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Competing and Conflicting Messages via Online News Media:
Potential impacts of claims that the Great Barrier Reef is Dying

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Abstract

Coverage of issues by news media is known to impact on both public perceptions and policy development aimed at addressing the featured issues. We examine the potential impact of news media coverage regarding the health and potential future of the World heritage-listed Great Barrier Reef, which is under multiple pressures, both natural and anthropogenic. We draw on the extant literature regarding the impact of news media coverage of other complex issues, linking to relevant, albeit limited theoretical concepts that have been applied to previous media studies. We find that media coverage is predominately sensationalized and negative, with the potential to reinforce perceptions that mitigation attempts will be ineffective and thus likely to inhibit future policy development. We discuss the need for a review of existing science communication models and strategies to reduce the knowledge-practice gap between scientists and policy makers, together with proactive strategies to counter negative news coverage.

Keywords: news media, media impact, Great Barrier Reef, public perceptions

1. Introduction

The impact of mass media coverage on public attitudes and beliefs regarding complex issues such as environmental protection and climate change impacts and on policy development is well documented (Anderson, 2009; Schmidt et al., 2013; Van Aelst and Walgrave, 2011). We use the example of Australia's Great Barrier Reef (GBR), an iconic natural resource under pressure from a range of natural (e.g., cyclones, floods, natural disasters including coral bleaching events etc.) and anthropogenic factors (e.g., pollution, population growth, deforestation etc.) factors, to discuss the impact of media coverage on attempts to improve water quality on the reef and thus protect the reef itself and a range of marine wildlife. We use content analysis underpinned by common media theories to analyse the mass media coverage of the health of the GBR across one calendar year and discuss the implications for policy makers and for natural resource management bodies.

2. Materials and Methods

We have followed the strategy outlined in McLennan et al.'s (2014) analysis of media representation of issues, noting the decline in traditional print-based newspaper readership and the increased use of electronic media forms (Haddock-Fraser, 2012). Thus we have restricted our analysis to online news articles, press releases and blogs. We acknowledge that a small number of articles are available on subscription only, and note McLennan et al.'s observation that "*audio or televised news may be under-represented. However, with many news-providers now publishing transcriptions of their in-print, audio or televised news online, this was not considered to overly bias the data*" (2014).

Further, the focus on internet-based material is also justified in that it captures small local media as well as larger metropolitan and regional media and is seen as providing a "*more level playing field*" than conventional media (Gavin, 2010), presenting "*communication opportunities not available in the mainstream media*" including for those with perceptions

and views at odds with prevailing views (Stein, 2009), offering the ability to reach a global audience at minimal cost (Barr et al., 2011; Douglas and Sutton, 2004).

Following the McLennan et al.'s (2014) strategy of using the Google News search function (https://news.google.com.au/), we searched for all news items relating to the Great Barrier Reef during 2016. In total 242 articles were identified, including news media, blogs and online press releases from government agencies or organisations or from lobby groups. These were then reviewed to determine which articles were relevant to this study.

Inclusion criteria:

The following criteria was included to ensure that all relevant material was captured in the data search.

- Any topic dealing with the current or projected future state of the GBR, water quality issues, impact of natural events such as climate change or anthropogenic influences such as agricultural runoff and the impact of industry on the GBR.

Exclusion criteria:

The following criteria was excluded to exclude non-relevant information:

- Articles not in English: articles not in English were excluded due to time constraints of having the material interpreted from the foreign language to English and back again to ensure that the translation was accurate.

- Articles requiring subscription / purchase. Two media outlets, The Courier Mail and Cairns Post newspapers were excluded (8 articles in total, all of which carried headlines similar to those in freely available outlets at the same point in time).

- Articles relating to snorkelling / diving deaths or boating incidents on the GBR as these were not related to the scope of the study i.e. water quality issues, impact of natural events such as climate change or anthropogenic influences.

- Articles directly or indirectly promoting tourism or detailing changes to infrastructure such as transport as these were not related to the scope of the study i.e. water quality issues, impact of natural events such as climate change or anthropogenic influences.

- Articles relating to medical breakthroughs using fish venom as these were not related to the scope of the study i.e. water quality issues, impact of natural events such as climate change or anthropogenic influences.

- Government or environmental activist website content as these sites tended to display extreme views of the topic in the article.

2.1. Coding strategy

The articles selected for detailed analysis were initially coded into key issues and then re-coded inductively to identify the media frames being used, noting potential distorting factors such as government elections and the submission dates of reports to international bodies such as UNESCO. In addition, a specific author category was set up to distinguish material from that of journalists or other sources to Academics who frequently contribute to *The Conversation* (an independent source of news and views, sourced from the academic and research community and delivered direct to the public) and occasionally in other media.

We have used the accepted benchmark measures for inter-coder reliability (the extent to which two or more independent coders agree on the coding of the content of interest with an application of the same coding scheme) of .90 being acceptable in all situations and .80 being acceptable in most situations (Lombard et al., 2002). Initial discussions were held regarding the coding strategy and trial coding conducted. One author then completed coding of all articles, with a second author then recoding the material, resulting in 100% agreement on all coding decisions.

2.2. Relevant Theory

While there are several media theories commonly cited in the literature (see, for example, McLennan et al., 2014; Walters et al., 2016), these are descriptive rather than offering predictive capacity and have not been empirically tested. Accepting these limitations, we have drawn on the most commonly cited of these theories in the analysis reported in the following sections.

Agenda Setting Theory: decisions regarding what to display as news and how, in order to influence both public opinion and policy makers (e.g. the GBR being dead or dying).

Media Framing Theory (also referred to as second-order agenda setting): decisions regarding what specific parts of an issue should be highlighted in order to give a specific interpretation. This is closely linked to issues of sensationalism and media hype, discussed earlier, where the reporting of an issue may be exaggerated or distorted.

Valance framing: decisions regarding whether to portray issues in either positive or negative terms.

Hedging framing: where claims are phrased as tentative, e.g. "might".

Adversarial framing: where conflict between opposing groups is highlighted without reference to the level of agreement across all stakeholders.

(McLennan et al., 2014; Scheufele, 1999; Scheufele and Tewksbury, 2007; Walters et al., 2016).

2.3. News Media Influence and Impacts

In spite of the growth of purely digital options, mass media, via either digital or traditional formats, continues to be the primary source of information for the majority of people (Schmidt et al., 2013). There is strong evidence that these media are a substantial influence on public perceptions of specific issues and on policy development (Anderson, 2009; Boykoff and Yulsman, 2013; Happer and Philo, 2016), both reflecting and shaping

public opinions (Leitch and Bohensky, 2014). Its influence raises concerns regarding the potential for misinformation to be widely disseminated or for erroneous perceptions on specific issues to be reinforced (Lewandowsky et al., 2012). As has been found in relation to complex issues such as climate change, the media frame issues in terms of extremes, either using conflicting views or potential outcomes (Wojcik et al., 2014).

2.4. False Balance

In terms of reporting of conflicting views, the news media frequently gives equal coverage, irrespective of the amount or quality of evidence presented or whether some views come from a small number of people, to both sides of debate where there are divergent views (Boykoff and Boykoff, 2004; Gross, 2009; Lewandowsky et al., 2012). While this 'objectivity' in being seen to present all views is claimed to be a basic principle of journalism (Clarke, 2008), this false balance can cause intentional or unintentional bias, magnifying the perceived levels of agreement or disagreement (Boykoff and Mansfield, 2008; Finnis et al., 2015). In particular, by not stating what the relative strength of evidence offered by different parties is, perceptions may be created or maintained that there is a lack of consensus on particular issues (Clarke et al., 2015). The journalist code of ethics regarding not suppressing "*relevant available facts or distorting emphasis"* (Hurlimann and Dolnicar, 2012) would appear to be not adhered to when emphasis is unduly distorted.

In addition, while stories of conflict or disagreement may stimulate attention and interest, they have been shown to decrease confidence in scientific evidence (Jensen and Hurley, 2012; Stocking and Holstein, 2008). However, while criticism of journalism practices is widespread, a failure to provide solutions that are achievable within available resources is noted (Secko et al., 2013). Further, uncertainty and doubt may be magnified, misrepresented or manipulated (Bailey et al., 2014), particularly by providing a "*forum for contrarian views*" (Brüggemann and Engesser, 2017).

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2.5. Reporting of Disagreement

An example of reporting disagreement is found in the 2016 media coverage of public disagreement by a scientist. The reports in the media from a large group of other experts regarding the extent and consequences of coral bleaching, appeared under headlines such as "*Great barrier battleground over coral bleaching*" (see, for example, the June 24 item : http://www.theaustralian.com.au/news/inquirer/great-barrier-battleground-over-coral-bleaching/news-story/e74d24eee3c4a01400e91ec7cefa5258). When similar controversies have been reported regarding issues such as climate change, there is evidence that the media coverage may have increased doubt regarding the validity of the overall body of scientific evidence. It has also increased perceptions that risks have been exaggerated (Weingart et al., 2000) as well as overstating the number of members of the scientific community with dissenting views (Poortinga et al., 2011). Closely linked to this is a debate regarding whether scientists should simply provide information for policy makers or whether, and in what ways they might become effective advocates for change (Bickford et al., 2012; Bramwell et al., 2016).

2.6. Science Communication Models

A range of science communication models have been proposed, with acknowledgement that a linear transmission from scientific experts to lay publics is no longer effective in the digital age and also that there is an increased call for interaction between the two communities, with the latter seeking participation in policy issues and debates as well as, importantly, empowerment to make decisions (Secko et al., 2013). Awareness of an issue does not necessarily create public concern that will pressure policy makers into immediate responses, particularly where dissent among the scientific community is evident (Aklin and Urpelainen, 2014). Where media coverage repeats negative news without offering potential actions that individuals may be able to take, the response may be maladaptive: the feeling that the problems are too big for individuals to be able to influence may lead to increased feelings

of helplessness and ultimately to reduced support for any proposed action (Becken, 2007; Hamblyn, 2009; Hobson and Niemeyer, 2013). Without support, policy change and effective management actions may not be achieved (Dale et al., 2013).

2.7. Data analysis

A series of cross tabulations were initially performed to summarise the data. Due to the nature of the data collected, with a mixture of categorical and ordinal data and low numbers in several categories (for example, only one article used hedging wording and only two articles were directly authored by government officials), a Kruskal-Wallis one-way ANOVA non-parametric tests was run. The results of the analysis are contained in Section 4.

3. *Great Barrier Reef (GBR) Overview and Economic Importance*

The Great Barrier Reef became a Marine Park in 1975 and was then listed as a World Heritage site in 1981 (Foxwell-Norton and Lester, 2017). There is 99% overlap between the Park and Heritage areas (Great Barrier Reef Marine Park Authority, 2017). It stretches for more than 2,300 km along the Queensland (north-eastern) coast of Australia, covering an area of 348,000km^2 (Teakle et al., 2015). It is the world's largest coral reef system and is estimated to support between 65,000 and 69,000 full time equivalent jobs (Butler et al., 2013; Deloitte Access Economics, 2013; Kroon et al., 2016; Piggott-McKellar and McNamara, 2016). It generates significant revenue as shown in Table 3.1.

Table 3.1: Estimated Annual Revenue from Economic Activity on the Great Barrier Reef (Butler et al., 2013; Deloitte Access Economics, 2013)

Sector	Revenue (AU$)
Tourism	6 billion
Recreational fishing	623 million
Commercial fishing	251 million
Overall direct and indirect contribution to the Australian economy	11.6 billion

Agricultural industries that operate on the GBR water catchment areas are also significant contributors to the Queensland state economy, with sugar production being worth $AU1.75 - $2 billion per annum (Department of Agriculture and Fisheries, 2012; Queensland Cane Growers Association, 2010), and meat production contributing a further $AU4.6 billion per annum (Queensland Government, 2016).

3.1. Pressures on the Great Barrier Reef (GBR)

There have been concerns for several years regarding the declining quality of water on the GBR. It has been reported that coral cover has halved in the last 30 - 40 years due to cumulative effects of a range of natural (e.g., cyclones, floods, natural disasters including coral bleaching events etc.) and anthropogenic factors (e.g., pollution, population growth, deforestation etc.) (Hughes et al., 2015; Kroon et al., 2016). The decline in coral cover has been reported widely in the media and also by organizations such as the World Wildlife Foundation (WWF) (Dalberg Global Development Advisors, 2015). We note that the original study on which these reports are based (De'ath et al., 2012) did not involve a detailed physical survey of all GBR areas, but rather on a substantial time series data analysis and modelling. There have been several cyclones (hurricanes) that have damaged sections of coral: Cyclone Yasi in February 2011 is estimated to have damaged some 15% of corals (Beeden et al., 2015). Cyclone Debbie hit the southern part of the GBR in late March 2017. However, the full impact of the damage to the GBR to date, has not been fully assessed. Heavy rainfall from cyclones has also increased the amount of fresh water flowing from rivers onto the GBR: changes to salinity levels can kill corals (Hoegh-Guldberg, 2011). These fresh water flows also deposited sediment on seagrass meadows, which are significant habitats for endangered dugongs and turtles as well as fish (Coles et al., 2015; Great Barrier Reef Marine Park Authority, 2014a; Perry et al., 2014; Wooldridge, 2016). Increased sediment in water also reduces the amount of light for photosynthesis, leading to seagrass loss (Petus et al., 2014). Seagrasses, along with mangroves and salt marshes, are also

effective at capturing and storing carbon ('blue carbon') (Mcleod et al., 2011), thus

significant decline in seagrass meadows may result in carbon being released and potentially

accelerating global warming (Duarte et al., 2013; Macreadie et al., 2014). Australia has the

highest per capita carbon dioxide emissions of the 34 OECD countries, primarily due to

heavy reliance on coal-fired electricity generation (Organisation for Economic Cooperation

and Development (OECD), 2015). A quarter of carbon dioxide released into the atmosphere

is absorbed by oceans, but as it dissolves in water, the acidity increases slightly, slowing coral

growth and increasing coral erosion (Albright et al., 2016; Ko et al., 2016)

3.2. Agricultural Impacts

The agricultural sector is also cited as contributing to the decline in water quality through

sediment loss from erosion of grazing land (Thorburn et al., 2013) and leaching of fertiliser

and pesticide residues (Butler et al., 2013). Increases in outbreaks of the coral-destroying

crown-of-thorns starfish have been linked to increased levels of nutrients such as fertilizer in

water (De'ath et al., 2012; Fabricius et al., 2010). Resultant publicity has led to claims of

unfair blame from groups such as cane growers (Eagle et al., 2016; Flick et al., 2010;

Galligan, 2016) although this is claimed more in news media than in academic literature. In

spite of numerous initiatives, water quality improvement targets have not been met (Kroon et

al., 2016), leading to UNESCO reviewing the World Heritage status over the 2011 – 2015

period but delaying a final decision until 2020 (Coghlan et al., 2016).

While a series of agriculture sector-specific 'best management practices' have been

developed, uptake of these by land mangers has been lower than expected   (Emtage and

Herbohn, 2012; Great Barrier Reef Marine Park Authority, 2014b), with little evidence of

significant long-term impact on the environment (Greiner and Gregg, 2011), partially because

a significant percentage of farmers do not (Farr et al., 2017) accept that their farming

practices may adversely affect water quality (Blackstock et al., 2010; Collins et al., 2016). A

challenge is that agricultural runoff is a form of diffuse pollution, with difficulties in

determining exactly what runoff comes from individual properties and thus what remedial action could or should occur to minimize it (Kroon et al., 2014; Patterson et al., 2015).

3.3. Industrial Activity Adjacent to the GBR

These issues are complicated further by additional pressures from coastal development and industrial activity. Coal mining is a major industry in Queensland, supplying both domestic coal for electricity generation and also coal for export, generating an estimated $1.6 billion in royalties for the state of Queensland in 2016 (Queensland Treasury, 2016). However, the coal sector has been accused both of contributing to climate change through CO_2 emissions, and also distorting its value to the economy through concealing both direct and indirect subsidies, estimated at $5 billion per annum for the entire country (Makhijani and Doukas, 2015). Of particular concern is that in 2014, an extension was approved for the existing port of Abbot Point, one of three major export-oriented ports along the GBR. The expansion rationale was that it was needed to accommodate the export of coal from new mines inland from the GBR. Up to 3 million cubic metres of sediment were approved to be dredged, raising concerns not just about the disposal of dredged material, but also increased risk to the GBR from coal dust and potential damage from increased port activity (Foxwell-Norton and Lester, 2017; Grech et al., 2015; Salvatierra and Walters, 2016). This dredging has yet to occur and will involve depositing dredged material on land rather than, as was originally proposed, in the ocean (The Australian, 2014).

3.4. Ship Groundings on Coral Reefs

Concern regarding shipping through the GBR (and other coral reefs) is not without foundation: in 2010, a bulk coal carrier, the Shen Neng grounded on the reef, causing damage not just to the corals from the actual grounding, but also from a ruptured fuel tank and the release of toxic anti-fouling paint. The impact of the grounding is summed up as follows: "*15,000 m2 of the shoal were severely damaged or completely destroyed. Further, patchy or moderate damage occurred over much of the rest of the 400,000 m2 that the ship*

covered during this incident" (Great Barrier Reef Marine Park Authority, 2011). In March 2017, a UK cruise ship ran aground on an Indonesian coral reef, reportedly damaging 1,600 square metres of coral (Franciska, 2017).

3.5. Last Chance Tourism

We have noted earlier the importance of GBR tourism to the economy. Of concern therefore is the growth in "last chance tourism", i.e. visits undertaken before the attractions of a destination disappear (Lemelin et al., 2010). While this may result in a short-term increase in tourism, this may present problems in terms of pressures on resources and the GBR itself (Piggott-McKellar and McNamara, 2016). These authors found that just under 70% of GBR tourists surveyed in 2015 were motivated by the perception that it was a chance "*to see the reef before it's gone*" . This perception has been generated largely by news media coverage, with coverage having focused for several years on the declining health of the GBR (Coughlan and Prideaux, 2012). It is suggested that annual tourism revenue may fall by as much as $1billion due to the impact of coral bleaching, and the sustained news coverage of damage (Willacy, 2016) but actual visitor data for 2016 / 2017 is not yet available.

4. *Findings*

We have summarized the articles analysed in a series of cross tabulations, commencing with analyses of articles by 14 major themes by type of media outlet, author type, framing and tone of articles. Coral bleaching was the most commonly reported theme overall (59 articles, 24.4% of the total articles analysed). Climate change / global warming and the associated ocean acidification (34 articles, 14.0% of the total articles analysed) followed. The potential impact of coal mining on the reef and reports that the GBR is dying each featured in 25 articles, 10.3% of the total analysed). Calls to increase funding to address the health of the GBR were reported in 20 articles (8.3% of the total). The other topic themes received less coverage, especially from international media (Refer Table 4.1). A Kruskal-Wallis one-way ANOVA non-parametric test showed significant differences for themes by

media (p =.000), with clear differences in the focus of international, national, regional and local media on themes such as climate change and coral bleaching that featured strongly in international media compared to calls for more localised themes such as funding increases (refer Table 4.1).

Table 4.1: Cross Tabulation: Theme by Type of Media Outlet

*p = .000		International media	National media	Regional media	Local media	Online only	Blog	Total
*Climate change / global warming / ocean acidification	n	13	0	0	0	20	1	34
	%	19.4	0.0	0.0	0.0	27.4	12.5	14.0
*Coral bleaching	n	22	18	5	0	13	1	59
	%	32.8	27.7	26.3	0.0	17.8	12.5	24.4
Reef is dead / dying	n	9	3	1	0	9	3	25
	%	13.4	4.6	5.3	0.0	12.3	37.5	10.3
Science disagreement controversy	n	0	4	1	2	1	3	11
	%	0.0	6.2	5.3	20.0	1.4	37.5	4.5
UNESCO potential 'at risk' listing	n	9	2	3	0	5	0	19
	%	13.4	3.1	15.8	0.0	6.8	0.0	7.9
Water quality improvement	n	0	3	0	0	2	0	5
	%	0.0	4.6	0.0	0.0	2.7	0.0	2.1
*Funding increase calls	n	0	11	2	0	7	0	20
	%	0.0	16.9	10.5	0.0	9.6	0.0	8.3
Cane monitoring compliance	n	1	1	0	1	1	0	4
	%	1.5	1.5	0.0	10.0	1.4	0.0	1.7
Farmer protest negative portrayal	n	0	2	0	2	0	0	4
	%	0.0	3.1	0.0	20.0	0.0	0.0	1.7
Government actions	n	1	4	0	1	0	0	6
	%	1.5	6.2	0.0	10.0	0.0	0.0	2.5
Reef Report card	n	1	1	0	0	3	0	5
	%	1.5	1.5	0.0	0.0	4.1	0.0	2.1
Plastic bag ban	n	3	5	4	0	1	0	13
	%	4.5	7.7	21.1	0.0	1.4	0.0	5.4
Coal mining / dredging	n	6	6	2	2	9	0	25
	%	9.0	9.2	10.5	20.0	12.3	0.0	10.3
Shipping	n	2	5	1	2	2	0	12
	%	3.0	7.7	5.3	20.0	2.7	0.0	5.0
Total	**n**	**67**	**65**	**19**	**10**	**73**	**8**	**242**
	%	**100**	**100**	**100**	**100**	**100**	**100**	**100**

This cross-tabulation between the theme of the article and the type of media outlet shows there is significant difference in the focus of international, national and regional/local media.

Recently, the GBR has been subject to significant coral bleaching due to extended warm periods and increased sea temperatures, with many researchers linking this directly to climate change effects (see, for example, Ainsworth et al., 2016; Anthony et al., 2015; Baker et al., 2008; Great Barrier Reef Marine Park Authority, 2016; Hughes et al., 2017). This link is repeated in mass media as shown in Table 4.2.

Table 4.2: Examples of 2016 Online News Media Headlines Directly Linking Coral Bleaching to Climate Change/Global Warming

Greshko, M. Warning threatens the Great Barrier Reef even more than we thought. National Geographic, 14 April.
Hoegh-Guldberg, O. & Ridgway, T. (2016). David Attenborough says the Great Barrier Reef is in 'grave danger' – it's time to step up. The Conversation, April 24
King, A. et al., (2016).Great Barrier Reef bleaching would be almost impossible without climate change. The Conversation, April 29.
Slezak, M. (2016). The Great Barrier Reef: A catastrophe laid bare. The Guardian, 7 June
McKibben, B. (2016) The coral die-off crisis is a climate crime and Exxon fired the gun. *The Guardian*, 17 August.
England, C. (2016). New pictures show Great Barrier Reef is not repairing itself as it should. *The Independent*, 14 October.
Ritter, D. (2016). Great Barrier Reef: why are government and business perpetuating the big lie? *The Guardian*, November 1.
Mooney, C. (2016). Global warming could be breaking up this 200 million year old relationship. *The Washington Post*, November 2.
Anon via Al Jazeera News (2016). Coral catastrophe: The fight to save our dying reefs. *Al jazzeera.com*, November 6.
Ferrier, T. (2016). Warming causes epic reef die-off: expert. *Yahoo 7 News*, 29 November.
Collins, A. (2016). Great Barrier reef not likely to survive if warming trend continues, says report. *The Guardian*, 9 December.
The Washington Post (2016). View from away: The Great Barrier Reef is dying and global warming set the scene, The Washington Post, 29 December.

There were eight major mass bleaching episodes between 1979 and 2011 (Hughes, 2011), with a further, and the most damaging bleaching event to date, occurring in 2016. The extent and impact of this last event was the subject of considerable, sensational, media coverage as illustrated by the examples of headlines shown in Table 4.3.

Table 4.3: Examples of 2016 Online News Media Headlines Regarding the Impact of the 2016 Coral Bleaching Event

Anon. How we are all affected by the destruction of coral reef. *BBC.* 28 November.
Griffith, H. (2016). Great Barrier Reef suffered worst bleaching on record in 2016, report finds. *BBC*, 28 November.
Mooney, C. (2016). Scientists chart a 400-mile zone of coral devastation at the Great Barrier Ref. *The Washington Post*, November 28.
Rice, D. Australia's Great Barrier Reef has worst coral die-off ever. *USA Today*, 28 November.
Anon. (2016). Largest ever coral die-off confirmed on great Barrier Reef, *Deutsche Welle*, 29 November.
Brissenden, M. (2016). Two-thirds of the northern Great Barrier Reef wiped out. *ABC Radio*, 29 November. Also picked up by *BBC World Service*
Horn, A. (2016). Record die-off of Great Barrier Reef coral confirmed by scientists, while some tourist areas improved. *ABC News*, 29 November. Also reported in multiple other media outlets
Hughes, T., Shaffleke, B. & Kerry, J. (2016). How much coral has died in the Great Barrier Reef's worst bleaching event? *The Conversation*, November 29.
Reuters (2016). Great Barrier Reef suffers most extreme coral die-of. *Reuters.com*,   29 November.
Westcott, B. Australia's Great Barrier Reef suffers worst ever coral bleaching. *CNN.com*, 29 November.
Innis, M. (2016). Great Barrier Reef Hit by Worst Coral die-off on record, scientists say. *The New York Times*, 30 November.
McGuirk, R. (2016). Australia's Great Barrier Reef continues to decay at record rate. *Skift.com*, 3 December.
Assoc Press (2016). Great Barrier Reef sees record coral deaths this year. *Business Mirror*, 4 December.
Anon. (2016). The Great and Dying Barrier Reef. *The New York Times*, December 6.
Anon. (2016). North and South reefs poles apart in bleaching results. *Great Barrier Reef Foundation*, 7 December.
Dyne, B. (2016). Great Barrier Reef suffering worst-ever coral bleaching. World Socialist Web Site, 30 December

The media coverage of the 2016 bleaching resulted in an official report '*setting the record straight*' (Great Barrier Reef Marine Park Authority, 2016; Reichelt, 2016), that stated 22% of coral had died with the far northern section being the most severely affected and more southern areas (where the majority of tourism activity is located) being far less affected. However, this information was not subsequently reported in the news media.   We note that

there are indications of disagreement regarding the reporting of the extent of bleaching and
prospects for corals to recover. Some media reported that a planned joint statement between
the Great Barrier Reef Marine Park Authority and the scientists who had undertaken the
survey of bleaching had not proceeded due to concerns over potential exaggeration of the
impact. This was reported under sensational headlines such as "*Great Barrier Reef:
scientists 'exaggerated' coral bleaching*" (Lloyd, 2016). The implications of media reporting
of potential conflict is discussed in a later section.

Table 4.4 analyses the themes by author type. Journalists were the largest author type, contributing 172 of the 242 articles (71%) but while their focus was stronger on climate change and coral bleaching than other author categories, there was no statistically significant differences across the author types (p = .103).

Table 4.4: Cross Tabulation: Theme by Type of Author

p = .103		Media journalist	Academic / scientist writing in mass media	Government organisation	Lobby group	Other / Unidentifiable	Total
Climate change / global warming / ocean acidification	n	18	12	0	0	4	34
	%	10.5	26.1	0.0	0.0	25.0	14.0
Coral bleaching	n	45	10	0	1	3	59
	%	26.2	21.7	0.0	14.3	18.8	24.4
Reef is dead / dying	n	20	2	1	0	2	25
	%	11.6	4.3	50.0	0.0	13.3	10.3
Science disagreement controversy	n	10	1	0	0	0	11
	%	5.8	2.2	0.0	0.0	0.0	4.5
UNESCO potential 'at risk' listing	n	12	7	0	0	0	19
	%	7.0	15.2	0.0	0.0	0.0	7.9
Water quality improvement	n	3	2	0	0	0	5
	%	1.7	4.3	0.0	0.0	0.0	2.1
Funding increase calls	n	14	5	0	1	0	20
	%	8.1	10.9	0.0	14.3	0.0	8.3
Cane monitoring compliance	n	3	0	0	0	1	4
	%	1.7	0.0	0.0	0.0	6.3	1.7
Farmer protest negative portrayal	n	4	0	0	0	0	4
	%	2.3	0.0	0.0	0.0	0.0	1.7
Government actions	n	6	0	0	0	0	6
	%	3.5	0.0	0.0	0.0	0.0	2.5
Reef Report card	n	2	0	1	2	0	5
	%	1.2	0.0	50.0	28.6	0.0	2.1
Plastic bag ban	n	11	0	0	2	0	13
	%	6.4	0.0	0.0	28.6	0.0	5.4
Coal mining / dredging	n	16	6	0	0	3	25
	%	9.3	13.0	0.0	0.0	18.8	10.3
Shipping	n	8	1	0	1	2	12
	%	4.7	2.2	0.0	14.3	12.5	5.0
Total	**n**	**172**	**46**	**2**	**7**	**15**	**242**
	%	**100**	**100**	**100**	**100**	**100**	**100**

This cross-tabulation between the theme of the article and the author shows the difference in author focus between journalists and other authors

There were statistically significant differences in terms of message framing (p = .000), with sensational framing and mixed framing predominating, with 40.5% of articles in each category (Table 4.5).

Table 4.5: Cross Tabulation: Theme by Type of Framing

*p = .000		Sensational	Adversarial	Hedging	Neutral / mixed both positive and negative	Total
*Climate change / global warming / ocean acidification	n	23	4	1	6	34
	%	23.5	8.9	100.0	6.1	14.0
*Coral bleaching	n	41	6	0	12	59
	%	41.8	13.3	0.0	12.2	24.4
*Reef is dead / dying	n	15	5	0	5	25
	%	15.3	11.1	0.0	5.1	10.3
Science disagreement controversy	n	0	11	0	0	11
	%	0.0	24.4	0.0	0.0	4.5
UNESCO potential 'at risk' listing	n	2	7	0	10	19
	%	2.0	15.6	0.0	10.2	7.9
Water quality improvement	n	0	0	0	5	5
	%	0.0	0.0	0.0	5.1	2.1
Funding increase calls	n	3	3	0	14	20
	%	3.1	6.7	0.0	14.3	8.3
Cane monitoring compliance	n	1	0	0	3	4
	%	1.0	0.0	0.0	3.1	1.7
Farmer protest negative portrayal	n	0	3	0	1	4
	%	0.0	6.7	0.0	1.0	1.7
Government actions	n	0	1	0	5	6
	%	0.0	2.2	0.0	5.1	2.5
Reef Report card	n	3	0	0	2	5
	%	3.1	0.0	0.0	2.0	2.1
Plastic bag ban	n	2	1	0	10	13
	%	2.0	2.2	0.0	10.2	5.4
Coal mining / dredging	n	6	4	0	15	25
	%	6.1	8.9	0.0	15.3	10.3
Shipping	n	2	0	0	10	12
	%	2.0	0.0	0.0	10.2	5.0
Total	n	**98**	**45**	**1**	**98**	**242**
	%	**100**	**100**	**100**	**100**	**100**

This cross tabulation between the theme of the article and they types of framings shows that the news articles written by Journalists (71%) and others were phrased in sensational language as opposed to more neutral language.

There were also statistically significant differences in terms of tone (Table 4.6) with only 11.5% of articles being moderately positive and none being very positive, whereas 51.2% were moderately or very negative (p=.000) indicating that those writing about the topic are focussing on the negative prospects of GBR health.

Table 4.6: Cross Tabulation: Theme by Tone of Article

*p = .000		Very negative	Moderately negative	Neutral / mixed	Moderately positive	Total
*Climate change / global warming / ocean acidification	n	14	9	9	2	34
	%	30.4	11.5	10.0	7.1	14.0
*Coral bleaching	n	19	16	21	3	59
	%	41.3	20.5	23.3	10.7	24.4
*Reef is dead / dying	n	10	6	7	2	25
	%	21.7	7.7	7.8	7.1	10.3
Science disagreement controversy	n	1	8	2	0	11
	%	2.2	10.3	2.2	0.0	4.5
UNESCO potential 'at risk' listing	n	1	9	9	0	19
	%	2.2	11.5	10.0	0.0	7.9
Water quality improvement	n	0	0	2	3	5
	%	0.0	0.0	2.2	10.7	2.1
Funding increase calls	n	0	7	9	4	20
	%	0.0	9.0	10.0	14.3	8.3
Cane monitoring compliance	n	0	1	2	1	4
	%	0.0	1.3	2.2	3.6	1.7
Farmer protest negative portrayal	n	0	0	3	1	4
	%	0.0	0.0	3.3	3.6	1.7
Government actions	n	0	0	5	1	6
	%	0.0	0.0	5.6	3.6	2.5
Reef Report card	n	0	3	1	1	5
	%	0.0	3.8	1.1	3.6	2.1
Plastic bag ban	n	0	2	2	9	13
	%	0.0	2.6	2.2	32.1	5.4
Coal mining / dredging	n	1	11	12	1	25
	%	2.2	14.1	13.3	3.6	10.3
Shipping	n	0	6	6	0	12
	%	0.0	7.7	6.7	0.0	5.0
Total	n	**46**	**78**	**90**	**28**	**242**
	%	**100**	**100**	**100**	**100**	**100**

This cross tabulation between the theme of the article and the tone of the article suggests that the articles are written in a more negative tone than a positive tone

There were also statistically significant difference between the type of media outlet and the tone used (p = 0.17) see Table 4.7 and also message frame used (p = .000) see Table 4.8. International media are more likely to use negative tones and sensational framing re coral bleaching including "*Reef is dead / dying*" headlines, and local media are more prone to use adversarial framing in reporting of controversies in and criticism of government inaction / policy / support of coal lobby, particularly a proposed development of a large export-oriented coal mine that would utilise the Abbot Point export terminal (refer Section 3.3).

Table 4.7: Cross Tabulation: Type of Media Outlet by Tone of Article

*p = .017		Very negative	Moderately negative	Neutral / mixed	Moderately positive	Total
*International	n	20	21	21	5	67
	%	43.5	26.9	23.3	17.9	27.7
National media	n	6	22	23	14	65
	%	13.0	28.2	25.6	50.0	26.9
Regional media	n	2	6	9	2	19
	%	4.3	7.7	10.0	7.1	7.9
Local media	n	0	3	7	0	10
	%	0.0	3.8	7.8	0.0	4.1
Online only	n	17	20	29	7	73
	%	37.0	25.6	32.2	25.0	30.2
Blog	n	1	6	1	0	8
	%	2.2	7.7	1.1	0.0	3.3
Total	**n**	**46**	**78**	**90**	**28**	**242**
	%	**100**	**100**	**100**	**100**	**100**

This cross tabulation between the type of media outlet and the tone of the article indicates that international media are more likely to use negative tones when reporting on the GBR

Table 4.8: Cross Tabulation: Type of Framing

p = .000		Sensational	Adversarial	Hedging	Neutral / mixed both positive and negative	Total
International	n	44	9	0	14	67
	%	44.9	20.0	0.0	14.3	27.7
National media	n	15	14	0	36	65
	%	15.3	31.1	0.0	36.7	26.9
Regional media	n	5	5	0	9	19
	%	5.1	11.1	0.0	9.2	7.9
Local media	n	1	4	0	5	10
	%	1.0	8.9	0.0	5.1	4.1
Online only	n	28	10	1	34	73
	%	28.6	22.2	100.0	34.7	30.2
Blog	n	5	3	0	0	8
	%	5.1	6.7	0.0	0.0	3.3
Total	**n**	**98**	**45**	**1**	**98**	**242**
	%	**100**	**100**	**100**	**100**	**100**

This cross tabulation between the type of media outlet and the type of framing uses in the article indicates that international media are more likely to use sensational framing when reporting on the GBR

Water quality on the GBR is identified as a 'wicked problem', i.e. it has no single cause, the magnitude of causes are disputed, and there are multiple threats, not all of which are controllable or even predictable, and therefore no single evident solution (Lane and Robinson, 2009). It may now be reaching the status of a 'super wicked' problem, i.e. "*time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address them is weak or non-existent; and irrational discounting occurs that pushes responses into the future*" (Levin et al., 2012). Concerns regarding the future of the GBR have been heightened by dramatic news headlines claiming that the GBR is dead or dying, such as those shown in Table 4.9.

Table 4.9: Examples of 2016 Online News Media Headlines Claiming Great Barrier Reef is Dead or Dying

Jacobsen, R. (2016). Obituary: Great Barrier Reef (25 Million BX-2016). *Outside*, 11 October.
D'Angelo, C. (2016). Great Barrier Reef Obituary Goes Viral, To the Horror of Scientists. *The Huffington Post*, October 14.
Horton, H. (2016) Great Barrier Reef is 'almost dead', say scientists. *The Telegraph* (UK). 14 October.
Jones, F. (2016). The Great Barrier Reef pronounced dead by scientists. *Newstalk*, 14 October.
Gillespie, T. (2016). The Great Barrier Reef is 'dead' at the age of 25 million years after 'worst mass bleaching on record', claims writer. *The Sun / News.com*, 15 October.
Lloyd, R. (2016). Death on the Great Barrier Reef. *The Conversation*, 19 October.
Schelgl, K. (2016). Top tourist Destinations in Queensland now that the Great Barrier Reef is basically dead. *SBS.com*, 30 November.
Slezak, M. (2016). Two thirds of Australians think reef crisis is 'national emergency' – poll. *The Guardian*, 2 December.
Narra, A. (2016). Australia's Great Barrier Reef in great Danger; Extensive Damage to the reef to the point of dying expected? *News Everyday*, 5 December.
Anon. (2016). The Great and Dying Barrier Reef. *The New York Times*, 6 December (see also bleaching coverage and responses).
Burke, D. (2016). Great Barrier Reef Seriously struggling. *Yahoo.com*, 7 December
Messina, K. (2016). Great Barrier Reef slowly dying. *The Simmons Voice*, 7 December.
Smyth, J. (2016). Paradise lost: The crisis on the Great Barrier Reef. *Financial Times*, 17 December.

5. Conclusions

This paper has aimed to provide a structural foundation to better understand the nature and of media coverage of the GBR and its potential impact on the public and policy makers through an exploration of the way issues relating to the health and future of the GBR are portrayed.

The reporting presents a negative and sensationalized view of the current and potential future health of the GBR. Repetition of sensationalized headlines and editorial will likely reinforce the negative perception of the future of the GBR even where there is a gap between perceptions of the GBR's health as portrayed in the media and the reality as

identified in analyses of other issues covered in the media (see, for example, McLennan et al., 2014).

Of more concern is that continued repetition of statements that the GBR is dying is likely to reinforce perceptions that any individual action, such as by farmers, to mitigate water quality problems will be useless, making it difficult to set well-informed effective policies for future management of the GBR. Further, as noted in the literature review this repetition, may not create the public concern that could drive policy change especially where there is dissent within the scientific community (Aklin and Urpelainen, 2014).

Missing from the current debate are clear calls to action. While there has been a marked increase in 'citizen science' to date it offers opportunities to assist in monitoring coral health (see, for example, Marshall et al., 2017). As we have already noted, if the problem is seen as being too big for individual action, support for any action may actually decrease (Hobson and Niemeyer, 2013) and ascribing the problem to global climate change may result in de-emphasis of local mitigation strategies (Bischof, 2010).

There is a need to not only provide knowledge, but to empower all stakeholders to participate in knowledge exchange and the mobilization of it in forms and ways that are relevant to, and usable by, decision makers at all levels of government (Castree et al., 2014; Cvitanovic et al., 2015), noting that policy makers are "*highly risk adverse and seek to avoid failures for which they can plausibly be held responsible*" (Howlett, 2014).

A knowledge-practice gap between scientists and policy makers, and associated frustrations have been repeatedly identified, together with calls to rethink the way that the two sectors, and other relevant stakeholders could interact in the future (see, for example, Toomey, 2016; van Kerkhoff and Pilbeam, 2017). This will also require a redevelopment of science communication models as discussed in Section 2.6.

The analysis revealed that there were very few attempts to counter negative news media coverage, two notable exceptions being criticism of the reporting of coral bleaching

data (Day, 2016) and an article in the New York Times by the Federal Minister for the Environment and Energy (Frydenberg, 2016) in response to an editorial six days prior titled "*The Great and Dying Barrier Reef*". A much more proactive strategy for providing balance and countering misinformation would appear to be warranted. There is also the need for a proactive 'image recovery' strategy (Walters et al., 2016) involving all stakeholders e.g. tourism as well as management organizations / regional authorities involved in managing the GBR and its resources.

6. Limitations

Only freely available online news articles are included, therefore other news outlets such as television and radio may be under-represented.

7. *Directions for Further Research*

In order to fully understand the extent and nature of discussions regarding the health and future of the GBR, we intend to extend the analysis to include:

- Social media discussions and online videos, e.g. YouTube, and contrast material from traditional media sources versus 'pure' online communications, given that the latter is noted as being under-researched (Lörcher and Neverla, 2015).

- Documentaries, a second area noted as under-researched (Campbell, 2014)

- Visual imagery. As noted in Hay and Eagle (2016), the choice of images used as part of communication has significant impact on engagement with issues, with the link between imagery and communications framing being noted (Geise and Baden, 2015) but under-researched in the environmental context (Hansen and Machin, 2013). It is suggested that the visual images that accompany news items may increase misconceptions about the true nature of an issue (Ryu et al., 2013; Walters et al., 2016)

- 2017 media coverage, contrasting it with the 2016 material as we note new factors are entering the news media coverage themes e.g. algae and that comments regarding the imminent demise of the GBR are increasing, together with coverage of the impact of Cyclone Debbie which damaged central and southern portions of the GBR in March 2017 but also lower sea temperatures (Copp, 2017): the long term impacts have yet to be evaluated.

- Actual tourism impact on different sections of the GBR and an analysis of the impact of the tourism industry's strategies to mitigate the impact of sensationalized reporting of likely future tourism experiences.

These analyses will then be used to inform a critical analysis of existing science communication models as discussed in Section 2.6, and to guide the development and testing of potential new models that may be more applicable in the digital era.

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