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Article

Changes in Media Portrayal of Human-wildlife Conflict During Successive Fatal Shark Bites

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Abstract

Encounters between humans and wildlife that result in human fatalities can generate public anxiety and increase pressure on conservation managers and governments for risk mitigation. Low probability-high consequence events such as shark bites on humans attract substantial media attention for short time periods, but how the media react when several of these rare but fatal events occur in quick succession has seldom been subject to quantitative analysis. Understanding media portrayal of such encounters is important because it both reflects and influences public perceptions of risks, mitigation measures, and conservation policies. This study examined media portrayals of sharks between 2011 and 2013 in the state of Western Australia during which six shark bites resulting in fatalities occurred. We analysed 361 shark-related articles published in major Western Australian newspapers over 26 months to trace changes in media reporting about sharks prior to, during, and after the six fatalities. The findings indicate that when rare, but fatal human-wildlife events occur in quick succession, negative framing by media of wildlife behaviour and threats can exaggerate public anxiety about the pervasive presence of wildlife predators and high risk of human fatalities. The study highlights the need for government agencies and conservation scientists to better engage with media to provide accurate and effective information and advice to swimmers and surfers about shark ecology and behaviour.

Keywords: culling, drum-line programme, media content analysis, mitigation measures, newspapers, shark attacks, Western Australia, wildlife conservation

INTRODUCTION

Human-wildlife encounters are intractable and complex issues faced by conservation biologists and natural resource managers (Dickman 2010; Crossley et al. 2014). This is particularly acute in the context of predatory megafauna species that are considered threatened by humans and in need of protection to rebuild their populations (Meeuwig and Ferreira 2014; Shiffman 2014). In extreme situations when human-wildlife encounters lead to human fatalities, the immediate public response can include calls for culls and hunting campaigns (Fukuda et al. 2014). Hence, when wildlife species pose a direct risk to humans, social acceptance and public perception of risk can make conservation management extremely difficult (Dickman 2010; Jacobson et al. 2012).

Many wild animals such as lions (*Panthera leo)*, jellyfish (*Carukia barnesi)*, and crocodiles (*Crocodylus porosus*) are potentially dangerous to humans, but few marine species are feared more than sharks, which have captivated human imagination through common portrayal as 'man-eaters' (Muter et al. 2013; Neves and Monteiro 2014). The probabilities of shark bites on humans are, however, very low compared to many other potential life-threatening risks that humans negotiate in their daily lives (International Shark Attack File 2017). Although shark bite events are rare, they can result in

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fatalities or severe disabling injuries when they do occur. Such low probability-high consequence (i.e., rare but fatal) events have high news value for media (Price and Tewksbury 1997) because they typically evoke a dramatic emotional response from the public (Curtis et al. 2012; Muter et al. 2013).

Shark bite incidences (non-fatal and fatal) in relation to the human population in Australia is ~0.5 per 100,000 people (Chapman and McPhee 2016), while the number of fatal shark bites is low, and estimated at 1.1 fatalities per year (West 2011). In this study, we analyse the changes in media coverage and portrayal of sharks over a 26-month period between 2011 and 2013 in the state of Western Australia during which there were six human fatalities from shark bites. How the media react when several of these rare but fatal events occur in quick succession has seldom been subject to quantitative analysis by conservation scientists and managers. Such analysis is necessary because media portrayal of sharks, shark bites, and episodes of successive bite events can both reflect and influence public understanding of perceived levels of risk, which, in turn, can influence conservation policies and marine wildlife management (Slovic et al. 2004; Gore and Knuth 2009; Alexander and Quinn 2012).

Our analysis focuses on shark-related articles published in major Western Australian newspapers to trace changes in media reporting about sharks prior to, during, and after, the six shark bites that resulted in fatalities. We use four perspectives from media and communication theories to examine the different ways in which media can shape the sense of reality, perception of danger, and opinions for action at the individual and public levels. We argue that when low probability-high consequence human-wildlife events occur in quick succession, negative framing of wildlife behaviour by media can heighten public anxiety about the pervasive presence of wildlife predators and probability of encounters resulting in human fatalities.

Theoretical Perspectives on media influence

Popular and mass media plays a vital role in shaping perceptions of human-wildlife interactions and the ability to co-exist with wildlife (Freeman et al. 2011). Theories of mass media have focused on the many ways in which their modes of communication shape individual and public understanding of the worlds they are part of (Craig 1999; McQuail 1987). We draw on four perspectives from these bodies of theory that are particularly relevant for media portrayals of human-wildlife conflicts: cultivation, framing, agenda-setting, and risk amplification.

Cultivation theory argues that mass media shapes a person's sense of reality because information is acquired through such mediated sources rather than direct experience (Gerbner 1969). One of the most well-known examples of the media cultivation effect is that people who are heavy television viewers see the world as more violent than it really is (Gerbner and Gross 1976). While there are many studies that substantiate this perspective (Potter and Riddle 2007), they have also been criticised for their shallow application of Gerbner's original argument about the mediation of individual perceptions and their interactions through everyday activities within their public spheres (Potter 2014).

Theories of framing refer to the selection and highlighting of some facets of events or issues, and making connections between them to promote a particular interpretation, evaluation, and/or solution (Entman 2004). This perspective suggests that the frame within which an issue is presented by the media determines how their audiences will psychologically process the information provided and respond to the issue (Goffman 1974). From a psychological perspective, a frame's valence refers to the emotions it conveys or seeks to evoke in the observer or reader. It can present an issue in a positive, negative, or neutral manner and thereby evoke corresponding feelings in people to influence public reaction and support for policies related to that issue (De Vreese and Boomgaarden 2003).

The valence of an issue is also influenced by whether the media presents it in a 'thematic' or 'episodic' frame. For instance, using climate change as an example, a thematic frame would present general trends and information about weather patterns and temperatures and use these features to discuss future consequences and policies. Episodic framing, in contrast, would focus on the impacts of climate change on individual experiences or cases that the audience can relate to and convey a message of personal responsibility for responding to future consequences. Thus, thematic framing tends to direct attention towards the future and attribute responsibilities for action to political leaders and policy makers, while episodic frames focus on past experiences that provide examples of how individuals can personally solve the issue and take control of their futures (Iyengar 1991).

Framing is also used by media organisations to set the agenda for an issue, decide whether the public will find it newsworthy, and determine how much attention a new story receives (McCombs and Shaw 1972). This form of agenda-setting implicitly influences the audience by determining the extent and frequency of coverage and directing their focus towards individual or collective consequences. Framing and agenda-setting by media, therefore, tells the public what they should pay attention to and how to think about that issue.

Risk amplification is a process whereby media coverage of an issue can heighten the sense of risk to the extent that it changes the behaviour of individuals or groups (Kasperson et al. 2001). For example, the media coverage of Creutzfeldt-Jakob Disease (colloquially referred to as mad cow disease) in the UK during its peak in 1993 increased the perceived risk of eating beef and contributed to a sharp drop in beef consumption during that period (Frewer et al. 2002). Risk amplification by media often occurs with respect to rare events that are likely to affect relatively few people, but which tend to elicit strong public concern and response (Scherer 1991; Leschine 2002; Crossley et al. 2014; but see Gore et al. 2005 for exception).

By cultivating, framing, agenda-setting, and risk amplification, mass media can both shape public understanding, emotional experiences, perceived levels of wildlife-risk, and

influence political decisions and public campaigns for wildlife conservation (McCombs and Shaw 1972; Wolch et al. 1997; Slovic et al. 2004; Gore and Knuth 2009; Freeman et al. 2011; Alexander and Quinn 2012). This can work in both negative and positive ways. For example, Herrero (2005) observed that media coverage of bear attacks negatively affected conservation efforts. Media coverage of a cougar attacking a person in the Los Angeles area was linked to significant change in public perception of cougar abundance, distribution, and threat to humans (Riley and Decker 2000). A positive example of media influence for conservation was when many newspapers published editorials calling for Californians to vote *No* to a proposition that would allow sport hunting of cougars (*Felis concolor*; Wolch et al. 1997).

Media portrayal of sharks is often negative, with sensationalistic headlines and imagery that amplify public fear and perception of threat from sharks (Philpott 2002; Peschak 2006). This reaction, in turn, influences government policy responses and public expectations of action from its political leadership (Neff 2014). Achen and Bartels (2013), for example, note that the series of shark bite events that took place in the US state of New Jersey during 1916 nearly resulted in the incumbent president losing the election because voters in New Jersey and the northeast and Great Lakes states expected decisive action from him and the senators even though events were beyond their control.

Understanding media coverage of wildlife-related risk is, therefore, critically important for wildlife management. Wildlife scientists, conservation groups, and managers need to recognise the patterns of media portrayal and framing of stories about human-wildlife encounters, conflicts, and mitigation measures (such as culling, in the case of sharks), and anticipate the types of media coverage the public may be exposed to following rare but fatal incidences of wildlife attacks. This will enable wildlife managers to improve their communication strategies with the media and public, thereby limiting the effects of social amplification of the perceived risk of shark bites.

Study Context

Between 1990 and 2009, the state of Western Australia, which has the longest coastline of all Australian states, had a total of 35 shark bite incidences of which six resulted in human death (0.2 fatal bites/year) (West 2011). However, within 26 months between 2011 and 2013, six fatalities from shark bites occurred along a 400 km stretch of the coastline between Perth and Geraldton (2.8 fatal bites/year) (ASAF 2014). The occurrence of fatal shark bites within a relatively short period on a small stretch of the coast generated a large volume of media coverage which dubbed Western Australia as "the World's Deadliest Place for Shark Attacks" (News.com.au 2012; Time 2014). This media coverage led the Western Australian Government to announce a trial drum-line programme in November 2013. The programme intended to catch and kill white sharks *Carcharodon carcharias*, tiger sharks *Galeocerdo cuvier*, and bull sharks *Carcharhinus leucas* that were more than three metres in total length.

The proposed drum-line programme became controversial partly because white sharks are considered a threatened marine species and protected by Commonwealth (*Environment Protection and Biodiversity Conservation Act 1999*), by state legislations, and by international laws such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS). This led to conflicts between supporters of the drum-line programme who perceived that the introduced measures would increase public safety and opponents who felt that the measures would have no tangible benefits to ocean users and would undermine the protected status and welfare of white sharks (Gibbs and Warren 2015).

This study investigated the changing portrayal of sharks and shark-bite mitigation measures between 2011 and 2013 covered by a range of newspapers circulating in Western Australia. We examined how media portrayal of sharks, conservation issues, and mitigation measures changed as multiple fatal shark bites occurred within this time frame. We assessed articles published about sharks in these newspapers using five categories: Valence frame of the article; topic of the article; shark species mentioned; quotes from primary or secondary sources; and mitigation measures.

MATERIAL AND METHODS

Data sources and sampling time frame

McCagh et al. (2015) performed a media content analysis of one Western Australian newspaper between 2010 and 2013 to assess the correlation between public pressure and the decision to employ drum-lines as a mitigation measure. However, their study assessed the language used in the media content of one newspaper and hence their findings cannot be generalised across other newspapers in Western Australia. As media cultivation theory (Gerbner and Gross 1976) shows, it is possible that some newspapers seek to cultivate a specific ideological perspective. In contrast to McCagh et al., our study used the electronic search engine LexisNexis to identify shark-related articles published in all major newspapers circulated in Western Australia. We defined major newspapers as those whose circulation exceeded 30,000 papers per issue. This definition resulted in narrowing the sample to 16 newspapers that had regional, metropolitan, statewide, and nationewide circulation. Given the state's large size and sparsely distributed population, the newspaper sampling was biased towards the Perth metropolitan area due to its larger population and circulation compared to regional towns.

To trace media portrayal of sharks and reactions to a relatively quick succession of shark bite events in Western Australia, we chose the shark bite fatality on September 4, 2011 as the first of six fatalities that occurred between that date and November 23, 2013. The gap between the September 4, 2011 shark fatality and the one before it was over 13 months (383 days), and was therefore not included in the study.

However, to ensure inclusion of shark-related articles between long gaps and quick succession of fatalities, we identified shark-related newspaper articles six months prior to the first fatality (i.e., from March 4, 2011) to three months after the sixth fatality (February 23, 2014).

This study frame was then divided into 8 periods— Period 1, corresponding to 6 months prior to the first shark-bite fatality (185 days); Period 2, between the first and second fatality (36 days); Period 3, between the second and third fatality (12 days); Period 4 between the third and fourth fatality (161 days); Period 5, between the fourth and fifth fatality (105 days). Since the gap between the fifth and sixth fatality was over 16 months (497 days) we divided this into two periods: Period 6, which covered three months after the fifth fatality (93 days); and Period 7, which covered the 6 months before the sixth shark-bite fatality (185 days). Period 8 extended to 3 months after the sixth fatality (92 days). Each shark-related article was included under one of these eight periods.

Sampling size and selection

We limited our search to articles written by a journalist that contained the keyword 'shark' in either the title or body of the article, and excluding articles that contained the words 'league', 'rugby', 'football', 'NBA', 'NBL', 'coach', and 'loan' to avoid articles which were not related to chondrichthyans. We reviewed all articles identified through the search and excluded all non-relevant articles. A total of 845 shark-related articles were obtained from the database search. Of these, 361 articles (43%) were randomly selected for coding and media content analysis.

The desired sample size for each period was 50 shark articles, determined on the basis of the number of articles available during each period and the total number of articles to be coded (361). Up to 50 articles were randomly selected from each period in proportion to the number of shark articles per newspaper (Riffe et al. 2005). For example, 65% of the 60 shark-related articles published in Period 1 were published by the 'West Australian', so 65% of the 50 selected articles (n=32) were taken from the 'West Australian'. Periods 2 and 3 were of relatively short duration (36 days and 12 days respectively), and did not have 50 shark-related articles during these periods. Hence, the total number of articles for each of these periods (40 and 21 respectively) were included in the analysis. The sampling method and size is comparable to other media content analysis of human-wildlife conflict (e.g., Gore and Knuth 2009; Muter et al. 2013).

Media content coding

Media content analysis requires identification of themes associated with the presentation of issues in public discourse and coding them according to selected categories for analysis (Stempel 2003; Krippendorff 2004). In this study, we used eight variables (Appendix I) modified from the protocol and codebook developed by Muter et al. (2013) to code each article. These variables included: the name, date, and place of publication (article source information); main shark species mentioned; main topic of the article; the primary framing or valence of the article; primary person or authority directly quoted in the article; and main mitigation measure mentioned. We followed Houston et al. (2010)'s approach for categorising the primary framing or valence frame of each article. An article's valence or primary framing could be classified as negative *to* or *from* sharks, positive *to* or *from* sharks, multiple foci if both positive and negative messages were provided, and neutral if no opinion was provided (see Table 1 for example of sentences contributing to the possible frames).

Coding training and consistency was ensured both within and between two coders. We each coded ten randomly selected articles twice and compared results for consistency. If results differed, reasoning for choosing a specific code was discussed and a different set of 10 articles was selected for coding. This process was repeated until variables were consistently coded for the 10 articles, thereby ensuring reliability and replicability of coding across individuals. Inter-coder reliability of all variables was checked using Cohen's Kappa (K) (Cohen 1960). When the reliability was $< .7$, articles were re-coded. Values $> .7$ demonstrated a strong level of reliability (Lombard et al. 2002). When $K < .7$, both coders discussed discrepancies, and independently recoded articles for those variables. After the second round of coding, the inter-coder reliability for all variables was $>.7$ and analysis proceeded.

Statistical analysis of media content

All statistical analyses were performed using the analytical software R (R Core Team 2012) and the packages *lsr* (Navarro 2015) and *vcdExtra* (Friendly 2015). Contingency tables and chi-square analyses were used to assess whether the percentage of articles in which each of the eight variables was mentioned differed across the eight periods. To conform to Cochran's rule, we used a Monte Carlo correction when a cell had an expected value <1 and when less than 20% of the cells had an expected value <5 (Roscoe and Byars 1971). Standardised residuals (z scores) were calculated to assess which period contributed the most to the significant difference across periods, where $|z| > 2$ indicated a value significantly different to the expected value (Wickens 2014). The coefficient of correlation Cramer's V was calculated to estimate the strength of the correlation between each primary framing and period, and between each main topic of the article and the corresponding period.

RESULTS

Coverage pattern by circulation geography and numbers

Of the 16 newspapers identified by circulation size (30,000 or more per issue), there were ten newspapers from the Perth metropolitan area (62%), four from smaller regional

centres (25%), one newspaper with statewide circulation, and one with a nationwide circulation. The statewide newspaper contained the most shark-related articles (58%), followed by metropolitan newspapers (20%), the nationwide newspaper (14%), and regional newspapers (8%) (Table 2).

The intensity of coverage by period, calculated by dividing total number of articles by number of days for each period, was lowest in Period 1 which was prior to the first shark bite fatality and during which roughly one shark-related article was published every four days (Table 3). Coverage intensity increased to about one article per day after the first fatality and to almost two per day following the second fatality, which occurred ~1 month later. Coverage gradually declined over Periods 4 and 5, but increased in Period 6, after the fifth fatality. There was a large interval of 497 days (roughly 16 months) during which coverage intensity declined, prior to a dramatically increase following the sixth shark bite fatality in Period 8 during which the most shark-related articles were published.

Main article topics

The main topic of the coded articles varied significantly across the study periods (χ^2=215.682, p<0.001) (Figure 1). Overall, the most common article topic over the study periods was about shark bites and threats from sharks (25%; Cramer's V=0.307, p<0.001), and followed the pattern of valence framing towards the negative impacts from sharks. Period 1 had the lowest proportion of articles about shark bites and threats (10%, z=-2.707, p<0.001). From Period 2 to Period 7,

Table 1

Example of sentences characterising the primary frame of newspaper articles.

Primary frame	Examples
Negative impacts *from* sharks	Sarah Kate Whiley, 21, mauled to death by up to three bull sharks off North Stradbroke Island (Qld).
	As a long-term resident of the South West, he said the surge of shark attacks over the past three years had hit the region's confidence and economy hard.
	A British man is fighting for his life after being mauled by a shark while swimming in South Africa.
Negative impacts *to* sharks	It has become a witch-hunt with boats and helicopters stalking and hunting all species of shark.
	The next day Colin Barnett weighed in, confirming killing sharks was on the table.
	This year, Queensland's shark control program has already killed more than 630 sharks, 300 of them more than 2 m long and 100 reported to be great whites.
Positive impacts *from* sharks	Ningaloo Marine Park is home to friendly and magnificent whale sharks, manta rays, dugongs and turtles, which visitors can swim among.
	This is where I got to snorkel with the sharks as a birthday present from friends, because they know how much I adore sharks.
	Metropolis Fremantle director David Heaton went a step further jumping into the ocean surrounded by sharks to raise money for Princess Margaret Hospital as part of the Telethon Adventurers.
Positive impacts *to* sharks	Conservationists and water users have criticised the State Governments shark baiting policy, saying there should be more emphasis placed on shark detection, alerts and research.
	The study found that sharks are not mindless killers, but are in fact using sophisticated hunting strategies.
	Stories include visiting the Congo to find a mountain gorilla; uncovering an illegal shark finning operation in the Maldives.
Multiple foci	No person can ignore the trauma and horror experienced by the families of shark attack victims, and the communities in which the attacks occurred VS. Great Whites are part of living on this spectacular coast and those who enter the sea should accept the risks.
	There have been 877 recorded shark attacks in Australia since 1901, and while a sleek shoal of sharks haunts this book, the one that dominates is the great white VS. There is also a chapter devoted to the mammoth vegetarian cousins of the great white, the whale sharks of Ningaloo Reef. The next day Colin Barnett weighed in, confirming killing sharks was on the table VS. The Department of Fisheries remained skeptical, believing a cull was neither environmentally responsible nor likely to work.
Neutral	Research on a young colony of New Zealand fur seals at Rottnest Island shows they eat large fish such as salmon, squid and the occasional penguin but can fall prey to sharks.
	It's at the deco stage where he experiences the more challenging encounters sharks and whales.
	The whale sharks return each year to feed on plankton and billions of eggs spawned by tuna.

Table 2

Shark-related coverage between 2011 and 2013 by study periods, circulation geography, and number of articles. Numbers in parentheses indicate randomly sampled articles for analysis

Circulation geography	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Nationwide	8 (6)	4 (4)	5 (5)	24 (7)	15 (10)	23 (8)	7 (3)	28 (7)
Statewide	39 (32)	28 (28)	11 (11)	100 (28)	40 (25)	77 (25)	78 (35)	114 (27)
Metropolitan	13 (11)	5 (5)	4 (4)	37 (11)	8 (4)	47 (16)	20 (8)	47 (11)
Regional Centres	1 (1)	3 (3)	1 (1)	12 (4)	15 (9)	4 (1)	9 (4)	19 (5)
Total	60 (50)	40 (40)	21 (21)	173 (50)	78 (50)	151 (50)	114 (50)	208 (50)

the proportion of shark bite and shark threat topics increased to about 30%, but declined to approximately 6% in Period 8 (z=-3.406, p<0.001).

Mitigation measures, defined as policies or measures aiming to reduce the probability of shark bites, was the second most recurrent topic (25%; Cramer's V=0.517, p<0.001), and varied between periods. It initially followed the same pattern as the topic of shark bites and increased after the first and second incidents of fatal shark bite, but became the predominant topic in Period 8, with over 70% of articles being related to mitigation measures (z=8.210, p<0.001).

The proportion of articles about shark conservation (5%, Cramer's V=0.252, p=0.003), shark-related tourism (4%, Cramer's V=0.225, p=0.011), and sharks within entertainment (i.e. shark in movies, books, arts) (8%, Cramer's V=0.276, p<0.001) differed across periods. The proportion of articles related to these topics was higher in Period 1 than other periods (18%, z=4.345, p=0.003; 14%, z=4.626, p<0.001; and 24%, z=3.542, p=0.011 for shark conservation, shark-related tourism, and sharks within entertainment, respectively).

Main shark species

The white shark, tiger shark, whale shark (*Rhincodon typus*), and bull shark were the species most often cited (Figure 2). The proportion of articles mentioning white shark significantly differed between periods (X^2=31.963, p<0.001), with a lower proportion in period 1 (z=-3.760, p<0.001) and the highest proportions in Period 2 (z=2.702, p<0.001) and 3 (z=2.794, p<0.001). In contrast, the proportions of articles citing whale sharks rapidly decreased after the first fatal shark bite (z=6.924, p<0.001) between Periods 2–7, decreasing further in Period 8 (z=-2.678, p<0.001) (X^2=50.712, p<0.001). The proportions of articles mentioning tiger and bull sharks was originally low, and did not show significant increase (tiger shark: X^2=14.305, p=0.043; bull shark: X^2=21.919, p=0.003) until Period 8 (tiger shark: z=3.103, p=0.043; bull shark: z=3.994, p=0.003).

Article valence frames

Overall, 60% of the article valences were framed towards the negative impacts from sharks to humans. Although this negative framing was the most frequent throughout all eight periods, the article valences differed significantly among these eight periods (χ^2=114.327, p<0.001) (Figure 3). In Period 1, prior to the series of six fatal shark bites, article valence was evenly split between negative impacts *from* sharks, 'positive' impacts *from* sharks, and *neutral* framing *of* sharks. During this period, the proportion of articles with a negative framing from sharks was at its lowest (z=-5.278, p<0.001) (Cramer's V=0.366, p<0.001). After the first fatal shark bite, the valence

Table 3

Shark-related coverage by duration of periods and intensity (number of articles divided by number of days within the period)

Period	Period duration (days)	Date of fatal bite	Number of days between fatal bites	Total number of shark-related articles	Intensity of shark-related coverage
Before study period		17/08/2010			
Period 1: 6 months prior to 1st shark bite fatality until 1st shark bite fatality	185	04/09/2011	383	60	0.16
Period 2: 1st to 2nd fatal bite*	36	10/10/2011	36	40	1.11
Period 3: 2nd to 3rd fatal bite*	12	22/10/2011	12	21	1.75
Period 4: 3rd to 4th fatal bite	161	31/03/2012	161	173	1.07
Period 5: 4th to 5th fatal bite	105	14/07/2012	105	78	0.74
Period 6: 3 months after 5th fatal bite	93	-	-	151	1.64
Period 7: 6 months before 6th fatal bite	185	23/11/2013	497	114	0.62
Period 8: 3 months after 6th fatal bite	92	-	-	208	2.26

*Number of articles coded was <50 because of the quick succession of fatal shark bites

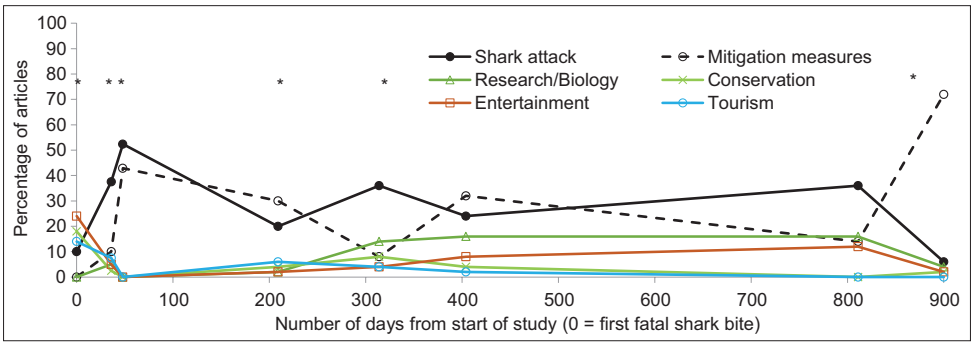

Figure 1

Percentage of shark-related articles from Western Australian newspapers with one of six possible main topics across eight periods spanning six fatal shark bites (represented by the asterix)

frame of negative impacts from sharks increased to about 70% and remained relatively constant throughout the following five study periods (Periods 3–7), then declined to around 40% following the last fatal shark bite (Period 8). During Period 3, which was very short, all article valences were framed towards the negative impacts from sharks ($z=4.004$, $p<0.001$). In Period 8, article valences framing the negative impacts from sharks declined from 60% to 40%, and the proportion framing the negative impacts *to* sharks (from humans) increased by about 20% ($z=4.361$, $p<0.001$).

Primary sources

Overall, 28% of the articles relied on the information provided by reporters covering the incidents, without reference to any specific person interviewed (primary source). Of the articles referring to primary sources, 18% quoted government officials (non-politicians), 18% members of the public, 13% state politicians, 13% cited survivors of shark bites or close relatives and friends of shark bite victims, and 10% cited scientists (Figure 4). Articles citing conservation organisations

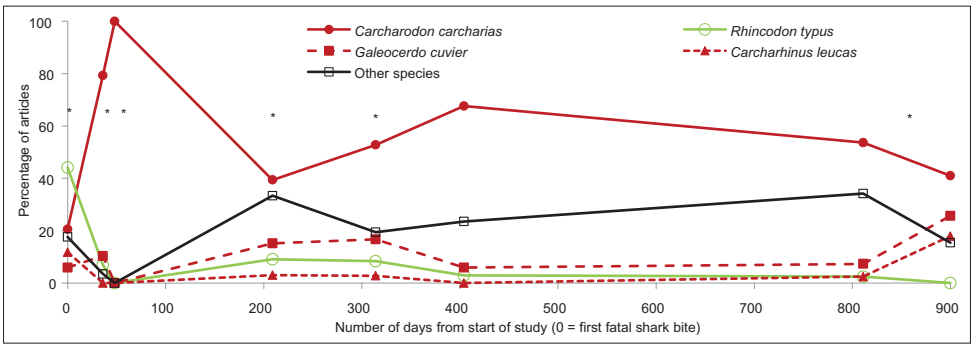

Figure 2

Percentage of shark-related articles from Western Australian newspapers mentioning species of sharks across eight periods spanning six fatal shark bites (represented by the asterix). Potentially dangerous species are represented in red

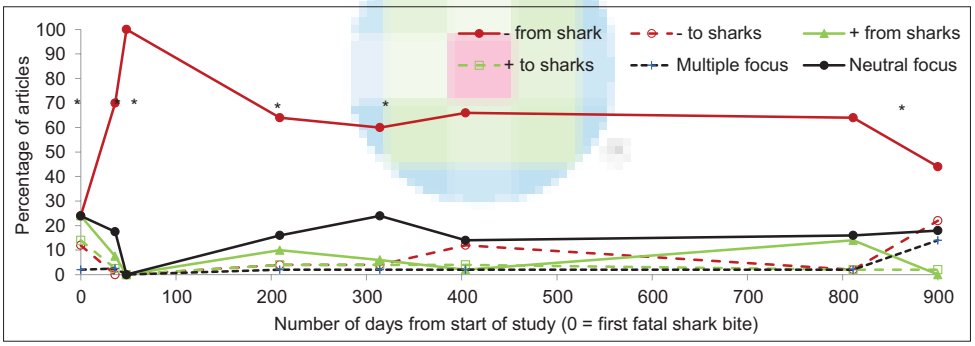

Figure 3

Percentage of shark-related articles from Western Australian newspapers with one of six possible main frames across eight periods spanning six fatal shark bites (represented by the asterix). Multiple foci refers to articles having more than one frame at an equal level. '+' is positive frame; '-' is negative frame. Framing of the article was based on the content and topic of the article as per Muter et al. (2013)

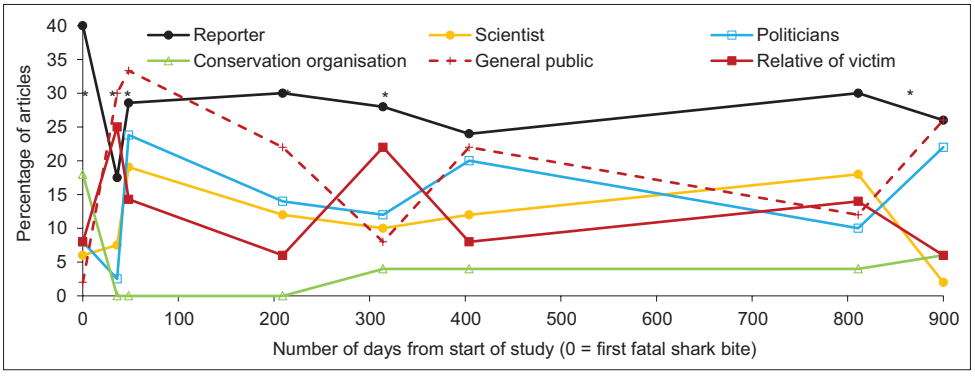

Figure 4

Primary source used in shark-related articles from Western Australian newspapers across eight periods spanning six fatal shark bites (represented by the asterix)

(X^2=24.116, p=0.001, period 1: z=4.555), members of the public (X^2=23.773, p=0.001, period 1: z=-3.173, period 2: z=2.094), and relatives of shark bite victims (X^2=17.916, p=0.012, period 2: z=2.968, period 5: z=2.115) as primary source significantly varied between periods. The use of the general public and relatives of victims as primary source increased, while conservation organisations had an opposite trend and was much lower after the first fatal shark bite. In Period 1, conservation organisations were the second most cited source of information, but was subsequently the least cited during Periods 2–7. Changes in the use of politicians and members of the public as primary sources were generally similar across the study timeframe and were the only two sources cited more in Period 8 than 7. All other primary sources were cited less in Period 8 than 7. Scientists were least cited in Period 8 compared to the other primary sources.

DISCUSSION

Media portrayal of sharks varied considerably over the eight periods, with the quick succession of shark bite fatalities being a key factor influencing the intensity of coverage, the main topic of articles, and valence framing. Since shark bites are traumatising events which can have long-term physical or mental health implications for survivors, victims, and their families, it is predictable that media coverage immediately following fatal shark bite events are negatively framed towards sharks. However, such negative framing, if repeatedly used by media contributes to two problems: 1) it amplifies the sense of risk, i.e., heightens fear among the public and leads them to believe that the risk of shark bites is greater than it actually is, and hence require extreme mitigation measures; 2) it ignores, or rather, diverts public attention from species most at risk of extinction, and persistent threats to sharks and their marine ecosystems such as overfishing, habitat degradation, and the illegal trade of shark products (Jacques 2010; Hart 2011; Dulvy et al. 2014).

Our results show that media intensity and main topic, when combined with citations from different primary sources and their perspectives regarding various shark species, set the context for an amplified sense of risk and probability of fatal encounters. The quick succession of fatal shark bites led to a change of media portrayal that was sustained for prolonged periods even when no fatalities occurred. The ensuing perception of shark bites being of high probability was sufficient to influence state policy makers to introduce mitigation measures targeted at killing sharks after the sixth shark bite incident, although no fatality had occurred in the preceding 16 months.

Although coverage intensity of shark-related articles initially increased when there were short intervals between fatalities, there were marked differences in coverage intensity between long intervals that indicated increasing concerns and interest regarding sharks. Period 1 had a coverage intensity of 0.16, which almost quadrupled during Period 7 (0.62) even though the shark bite fatality prior to Period 1 occurred 13 months earlier and the shark bite fatality prior to Period 7 was after a longer period without fatality (16 month). Similarly, Period 8 had the highest coverage of shark-related articles (2.26), but the interval between fatalities (497 days) was greater than before Period 6 (105 days) which only had a coverage intensity of 1.64. The rising intensity of media coverage in the later periods of the 26-month study timeframe signals a growing concern about sharks, and the strong likelihood that shark bite fatalities were being portrayed as 'high probability' occurrences.

Overall, media portrayal, valence, and framing were not consistent through time and significant changes occurred following the first and the sixth fatal shark bites. While the perception of risk from sharks did not attract the general attention of media in Period 1, the first fatality was sufficient to lead to a significant change in media portrayal, during which the media mainly focused on the threats of sharks to humans. The initial change in media content reflected the first fatal bite following a 13-month period without a major shark bite in Western Australia (ASAF 2014). Since the intervals between fatalities for Period 1 (13 months) and Period 7 (16 months) were more than one year, we would have expected media portrayal of sharks during these periods to be comparable. However, media portrayal of sharks in Period 7 remained similar to Periods 2–6 when fatalities occurred in relatively quick succession. The five fatalities within 10 months, and ensuing discussions among the general public and within governmental agencies, kept media attention focused on shark bite topics and heightened the perception that shark bites were becoming more frequent. These views and concerns were maintained throughout Period 7, even though 1.5 year had elapsed since the last fatality, and most likely contributed to the state government's response following the sixth fatality.

Neff (2014) has suggested that the 'Jaws Effect', i.e., the primal fear invoked by the 1975 Hollywood thriller film of a man-eating white shark, can have a powerful influence on perceptions of risk following a fatal incident, and can drive demand for policy decisions and extreme mitigation measures like culling. Our study shows that the increased in shark bite topics during Periods 2–7 and the accompanying decline in other shark related topics over the same time frame probably created an overall sense of increased danger of shark bites on human swimmers. Hence, in the aftermath of the sixth fatality, the Western Australian government may have felt compelled to demonstrate its concern for public safety by announcing a programme targeted and killing white sharks, tiger sharks, and bull sharks longer than 3 m using drum-lines near popular beaches (Neff 2012; Neff and Yang 2013).

Period 8, which followed the sixth shark bite fatality, showed the greatest increase (72%) in the proportion of articles discussing mitigation measures that involved targeted killing of sharks. The large increase was related to the media reflecting a combination of opinions for and against the WA government's new mitigation policy. The announcement of the drum-line programme generated enormous controversy within the state and nationally, evidenced by: 1) 286,000 emails and letters to the Department of the Premier and Cabinet (DPC)

(Government of Western Australia 2014a); 2) 6,751 public submissions and petitions with ~25,000 signatures related to the Public Environmental Review (PER) of the three-year proposal to extend the drum-line programme (Government of Western Australia 2014b); 3) the number of, and attendance at, rallies organised in opposition to the drum-line programme; and 4) the majority of ocean-users being opposed to the kill-based element of this policy (Gibbs and Warren 2015). Articles with negative valence from sharks declined further in Period 8 when the drum-line programme was announced, and countered by an increase in articles showing the negative valences to sharks and multiple framing of shark related issues. These shifts in article valence and framing indicate a more diverse representation of views about managing shark hazards and conservation, and most likely reflected the differences in opinions, views, and debates regarding the government's shark bite mitigation policies.

The results also highlighted the taxonomic bias in media coverage of sharks. Most articles mentioned the species responsible for the most shark bites (ISAF 2014), but did not discuss their conservation status (Peshack 2006; Muter et al. 2013). Although whale sharks, which are planktivorous and harmless to humans, have been categorised as Endangered in the IUCN Red List (Pierce and Norman 2016), the articles did not refer to their conservation status but rather in terms of their iconic status for tourism (Davis et al. 1997; Huveneers and Robbins 2014) because their seasonal aggregations off Ningaloo Reef attract thousands of visitors each year to Western Australia (Huveneers et al. 2017). However, taxonomic bias does not only occur in the media (Muter et al. 2013). It is also widespread within the ecological literature (Bonnet et al. 2002; Stein et al. 2002) and within the scientific community (Huveneers et al. 2015).

It is important to acknowledge that public perception regarding environmental issues is not solely influenced by stories in newspapers. As Cullen-Knox et al. (2017) observe, a loud minority or well-resourced environmental lobby groups and Environmental Non-Governmental Organisations (ENGOs) can also be selective in presenting information to suit their arguments regarding conservation of particular species or areas. They may be as effective as mainstream media in communicating their views to the public, influencing policy decisions, and driving change in public perceptions regarding environmental issues. However, an interesting finding emerging from our study was the limited presence of scientific 'experts' as primary sources in articles following shark bite fatalities. Although marine biologists and ecologists were primary sources for most general interest articles about sharks in Western Australian newspapers (Muter et al. 2013), they were rarely interviewed or quoted in the stories covering shark bites, and even less used in Period 8 following the announcement of the drum-line programme. In these stories, the primary sources were survivors, close family members of victims, members of the public, and politicians. The lack of representation of scientific experts in these articles may be due to two reasons. First, reporters may have chosen not to include scientist views that promoted shark conservation out of sensitivity for the traumas experienced by survivors or close relatives of victims. Second, scientists may have anticipated negative framing of articles following shark bite fatalities and chosen not to engage with media for fear of being misrepresented or seen as insensitive to the suffering of survivors or families of victims. Either way, the lack of quotes from local scientists and shark experts in the news coverage after each shark bite fatality reinforced the negative framing towards sharks and heightened the public sense that shark bite fatalities were high probability occurrences.

CONCLUSION

The media has long been recognised to reflect popular views (Katz and Lazarsfeld 1955; Jensen 2003; Gans 2004) and influence social attitudes about outcomes of wildlife and conservation policy (Wolch et al. 1997; Muter et al. 2009; Jacobson et al. 2012). Media content analyses are increasingly being used in wildlife-human conflicts to better improve the understanding of the social aspect of conflicts and provide tools for managing these conflicts (Krippenddorf 2004; Jacques 2010; Alexander and Quinn 2012; Jacobson et al. 2012; Rust 2015). As with other predators involved in human-wildlife encounters (Corbett 1992; Gore and Knuth 2009), most humans will not come across sharks, but will most likely rely on media portrayals of sharks to determine the level of risk they pose to public amenity.

Although traditional biological considerations are essential to assess the conservation status of a species, it is equally important for biologists and ecologists to understand the social context of media and learn to communicate their conservation messages through them to gain public support for effective management of these ecosystems (Riley et al. 2002; Jacques 2010; O'Bryhim and Parsons 2015). Our study highlights the need for scientists to be proactive and share information about shark behaviour and marine ecosystems through media in positive ways to reduce fear and increase public awareness. The ability to improve perception of sharks through such modes of education has previously been demonstrated through an experiment showing that priming for the absence of intent yielded reduced fear of sharks (Pepin-Neff and Wynter 2018). One approach is to work with people and groups who are regularly involved in beach and ocean activities such as surf life-saving clubs, divers, and surfers, to provide accessible stories in media about shark ecology, conservation status, and how to be alert when swimming in the ocean. Although these groups have significant experiential knowledge of shark ecology, conservation issues, and risk from sharks (Neff and Yang 2013; Friedrich et al. 2014), it is necessary to ensure that this information is coordinated with current scientific research to improve accuracy and efficacy of messages.

It is also necessary to build greater trust between reporters and scientists regarding the framing and information used for shark-related articles, particularly after shark sightings or shark bite incidents. This would alleviate the concerns

of scientists to be associated with articles that perpetuates a fear of sharks. This can increase the likelihood of scientists to engage with the media and to respond constructively with information and advice about shark behaviour and mitigation measures. Shark ecologists are also increasingly using social media like Twitter for communicating their research and providing advice to a wider audience and journalists could be encouraged to share their handles and feeds in their coverage (Parsons et al. 2014). These approaches, when combined, can steadily overcome the public perception of shark bites as high probability occurrences, generate broader public support for shark conservation, and lead to better policies for marine wildlife management.

The results from this study suggest that various stakeholder agencies concerned with shark conservation and marine management should maintain a clear communication strategy and be proactive in liaising with, and providing accurate information and advice to the media in the event of shark bite incidents (Preen and Richards 2006; Curtis et al. 2012). Managers and policy makers should be aware of the potential biases in the media portrayal of human-shark conflicts that can shift public perception regarding the probability of shark bite fatalities. They should also recognise the potential taxonomic biases that lead media and scientists to focus on charismatic and dangerous species to the exclusion of conservation concerns. Fear does not translate into support for conservation of a species (Liordos et al. 2017). By overlooking the conservation status of the species, the media can weaken public awareness of species that are vulnerable or most threatened by extinction due to human activities, and thereby undermine conservation efforts. Managers, policy makers, and scientists should also be trained and prepared to communicate their message in ways that are sensitive to the situation and account for the type and frame of the story before providing comments. Finally, as suggested by Eovaldi et al. (2016), journalists should reflect on their critical role in influencing public perceptions of sharks and the effectiveness of shark conservation efforts.

The present study quantitatively describes how media portray sharks when fatal shark bites occur and discusses findings in the context of cultivation theory, framing and agenda-setting, and social amplification. Combined, findings from this study and application of these theories suggest that the negative framing and agenda-setting of the media related to sharks, increased concerns of shark bite risk due to social amplification, and influences on people sense of reality through cultivation can detrimentally affect public perception of sharks and risk of shark bites. This has, however, not been tested and future studies should focus on public perception of sharks (e.g., Lynch et al. 2010; Crossley et al. 2014; Heard et al. 2016) and assess whether media portrayal of sharks has affected public behaviour and risk perception of sharks. This should be conducted across a range of metropolitan and regional areas, including both ocean-users and non-users. A comparative study of media portrayal and relationship with public perception should also be performed in other regions where a series of fatal shark bites has taken place (e.g., Reunion Island in 2011, Egypt in 2010, North coast of New South Wales, Australia in 2015–2016).

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APPENDIX I

General article information
1: Name of Publication
2: Article Date
3: Newspaper location (Perth metropolitan area, regional area, statewide, or nationally)
4: What are the main species mentioned?

Article primary frame
5: What is the primary article frame?
- 1 = Negative impacts from sharks
- 2 = Negative impacts to sharks
- 3 = Positive impacts from sharks
- 4 = Positive impacts to sharks
- 5 = Multiple foci
- 6 = No impacts, neutral to or from sharks

Article primary topic
6: What is the primary article topic?
- 1 = Shark attack(s) on people
- 2 = Shark attack mitigation measures (culling or WA drumlines and others)
- 3 = Shark-related research
- 4 = Shark biology/ecology
- 5 = Shark conservation issues
- 6 = Shark sighting(s)
- 7 = Sharks as entertainment media (e.g., movies, books, television, aquariums)
- 8 = Shark diving tourism (e.g., white shark cage-diving; whale shark snorkeling/diving)
- 9 = Other (e.g., shark in the arts)

Mitigation measures
7: Is the targeted killing of sharks mentioned (Y/N)
If B1 = Y, is it mostly mentioned in relation to:
- 1 = Threat to sharks
- 2 = Mitigation measure to protect humans

Primary messenger
8: Who is the primary messenger (e.g., source) of the information provided
- 0 = Journalist/reporter
- 1 = Scientist (e.g., university, government, self-proclaimed)
- 2 = Government officials (e.g., managers; Surf Life Savings Club; Water Police)
- 3 = Politicians (State)
- 4 = Politicians (Federal)
- 5 = Fishers (recreational; commercial; charter)
- 6 = Conservation organisation (e.g., NGO)
- 7 = General public (e.g., water user; concerned citizen)
- 8 = Survivor or relatives to shark attack victim (e.g. widow, close friend…)
- 9 = Tourism (e.g., shark dive operators, aquariums)
- 99 = Other