequency of emotionally valenced words (positive or negative) between 2013 and 2017, and displayed the results in colour-coded words clouds (see Figure 5).

Results

Sample description

A description of the commercial fisher samples from 2013 and 2017 is provided in Table 1. Due to the lower sample size in 2017, comparisons of some questions may not be reflective of a change across the entire industry. For example, the mean number of employees per business is higher in 2017, and this result is likely due to the proportion of smaller fishing operators who were unable to be contacted to participate in the 2017 survey. Nonetheless, broader changes and statistical comparisons of responses to many questions (i.e. those indicative of (i) aspirations capacity and stewardship, (ii) community vitality, (iii) culture and heritage, (iv) economic value, and (v) governance) are still considered noteworthy and relevant in the context of other social and ecological changes in the Great Barrier Reef region over the 2013-2017 period.

Table 1 Description and comparison of commercial fisher survey samples in 2013 and 2017

	Commercial fishers in 2013 (n=210)	Commercial fishers in 2017 (n=91)
Mean age (±SE; range)	55.0 (±0.76; 25-86)	53.6 (±1.28; 27-81)
Gender (F: M; %)	7:93	11:89
Mean years (personal) experience in GBR fishing industry (±SE; range)	28.9 (±0.87; 1-50)	29.5 (±1.30; 1-48)
Mean number of employees per business (±SE; range)	2.2 (±0.36; 1-50)	5.7 (±1.38; 1-80)
Proportion of respondents who rely on commercial fishing for 50% or more of their total household income (%)	71%	86%

Aspirations, capacity and stewardship

Commercial fishers' stewardship sentiments and empowerment to take action to reduce impacts and/or protect the GBR were assessed via ratings of agreement with the following statements: (a) "It is NOT my responsibility to protect the GBR" (sense of responsibility), (b) "I CANNOT make a personal difference in improving the health of the GBR" (sense of agency), (c) "I would like to do more to help protect the GBR" (willingness to act), (d) "I have the necessary knowledge and skills to reduce any impact that I might have on the GBR" (capacity to act), and (e) "I DO NOT have the time or opportunity required to reduce any impact that I might have on the GBR" (opportunity to act). Note that in the results below, responses to the negatively worded questions (a, b, e) are inverted for ease of interpretation (Figure 1). A comparison of 2013 and 2017 responses to these questions revealed some minor increases in the mean ratings; however, these differences were not statistically significant.

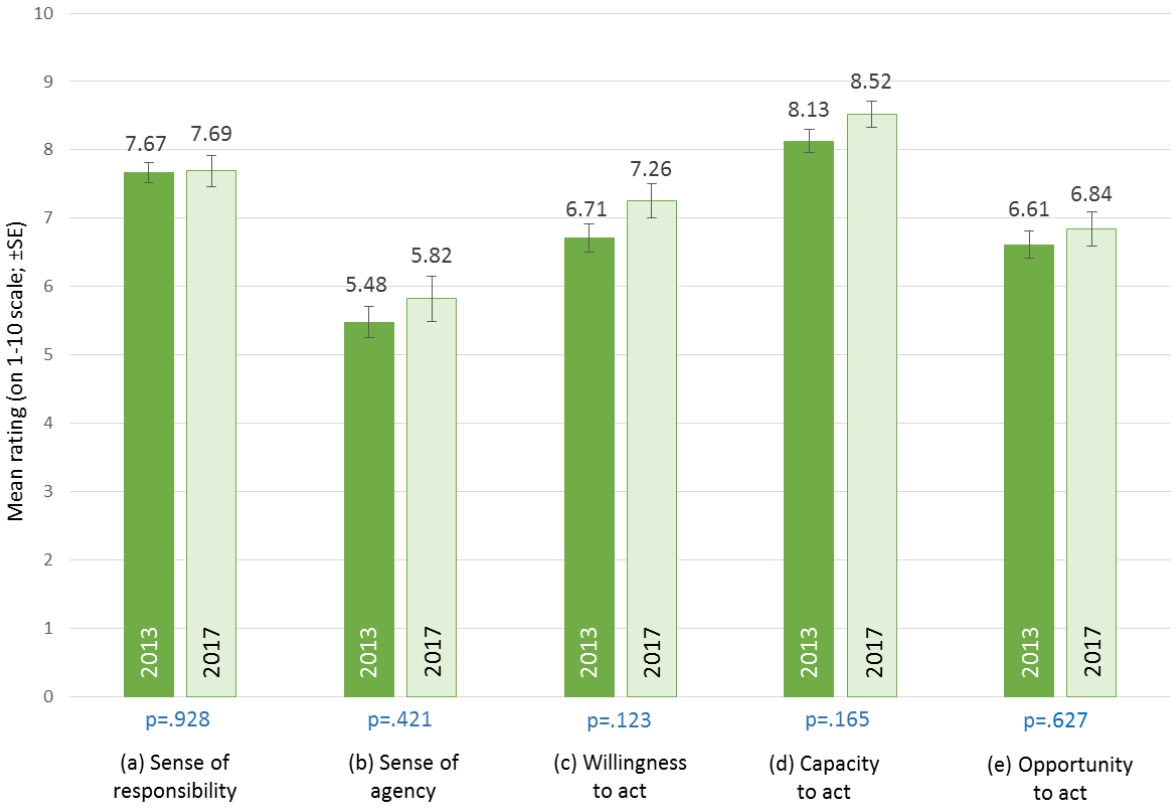

Figure 1 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers in the GBR region, comparing ratings of (a) their sense of personal responsibility for protecting the GBR, (b) sense of agency, (c) willingness to act, (d) capacity to act, and (e) opportunity to act

NB. Ratings of agreement for negatively worded statements (a, b, e) are inverted

Climate change attitudes

We evaluated commercial fishers' attitudes about climate change by asking respondents to select one statement from five options, which best reflected their beliefs. The five statements were: (i) "climate change is an immediate threat requiring action", (ii) "climate change is a serious threat, but the impacts are too distant for immediate concern", (iii) "I need more evidence to be convinced of the problem", (iv) "I believe that climate change is not a threat at all", and (v) "I do not have a view on climate change". While the proportion of respondents identifying with the first statement (i) increased from 16 per cent in 2013 to 27 per cent in 2017 (Figure 2), there remained a majority of respondents who indicated either climate change scepticism ("I need more evidence to be convinced of the problem"; from 40% in 2013 to 42% in 2017) or denial ("I believe that climate change is not a threat at all"; from 20% in 2013 to 13% in 2017).

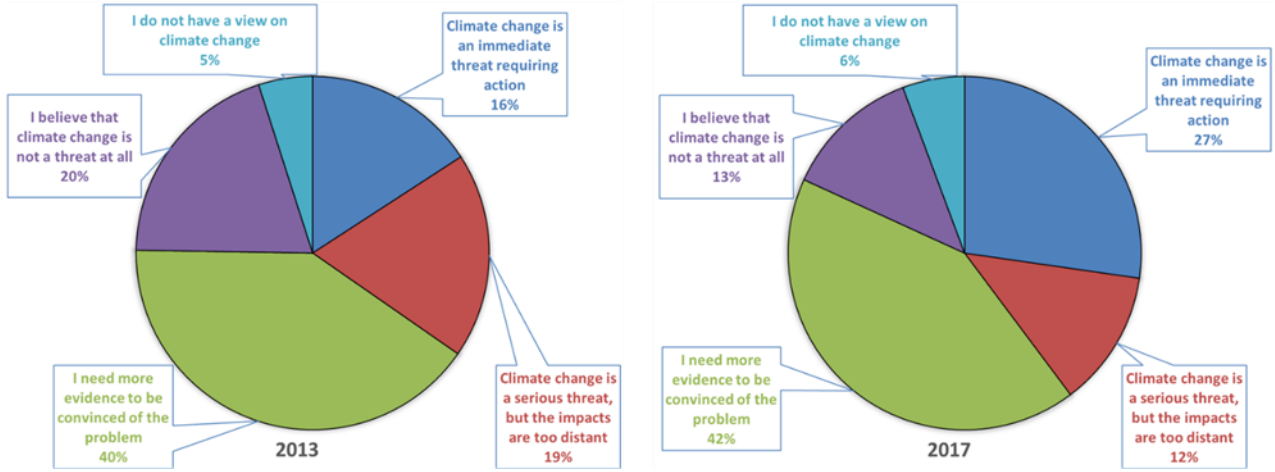

Figure 2 Comparison of the proportion of commercial fishers (2013 and 2017) in categories representing their climate change beliefs, indicated by agreement with one of five statements

Perceived threats to the GBR

Fishers were asked to list what they thought were the "three most serious threats to the Great Barrier Reef" in an open-ended format. In 2013, the most frequently identified threat was *coastal development* (cited by 39% of respondents), which was subsequently cited by only nine per cent of respondents in 2017, ranking ninth (Figure 3). *Fishing* became the highest ranked category in 2017 (cited by 19% of respondents in 2013, rising to 38% in 2017), encompassing a range of responses including 'recreational fishing', 'illegal fishing', 'foreign fishing' and 'overfishing'. *Water quality* remained second-ranked (cited by 37% of respondents in 2013 and 36% in 2017), and *climate change* increased from seventh-ranked in 2013 (17%) to third in 2017 (31%). Other threat categories that were identified with increasing frequency in 2017 included *governance* (from 19% in 2013 to 27% in 2017; encompassing responses such as 'poor management', 'bureaucracy' and 'politics'), *pollution* (from 9% in 2013 to 18% in 2017), and *coral bleaching* (from 0% in 2013 to 8% in 2017; Figure 3).

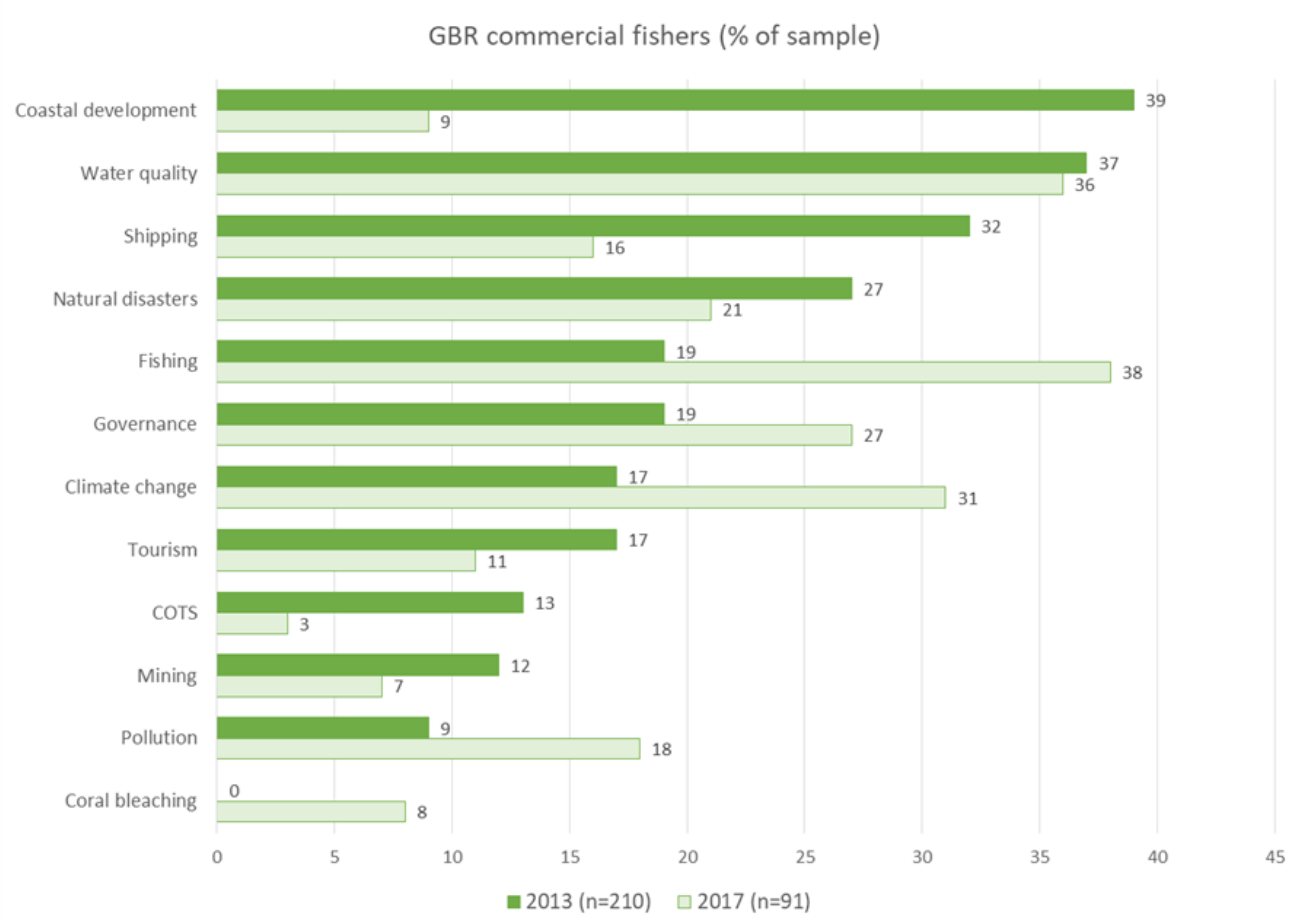

Figure 3 Comparison of the proportion of commercial fishers (2013 and 2017) who identified specific threats among their perceived 'three most serious threats to the Great Barrier Reef'

NB. Top ten response themes shown and ranked based on 2013 responses

Community vitality

Commercial fishers' indicated characteristics of their personal relationship with the GBR, identity and derived wellbeing, through ratings of agreement with the statements: (a) "I feel proud that the GBR is a World Heritage Area" (GBR pride), (b) "The aesthetic beauty of the GBR is outstanding" (aesthetic perception), (c) "The GBR is part of my identity" (GBR identity), (d) "I would NOT be personally affected if the health of the GBR declined" (affective vulnerability; NB. agreement ratings inverted due to negative framing of statement), (e) "I am optimistic about the future of the GBR" (GBR optimism), and (f) "The GBR contributes to my quality of life and wellbeing" (wellbeing from GBR) (Figure 4).

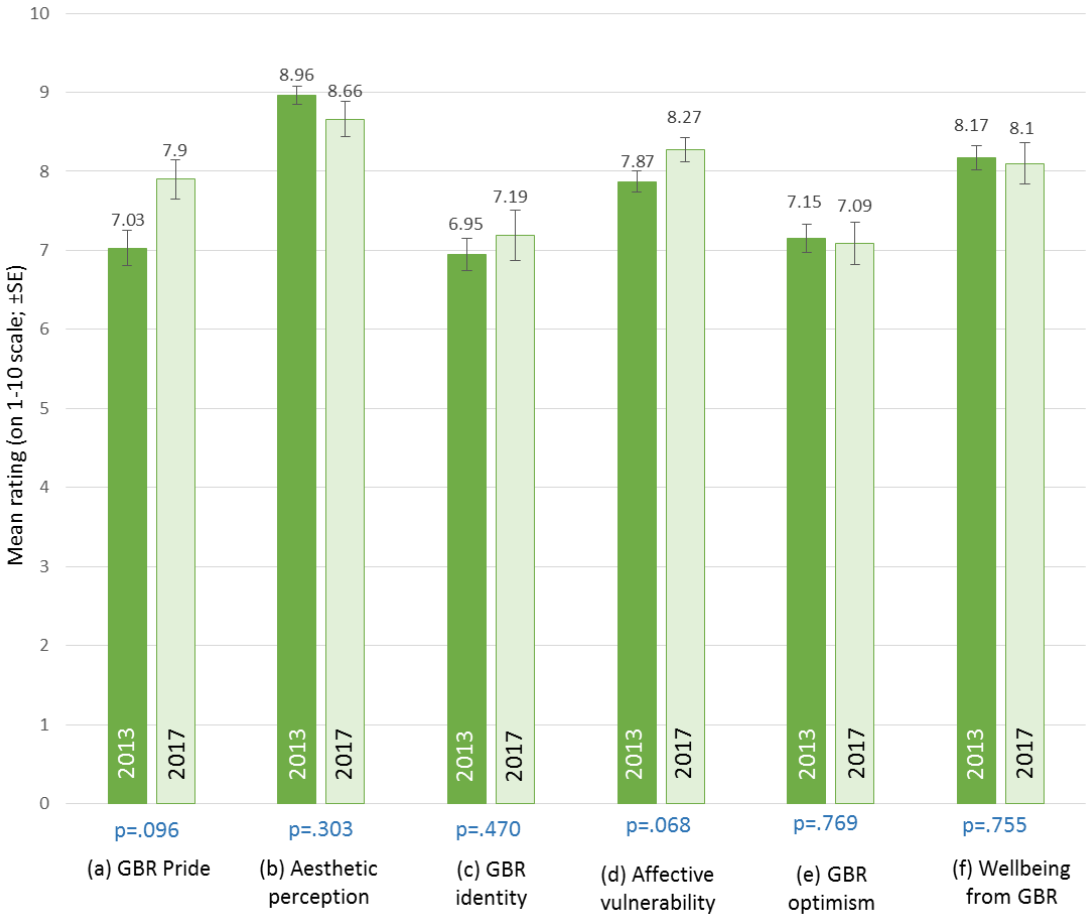

Figure 4 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers in the GBR region, comparing ratings of (a) GBR pride, (b) aesthetic perception, (c) GBR identity, (d) affective vulnerability, (e) GBR optimism, and (f) wellbeing derived from the GBR

NB. Ratings of agreement for negatively worded statement (d) are inverted

No substantive change was observed between years in ratings of *aesthetic perception*, *GBR identity*, *affective vulnerability*, *GBR optimism*, or *wellbeing from GBR* (Figure 4). An increase in respondent ratings of GBR pride (mean rating from 7.03 in 2013 to 7.90 in 2017) is notable, however, the change was not statistically significant.

In responses to the open-ended question: "what are the first words that come to mind when you think of the Great Barrier Reef?" we found a slight reduction in the relative occurrence of positive words (e.g. pristine, beautiful, amazing, great, protect) provided in responses from 2013 to 2017, from 21% to 18% respectively (Figure 5). The prevalence of negatively valenced words (e.g. trouble, disaster, endangered, problem, worried) did not change substantially between years, representing 14% of words provided in 2013, and 13% of words in 2017 (Figure 5).

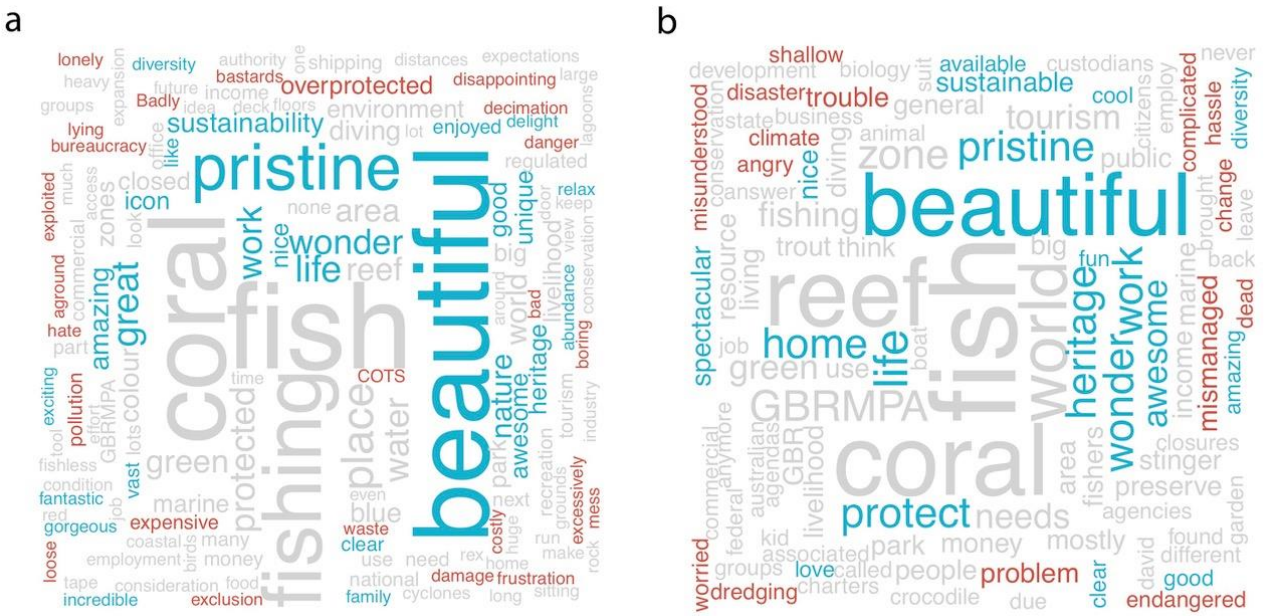

Figure 5 Word clouds comparing the relative frequency of emotionally valenced words associated with the GBR provided by commercial fishers in the GBR region, when asked: "what are the first words that come to mind when you think of the GBR", in (a) 2013, and (b) 2017. Words with positive and negative valence are coloured in blue and red, respectively. The size of words represents the relative frequency of responses

Culture and heritage

Commercial fishers indicated characteristics of their personal relationship with the GBR, occupational attachment and values assigned to the GBR, through ratings of agreement with the statements: (a) "I couldn't think of being anything other than a fisher" (occupational identity), (b) "The fishing industry to me is not just a job, it's my lifestyle" (lifestyle-occupation attachment), (c) "I value the GBR because it supports a variety of life, such as fish and corals" (GBR biodiversity value), (d) "The GBR is a great asset for the economy of this region" (GBR economic value), (e) "I value the GBR because we can learn about the environment through scientific discoveries" (GBR scientific heritage value), (f) "I value the GBR because it supports a desirable and active way of life" (GBR lifestyle value), and (g) "I value the GBR because it attracts people from all over the world" (GBR icon value; Figure 6).

There was a notable increase in 2017 ratings for *GBR icon value* (from 2013 mean of 6.79, to 7.83 in 2017) which was statistically significant (p=.002); however, for all other indicators there were no substantive (or statistically significant) differences in ratings between years (Figure 6).

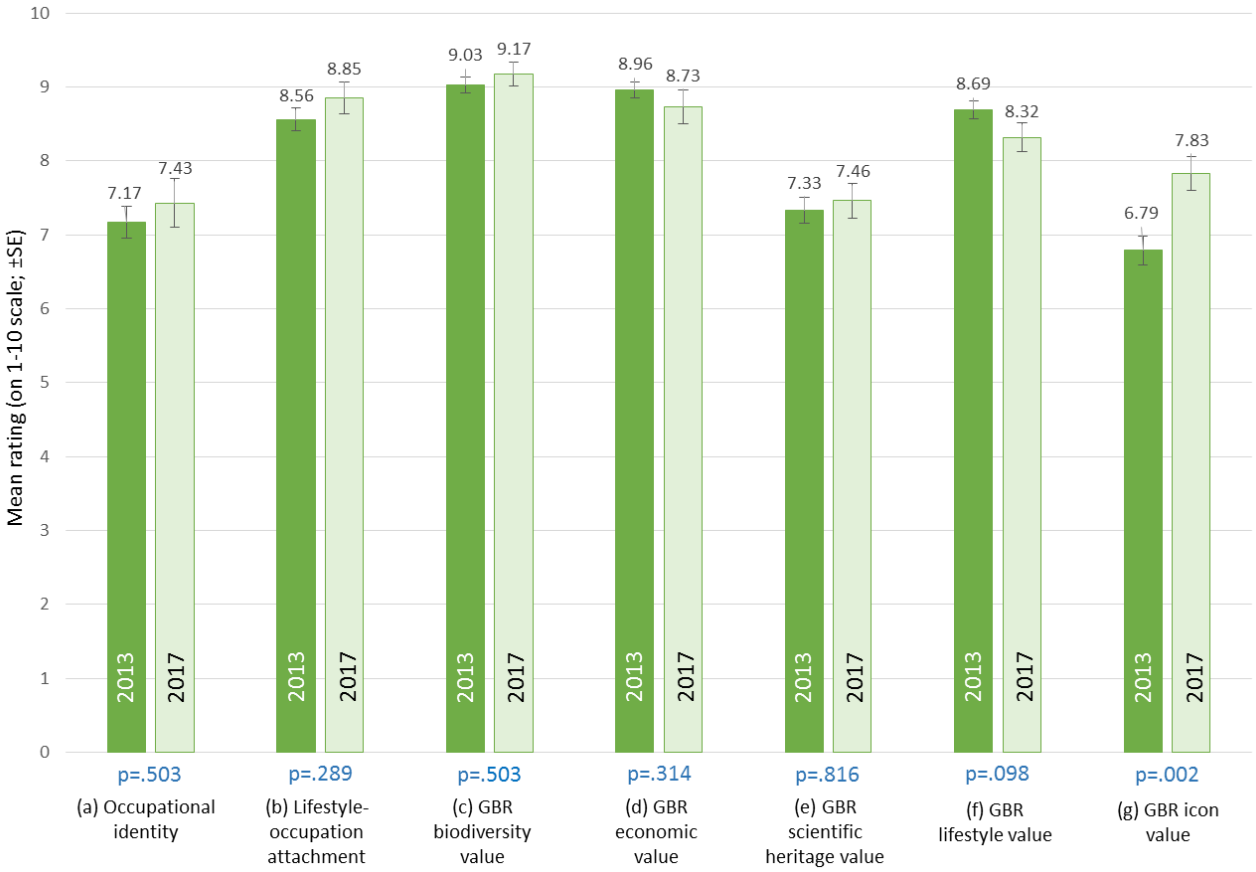

Figure 6 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers in the GBR region, comparing ratings of (a) occupational identity, (b) lifestyle-occupation attachment, (c) GBR biodiversity value, (d) GBR economic value, (e) GBR scientific heritage value, (f) GBR lifestyle value, and (g) GBR icon value

Economic values

Due to survey changes from 2013 to 2017, only two indicators of economic vitality in the commercial fishers' survey were comparable between years. Respondents indicated characteristics of the economic vitality associated with their business, through ratings of agreement with the statements: (a) "I am optimistic about the future of my business in the GBR" (future business optimism), and (b) "My business has NOT performed this year as well as last year" (perceived recent business performance). While there was an increase in ratings for both of these statements in 2017, the differences were not statistically significant (Figure 7). We note that the increase in ratings for recent business performance (indicating perceived lower performance compared with the previous year), does not mean that businesses' performance had dropped below that of 2013.

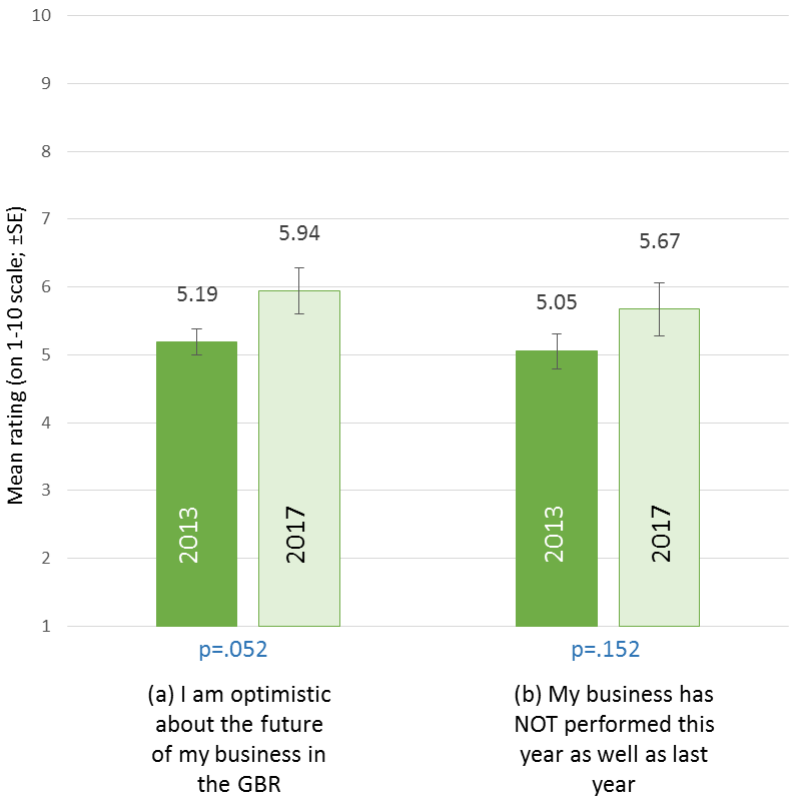

Figure 7 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers in the GBR region, comparing ratings of (a) future business optimism, (b) perceived recent business performance

Governance

Three indicators relevant to governance (i.e. perceptions of management effectiveness) were comparable in the commercial fisher survey between years. Respondents indicated their level of agreement with the following statements: (a) "I feel confident that the GBR is well managed" (confidence in management), (b) "I DO NOT have fair access to the GBR compared to other user groups" (perceived equity among users; NB. agreement ratings were inverted due to the negative framing of this statement), and (c) "I support the rules and regulations that affect access and use of the GBR" (regulatory support). Slight increases in mean ratings for *confidence in management* (from 5.02 in 2013 to 5.61 in 2017) and *regulatory support* (from 4.68 in 2013 to 5.36 in 2017) were observed; however, these increases were not statistically significant (Figure 8).

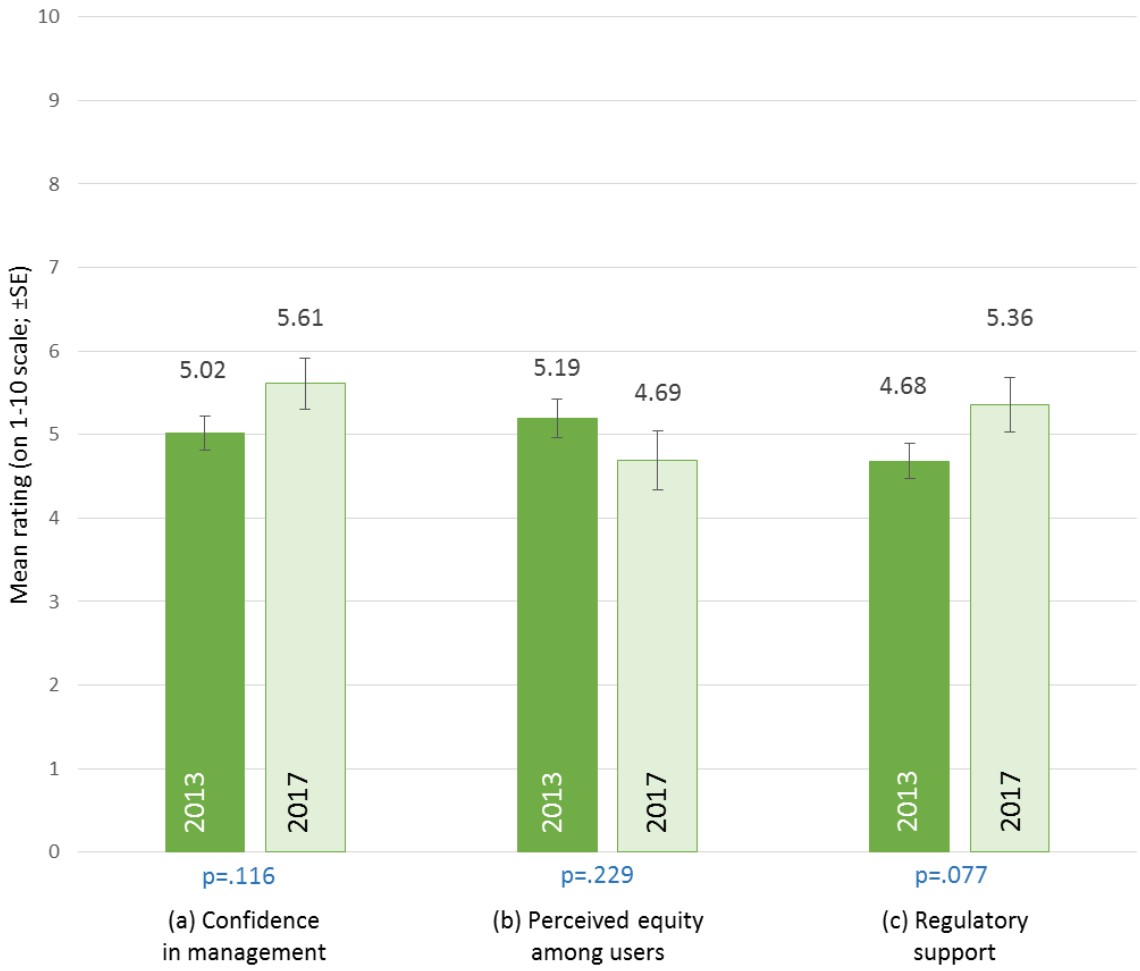

Figure 8 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers in the GBR region, comparing ratings of (a) confidence in management, (b) perceived equity among users, and (c) regulatory support

NB. Ratings of agreement for negatively worded statement (b) are inverted

Trust in GBR information from different sources

Fishers indicated their level of trust (1-10 scale; 1=do not trust at all, 10=trust very strongly) in the information they received about the GBR from different groups/sources, including (a) scientists from research institutions, (b) friends, family and/or work colleagues, (c) the Great Barrier Reef Marine Park Authority (GBRMPA), (d) Fisheries Queensland, (e) industry groups, (f) news media journalists, and (g) social media commentators/bloggers (Figure 9). Statistically significant increases were observed in trust ratings for family, friends and colleagues (highest ranked in both years; up from 6.01 in 2013 to 6.85 in 2017; p=.022) and for the Great Barrier Reef Marine Park Authority (ranked fourth in 2017; up from 3.92 in 2013 to 4.68 in 2017; p=.021; Figure 9). Minor (and non-significant) changes were observed in trust ratings for other information sources.

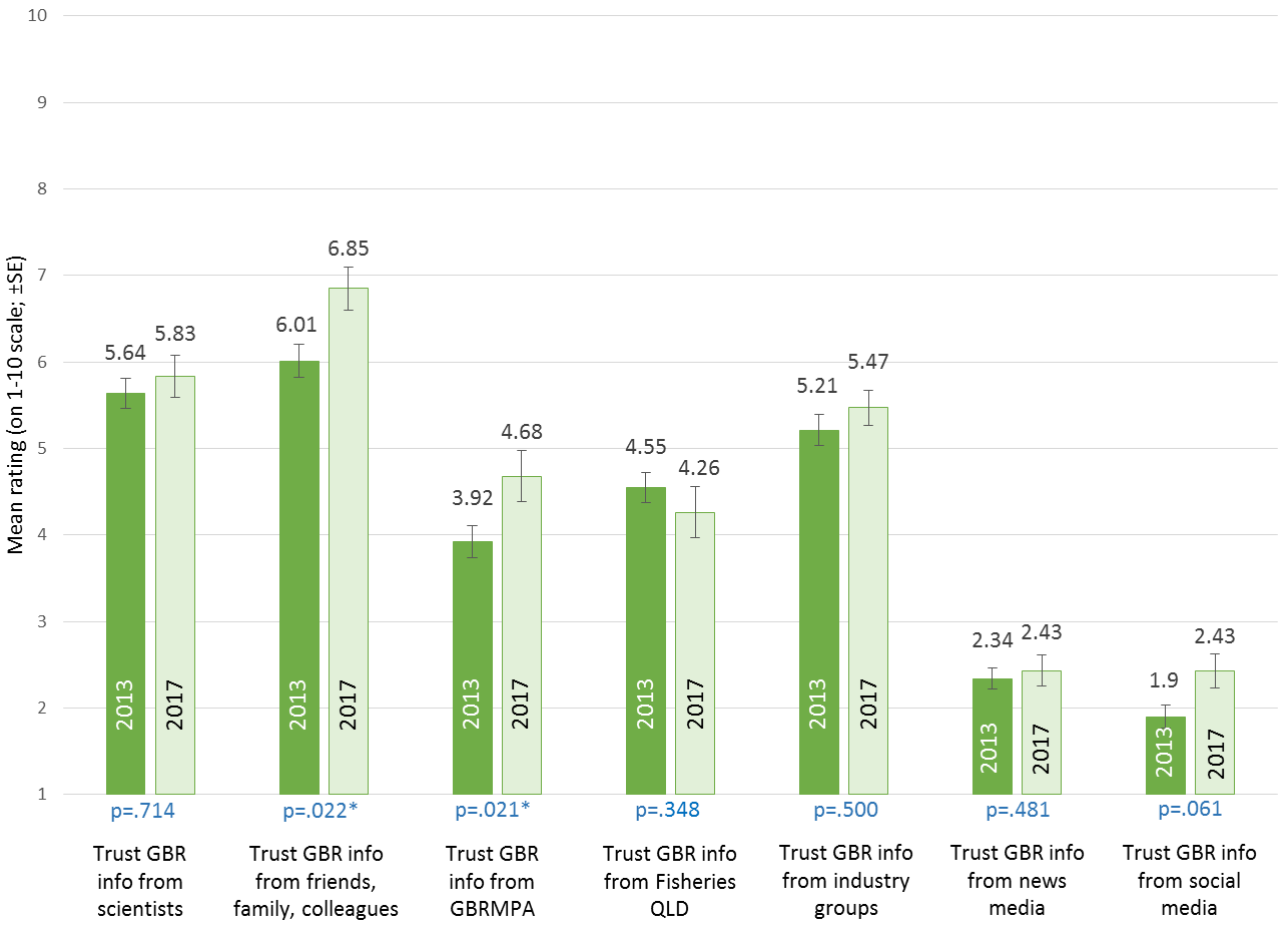

Figure 9 Comparison of mean ratings (1-10 scale; 2013 and 2017; ±SE) and statistical test results (p value) for commercial fishers' rated trust in different sources of information about the GBR

Summary of key findings

This report outlines some of changes that have occurred in perceptions, values and attitudes associated with the GBR among commercial fishers in the Marine Park between 2013 and 2017. Relative to the changes that were reported among tourists, tourism operators, and local residents of the GBR coastal region (cf. two other reports in this series: Marshall & Curnock 2019; Curnock & Marshall 2019), we note that only minimal changes are apparent among the reported indicators for the Great Barrier Reef commercial fishing industry during this period.

Given the uncertainties associated with a smaller 2017 sample size, this sample may mask changes in some indicators that exist within the industry, which could potentially be found to be statistically significant with larger samples. Of the changes that were observed, a notable result was the shift among commercial fishers in their attitudes towards climate change. An increased proportion of respondents acknowledged that climate change is an immediate threat requiring action (up from 16% in 2013 to 22% in 2017; Figure 2), and climate change was recognised by 31% of respondents in 2017 (3rd ranked; up from 17% in 2013) as one of the most serious threats to the Great Barrier Reef. However, in contrast with other groups sampled by SELTMP (e.g. tourists, tourism operators, coastal residents), the majority commercial fishers still remain in denial or are sceptical of the climate change threat (Figure 2). Our results suggest that the understanding among commercial fishers of threats to the Reef is improving (albeit slowly), and accompanying this recognition of the threat, an improved capacity to adapt becomes more likely (Marshall et al., 2013).

Fishers' values associated with the GBR were largely unchanged between the sampled years, unlike GBR coastal residents and tourists, as described in our accompanying reports from this series (Marshall & Curnock 2019; Curnock & Marshall 2019). However, the observed increases in commercial fishers' 2017 ratings for the GBR's icon value (Fig. 6g; statistically significant) and pride (Fig 4a; not statistically significant) suggests an increased awareness of the GBR's significance and status beyond that of local and Australian stakeholders. In related manuscripts, we draw attention to the global media attention brought by the 2016-2017 mass coral bleaching event, and associated affective responses among different communities of stakeholders in Australia and overseas (Marshall et al., 2019; Curnock et al., in review). While we did not detect a comparable affective response (cf. Fig. 5) or significant increase in stewardship sentiment (cf. Fig. 1) within the fishing community, we note that commercial fishers are considered to hold a more pragmatic relationship with their marine environment than other stakeholders (Marshall et al., 2010; Sutton & Tobin 2009).

Commercial fishers indicated higher levels of optimism about their business in the GBR in 2017 than they did in 2013 (Fig 7a). This might be explained by improvements in fishers' relationship with governing institutions, indicated via increased ratings of trust in the Great Barrier Reef Marine Park Authority (Fig. 9). However, trust ratings by commercial fishers for all sources of GBR information were the lowest among all the surveyed groups in both 2013 and 2017, suggesting that engagement with commercial fishers by management agencies (and scientists) remains an ongoing challenge.

Conclusion

Results presented in this report series can assist GBR managers in multiple ways, including in their assessment of management effectiveness, in their spatial planning for different activities and user types within in the Marine Park, and in their development of engagement strategies that aim to improve GBR stewardship among different community and industry groups. More immediately, these results provide valuable information on the current state of the human dimension of the GBR, and indicators that feed into the 2019 Outlook Report and Reef 2050 reporting processes, assisting with evaluation of targets identified in the Reef 2050 Plan.

Longitudinal, up-to-date and comparable social and economic datasets of key stakeholders remain scarce, but provide vital information to improve our understanding of the drivers, pressures, state, impacts and responses within the complex social-ecological GBR system. It is expected that the value of SELTMP will increase with each iterative sampling event. As additional data points become available, the synthesis and integration of these data in an integrated monitoring and reporting program (i.e. RIMReP) will provide improved system understanding, and will underpin decisions that provide more effective management for the GBR. In the meanwhile, the SELTMP 2017 snapshots of GBR stakeholders and communities, including the commercial fishing industry, provide the best, up-to-date depictions of the relationship between people and the GBR.

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Appendix A SELTMP 2013 and 2017 commercial fisher survey questions and results in human dimension indicator framework for Reef 2050 benchmarking

Table A: SELTMP commercial fisher survey questions as human dimension indicators for Reef 2050 integrated monitoring under RIMReP. Human dimension clusters and attributes organised according to Gooch et al.'s (2018) framework for human dimension benchmarking for targets and objectives of the Reef 2050 Plan.

Human Dimension Cluster	Attribute	Survey questions	Mean (±SE) 2013	Mean (±SE) 2017	Direction and significance
1. Aspirations, capacity and stewardship	Aspirations (ACS1)	• I would like to do more to help protect the GBR	6.71 (.207)	7.26 (.250)	.123
		• I would like to do more to improve water quality in the waterways in my region	NA	7.94 (.241)	NA
		• I would like to learn more about the condition of the GBR	NA	6.93 (.291)	NA
	Capacity and education (ASC2)	• I have the necessary knowledge and skills to reduce any impact that I have on the GBR	8.13 (.165)	8.52 (.195)	.165
		• I feel like I can contribute to GBR management	NA	7.14 (.322)	NA
		• I am not worried about climate change impacts on the GBR	NA	4.64 (.323)	NA
		• Climate change is an immediate threat requiring action	Yes = 16%	Yes = 27%	▲(%)
		• Do you have university of TAFE education?	Yes = 43.8%	Yes=48.4%	NA
		• I cannot make a personal difference in improving the health of the GBR	4.52 (.229)	4.18 (.335)	.421
		• I try to encourage other people to reduce their impacts on the GBR	6.86 (.210)	NA	NA
		• Fishers should take steps to reduce their impacts on the GBR	5.64 (.230)	NA	NA
		• Industry expectations are that fishers should take steps to reduce impacts on the GBR	5.51 (.229)	NA	NA
		• Other commercial fishers think that I should reduce my impacts on the GBR	2.70 (.188)	NA	NA
		• I do not have the time or opportunity required to reduce any impact that I might have on the GBR	3.39 (.200)	3.16 (.255)	NA
	Stewardship (ACS3)	• Does your business have fuel efficient engines?	Yes=87.6%	Yes=85.7%	NA
		• Does your business use an emissions calculator to plan your business operations?	Yes=12.4%	Yes=8.8	NA
		• Does your business use carbon offsets to counter emissions	Yes=4.3%	Yes=3.3	NA
		• Does your business have green energy, such as solar panels, for your vessel?	Yes=24.3%	Yes=30.8	NA
		• Does your business use alternative fuels such as biodiesel and ethanol?	Yes=4.8%	Yes=6.6	NA
		• Does your business participate in industry best	Yes=78.6%	Yes=80.2	NA

		practices via a code of practice?			
		• Does your business participate in GBRMPAs reef guardian fisher program?	Yes=24.8%	Yes=30.8	NA
		• Does your business contribute to any scientific monitoring programs?	NA	Yes=63.7	NA
		• It is not my responsibility to protect the GBR	2.33 (.151)	2.31 (.225)	.928
		• I feel a social expectation to reduce any impact that I might have on the GBR	NA	7.45 (.289)	NA
		• Are you part of a GBR based club or community group such as a spear- fishing club in your region? (1=yes, 2=no)	NA	NA	NA
		• I value the GBR because it makes me feel better physically and/or mentally	NA	6.93 (.296)	
		• I would not be personally affected if the health of the GBR declined	2.13 (.135)	1.73 (.152)	.082
		• Thinking about coral bleaching makes me feel depressed	NA	4.66 (.328)	NA
		• The coral reefs in my region are in good condition (2013; The place that I most recently visited in the GBR is NOT in good condition)	3.21 (.184)	7.23 (.250)	
		• I am worried about the status of freshwater fish in region	NA	5.53 (.358)	NA
2. Community vitality	Community health (CV3)	• The mangroves in my region are in good health	NA	7.72 (.256)	NA
		• The estuarine and marine fish in my region are in good condition	NA		NA
		• I like the colour clarity of water along the beaches in my region.	NA	6.23 (.314)	NA
	Satisfaction (CV4)	• There is too much rubbish (plastics and bottles) on the beaches in my region	NA	6.68 (.333)	NA
		• The freshwater areas (e.g. rivers, creeks) in my region are not in good condition	NA	4.30 (.342)	NA
		• The GBR contributes to my quality of life and wellbeing	8.17 (.156)	8.10 (.266)	.816
		• I feel optimistic about the future of the GBR	7.15 (.177)	7.09 (.272)	.861
		• I love that I live beside the GBR (2013; I live here because of the GBR)	6.59 (.241)	9.42 (.115)	NA
3. Culture and Heritage	Values (CH1) (CH3) (CH4)	• The aesthetic beauty of the GBR is outstanding	8.96 (.115)	8.66 (.223)	.188
		• I feel proud that the GBR is a World Heritage Area	7.03 (.219)	7.90 (.252)	.022 ▲
		• I couldn't think of being anything other than a fisher (FISHER ONLY)	7.17 (.213)	7.43 (.330)	.503
		• The fishing industry to me is not just a job, it's my lifestyle	8.56 (.154)	8.85 (.213)	.289
		• The GBR is an important part of my culture	NA	6.71 (.343)	NA
		• The GBR is a great asset for the economy of the region	8.96 (.109)	8.73 (.224)	.314
		• The GBR is part of my identity	6.95 (.203)	7.19 (.314)	.521
		• I value the GBR because it supports a variety of life, such as fish and corals	9.03 (.110)	9.17 (.161)	.503
		• The GBR supports a desirable and active way of life	8.69 (.120)	8.32 (.199)	.098
		• I value the GBR for the fresh seafood it provides	NA	9.29 (.148)	NA
		I value the GBR because it attracts people from all over the world	6.79 (.198)	7.83 (.225)	.002 ▲
		• The GBR contributes to my quality of life and wellbeing	8.17 (.156)	8.10 (.266)	.816

		• I value the GBR because of its rich traditional owner heritage	NA	4.93 (.294)	NA
		• I value the GBR because it provides a place where people can continue to pass down wisdom, traditions and a way of life	NA	6.93 (.308)	NA
		• I value the GBR because we can learn about the environment through scientific discoveries	7.33 (.173)	7.46 (.240)	NA
		• The GBR inspires me in artistic or thoughtful ways	NA	6.05 (.314)	NA
		• I value the GBR because it exists, even if I don't benefit from it	NA	7.94 (.260)	NA
		• I value the GBR because it is spiritually important to me	NA	6.03 (.351)	NA
4. Economic value	Economic viability (EV1) (EV2) (EV3) (EV4) (EV5)	ONLY FOR: commercial fisher and marine tourism operator surveys • How long have you been involved in the GBR fisheries/tourism industry?	28.86 Years (.869)	NA	NA
		• I am optimistic about the future of my business in the GBR	• 5.19 (.188)	• 5.94 (.339)	.042 ▲
		• How long has your current business been operating?	• NA	• NA	NA
		• What proportion of your household income came from tourism in the last financial year?	• 64.67% (2.695)	• 80.14% (3.064)	NA
		• How many employees (FTE) did your operation employ over the previous 12 months?	• 2.22 (.356)	• 4.41 (1.093)	.015 ▲
		• Do you have insurance for your business assets?	• Yes = 59.0%	• Yes=59.3%	NA
		• Could you please indicate (approximately) your business turnover (entire revenue) for the past 12 months, in broad categories?	• See Figure x.	• See Figure X.	NA
		• My business has not performed this year as well as last year	5.05 (.253)	5.67 (.387)	NA
5. Governance	Confidence in management (G3)	• Enough is being done to effectively manage the GBR	NA	4.93 (.316)	NA
		• I feel confident that the GBR is well managed	5.02 (.206)	5.61 (.306)	.116
		• I feel confident that the freshwater areas in my region are well managed	NA	3.93 (.288)	NA
		• I can contribute to GBR management	NA	7.14 (.322)	NA
	Equity issues (EV4)	• I do not have fair access to the GBR compared to other user groups	5.19 (.231)	4.69 (.354)	.229
		• Future generations have been adequately considered in the management of the GBR	NA	6.09 (.299)	NA
	Support for management (G3)	• I support the rules and regulations that affect access and use of the GBR	4.68 (.210)	5.36 (.327)	.077
		• I support the current rules and regulations that affect access and use of freshwater areas (rivers and creeks in my region	NA	5.74 (.354)	NA
	Traditional vs. progressive (G2)	• "Progressive" rather than, "traditional" on a ten point scale with traditional at one end, and progressive at the other.	NA	6.75 (.290)	NA
	Trust in networks (G4)	• On a scale of 1-10, how much do you trust the information you receive about the GBR from the following groups? (11 listed) • The Australian Government	NA	3.70 (.237)	NA
		• The Queensland government (2013: Fisheries QLD)	4.55 (.177)	3.35 (.254)	
		• Friends, family and/or work colleagues	6.01 (.193)	6.85 (.247)	.013* ▲

		• GBRMPA	3.92 (.188)	4.68 (.294)	.029 ▲
		• Scientists	5.64 (.173)	5.83 (.243)	.000 ▲
		• Industry Groups	5.21 (.180)	5.47 (.206)	.384
		• Australian based NGOs	NA	3.23 (.220)	NA
		• International NGOs	NA	2.43 (.207)	NA
		• New media journalists	2.34 (.126)	2.43 (.179)	.690
		• Other fishers	6.57 (.152)	NA	NA
		• Social media bloggers	1.90 (.133)	2.43 (.195)	NA
	Sources of Information (G4)	• On a scale of 1-10, how much do you rely on each of the following for news about your region and the world? (16 listed) • Local newspaper	NA	3.67 (.266)	NA
		• State papers	NA	3.09 (.244)	NA
		• Magazines	NA	3.07 (.259)	NA
		• TV	NA	5.00 (.254)	NA
		• Pay tv	NA	2.72 (.249)	NA
		• Digital streamlining	NA	2.64 (.269)	NA
		• Local radio	NA	4.53 (.305)	NA
		• National radio	NA	4.39 (.301)	NA
		• Online forums	NA	2.67 (.231)	NA
		• Facebook	NA	2.90(.268)	NA
		• Twitter	NA	1.52 (.155)	NA
		• Instagram	NA	1.47 (.140)	NA
		• Snapchat	NA	1.31 (.115)	NA
		• YouTube	NA	2.38 (.252)	NA
		• News media websites	NA	2.84 (.243)	NA
		• Word of mouth	NA	5.72 (.247)	NA
	Demographic Information (CV1)	• In what year were you born?	55.02 years (.765)	NA	NA
		• What is your current home postcode?	NA	NA	NA
		• For how many years have you lived in the GBR region?	34.31 (1.431)	35.674 (1.9029)	NA
		• How many years have you been fishing	28.86 (.869)	NA	NA
		• Are you currently married or have a partner?	Yes = 84.7%	Yes=86.8%	NA
		• Do you identify as an Aboriginal Australian (1=yes, 2=no)	NA	NA	NA
		• Do you identify as a TS Islander?	NA	NA	NA
		• Do you identify as FIFO	NA	NA	NA
		• Do you have university of TAFE education?	Yes = 43.8%	Yes=48.4%	NA

NB. A p value of .05 or smaller indicates a statistically significant difference in rating scores between years (95% confidence interval).

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