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Tourists’ aesthetic assessment of environmental changes, linking conservation planning to sustainable tourism development

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ABSTRACT

Tourists often travel to experience the natural beauty of a destination such as the Great Barrier Reef (GBR) in Australia. This nature-based destination attracts millions of tourists every year because of its outstanding underwater aesthetics. Recently, parts of the GBR have been degraded by warming sea temperatures and other local anthropogenic influences, threatening the Reef aesthetics and tourism in the region. In order to deal with this topical issue, the current research investigates tourists’ aesthetic assessment of environmental changes in the GBR ecosystem. Research outcomes indicate that tourists’ perceived beauty of the Reef is sensitive to environmental changes. The disappearance of sea animals (colourful fish, turtle), degrading coral and decreasing water quality negatively influence their aesthetic assessment, which can reduce tourist visitation in the long-term. Hence, sustainable tourism development in the GBR regions can only be achieved when government support for environmental management is strengthened. Conservation programs of the GBR should expand beyond coral restoration for controlling water quality, reducing pollution and protecting aesthetically appealing sea animals.

Introduction

The beauty of nature-based attractions is vital for tourism development because tourist visitation is driven by human appreciation of natural aesthetics (Awaritefe, 2004; Beh & Bruyere, 2007; Yoon & Uysal, 2005). Tourists often search for and use aesthetic information to make a destination choice (Vogt, Fesenmaier, & MacKay, 1994). Indeed, tourist aesthetic assessment of natural attractions influences overall satisfaction of a place visit and revisit intentions (Chi & Qu, 2008; del Bosque & San Martin, 2008; Lee, Jeon, & Kim, 2011). Overall, tourist perceived beauty of tourism destinations is instrumental in both stimulating travel and shaping satisfactory evaluations of travel experiences (Kirillova, Fu, Lehto, & Cai, 2014). The critical role of tourist aesthetic assessment in inspiring tourist visit behaviour is well established in tourism literature (Echtner & Ritchie, 1993; Hazen, 2009; Kock, Josiassen, & Assaf, 2016; O’Leary & Deegan, 2005).

The importance of aesthetics for tourism development is clearly demonstrated by the case of the Great Barrier Reef (GBR). The GBR was designated a World Heritage Area in 1981 for its superlative natural beauty (Criterion vii) among other natural listing criteria (Vercelloni et al.,
Aesthetics are ranked as the most important value of the GBR by tourists, residents, indigenous locals and tourism businesses (Marshall et al., 2018). “Beautiful” was the most frequently cited word in a survey of 9000 participants when answering the question of what first comes to mind about the GBR (Marshall et al., 2016). The outstanding aesthetics make the GBR an iconic tourism destination in Australia (Piggott-McKellar & McNamara, 2017) with 2.68 million visitor days only in 2017 (GBRMPA, 2018). The aesthetic value of a landscape is, thus, recognised as an important ecosystem service, and as such provides additional impetus for the conservation of ecosystems (Swaffield & McWilliam, 2013), especially when tourism is used as the main lever by conservation groups to protect the Reef from alternative and relatively more extractive uses (Liburd & Becken, 2017). Decreasing GBR aesthetics could negatively influence tourists’ interest in the Reef, with implications for both visitation behaviour and Reef protection (Coghlan & Prideaux, 2009).

The GBR aesthetics have been negatively influenced by human-driven impacts (e.g. reduced water quality) and climate change impacts such as rising sea temperature (GBRMPA, 2014). The record-breaking marine heatwaves in 2016 and 2017 caused large-scale coral bleaching on the GBR, catastrophic coral die-off and ecological transformations (Hughes, Kerry, Baird, et al., 2018). This is the most severe event in the GBR’s recent history, affecting up to 91% of the Reef (Hughes, Kerry, & Simpson, 2018). Up to 51% of reductions in live coral cover and consistent declines in the diversity of fishes were observed one year after the bleaching event (Stuart-Smith, Brown, Ceccarelli, & Edgar, 2018). These environmental changes have negative impacts on tourist aesthetic assessment of GBR underwater scenery, leading to serious challenges to sustainable tourism development in the Reef regions (Marshall et al., 2019). Meanwhile, research to identify and quantify exactly what makes an underwater ecosystem aesthetically pleasing is insufficient at present (Vercelloni et al., 2018). In fact, the aesthetics of underwater environments are possibly the least studied of all landscapes (Haas et al., 2015; Tribot et al., 2016).

Against this background, the current research aims to fill the knowledge gap in the literature and address the particular issue of understanding tourists’ aesthetic assessment of environmental changes in the GBR underwater ecosystem. Aesthetic research is vital to ensure sustainable tourism development because both tourist visitation (Hazen, 2009; Kirillova et al., 2014) and tourist conservation behaviour (Brady, 2006; Skibins, Dunstan, & Pahlow, 2017; Stokes, 2007) are motivated by tourist aesthetic assessment of nature-based destinations. The overarching goal of our research is achieved by pursuing three specific aims. The first aim is to identify key aesthetic attributes of GBR underwater scenery using advanced eye-tracking technology. The second aim is to quantify how environmental changes related to these key attributes are aesthetically evaluated by tourists. Conjoint analysis, a widely used method in consumer and tourist preference research (Chen, Hsu, & Lin, 2010; Suh & McAvoy, 2005), was applied for quantification purpose. The third aim is to translate research findings into practical marketing and conservation suggestions for GBR stakeholders that support sustainable tourism development. Organisations that proactively seek to improve the Reef’s protection and conservation such as the GBR Marine Park Authority (GBRMPA) or the GBR foundation can use the current research to advocate for future conservation programs in favour of tourism development.

**Literature review**

There are two main paradigms in conceptualising beauty: objectivist versus subjectivist. The objectivist paradigm derives from the 18th century Kantian idea of disinterestedness and picturesque. Objective beauty is inherent in the physical landscape and not subject to an observer’s evaluation (Beardsley, 1975). Human aesthetic assessment of natural scenery involves the recognition of its intrinsic, objective beauty (Hagman, 2002) and is convergent among the audience (Dinsdale & Fenton, 2006). Natural beauty is, therefore, explained by a number
of environmental factors (Haas et al., 2015). In the 20th century, there was a paradigmatic shift to a subjectivist approach to human aesthetic assessment (Todd, 2009). The subjectivist paradigm regards beauty as a product of the mental processes of the beholders (Kirillova et al., 2014) because aesthetics of natural landscapes cannot be framed or separated from the viewers (Hepburn, 1966). Aesthetic assessment, thus, reflects human responses to a scene involves one’s prior knowledge, experiences, values, emotional state and desires (Datta, Joshi, Li, & Wang, 2006).

The objectivist paradigm underlies expert surveys of physical landscapes, while the subjectivist paradigm underlies studies of observer preferences for natural sceneries (Lothian, 1999). It is worth noting that human aesthetic assessment and environmental preference are used interchangeably in the literature (Kirillova et al., 2014). Research applying the objective (vs. subjective) paradigm results in the identification of environmental (vs. individual) determinants of human aesthetic assessment.

**Determinants of landscape aesthetics**

An influential framework in landscape aesthetic research is the four-domain model of Kaplan, Kaplan, and Brown (1989). It includes four groups of environmental factors: land cover (i.e. forest, woodlawn); informational (i.e. complexity, mystery, coherence, legibility); perceptual (i.e. openness, smoothness, locomotion) and physical (i.e. relief, height). Later studies adopted this model but focused only on a small number of factors such as naturalness (Breiby & Slätten, 2015; Frank, Fürst, Koschke, Witt, & Makeschin, 2013; Nassauer, 1995); openness (Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles, 2004; Chen, Sun, Liao, Chen, & Luo, 2016); vegetation or landcover by green plants (Fyhri, Jacobsen, & Tømmervik, 2009; Rogge, Nevens, & Gulinck, 2007); water spaces (Coeterier, 1996; White et al., 2010); colour contrast (Arriaza et al., 2004; Lindemann-Matthies, Junge, & Matthies, 2010; Yao et al., 2012); diversity (Kirillova et al., 2014; Schirpke, Tasser, & Tappeiner, 2013; Van den Berg, Vlek, & Coeterier, 1998; van der Jagt, Craig, Anable, Brewer, & Pearson, 2014) and the presence/harmony of human elements (Fyhri et al., 2009; Sevenant & Antrop, 2010). Some of these factors also relate closely to the ecological health of an ecosystem (e.g. diversity), indicating that aesthetic and ecological values could be closely aligned (Yang, Luo, Lin, Qiu, & Luo, 2014).

The objectivist research stream provides a general picture of human aesthetic preference of landscape environments. Diversity and naturalness of landscapes are two key factors which can explain a considerable proportion of changes in viewers’ aesthetic judgments (Frank et al., 2013). Overall, people appreciate the aesthetics of natural landscapes that offer wider vistas, water spaces, high colour contrast and diversity (Van den Berg et al., 1998; Yao et al., 2012). The presence of human elements has positive or negative impacts, depending on how these elements are developed and maintained in harmony with nature (Breiby, 2014; Sevenant & Antrop, 2010).

The subjectivist research stream provides clarifications on individual differences in aesthetic assessment. Specifically, it is found that individual familiarity or experiences with judged landscapes (DeLucio & Múgica, 1994; Strumse, 1996; Van den Berg et al., 1998); profession (Rogge et al., 2007); actual living environment (Sevenant & Antrop, 2010); aesthetic distance between tourist destination and hometown (Kirillova & Lehto, 2015); environmental attitude and behaviour (Howley, 2011; Howley, Donoghue, & Hynes, 2012; Sevenant & Antrop, 2010) and demographic characteristics such as age and level of education (Howley et al., 2012; Strumse, 1996) differentiate human aesthetic assessment of the same landscape scenery.

**Determinants of underwater aesthetics**

Despite a rich body of literature on human aesthetic assessment of landscapes, aesthetic research of underwater scenery remains limited (Haas et al., 2015). Underwater scenes were given similar ratings to rural, green landscapes in terms of aesthetic preference, affective
responses and perceived restoration (White, Cracknell, Corcoran, Jenkinson, & Depledge, 2014). Regarding environmental factors, similar determinants of underwater aesthetics were found compared to landscape studies. The beauty of underwater scenery is characterised by three main factors: diversity (Marshall et al., 2019; Tribot et al., 2016); colour (Vercelloni et al., 2018) and water quality (Esparon, Stoeckl, Farr, & Larson, 2015; Johnston & Smith, 2014; Marshall et al., 2019).

First, underwater images showing species richness and abundance are rated relatively more positively in terms of attractiveness (Cracknell, White, Pahl, & Depledge, 2017; Polak & Shashar, 2013). Fish and coral are two key elements of underwater aesthetics, resulting in diver enjoyment of reef systems (Uyarra, Watkinson, & Cote, 2009). Coral topography (i.e. coral of high structural complexity) is strongly related to aesthetic evaluation (Marshall et al., 2019; Vercelloni et al., 2018). Other iconic marine species such as whales, dolphins and turtles also positively contribute to the aesthetic value of the Reef (Esparon et al., 2015). Second, reduced water quality (less visible) due to poor weather has a negative impact on tourist overall evaluation (Coghlan & Prideaux, 2009). Third, fauna and flora living in healthy reef system surpass all other ecosystems in their display of colour (Kaufman, 2005; Marshall, 2000) which leads to human aesthetic preference for underwater scenery (Haas et al., 2015).

There are only a few studies investigating individual differences in assessing underwater aesthetics. In a study comparing three groups with different experiences with coral reefs (i.e. experienced divers, citizens and marine scientist), no significant differences were found in their perceived beauty of the reef (Vercelloni et al., 2018). However, aesthetic preferences for fishes with different shapes differ between divers and non-divers (Tribot et al., 2018).

Based on the literature review, the current research applies a subjectivist approach to study tourist aesthetic assessment of underwater scenery, considering both environmental factors (diversity, colour, water quality) and tourist characteristics (gender, age, travel experiences to GBR, and snorkelling or diving experiences).

Methodology

Conjoint analysis is applied in this study to quantify the influences of environmental changes on tourist aesthetic assessment of the GBR underwater scenery (Green & Srinivasan, 1990). Conjoint analysis is a decompositional approach that employs an overall evaluation of a set of attributes to determine human preference structure. The basic conjoint model used in this research is:

\[ Y = X_1 + X_2 + X_3 + \ldots + X_n; \]

where \( Y \) represents the total utility of the respondent’s aesthetic preferences for an underwater scenery and \( X_i \) represents the specific utility for the correspondent aesthetic attribute (Hair, Black, Babin, Anderson, & Tatham, 1998). The relative importance of an attribute is calculated by dividing each attribute’s range of utility by the sum of all range values across attributes (Chen et al., 2010). The merit of conjoint analysis methodology has been widely supported by various marketing (Ares & Deliza, 2010; Silayoi & Speece, 2007) and tourism research (Huertas-García, Laguna García, & Consolación, 2014; Thyne, Lawson, & Todd, 2006).

In order to apply conjoint analysis, a multistage research was conducted: (1) identification of key GBR aesthetic attributes using eye-tracking technology; (2) preliminary study of aesthetic attribute manipulation; (3) design of survey materials and pre-test; (4) survey using the Qualtrics platform (www.qualtrics.com) and distribution service; and (5) data analysis using IBM SPSS for quantitative data and Leximancer for qualitative data. Details of each stage are discussed below.

Stage 1: Identification of the GBR aesthetic attributes

In this stage, eye-tracking technology was employed to identify key aesthetic attributes of the GBR underwater scenery. Given that aesthetic research to date almost exclusively focused on visual attributes and visual cues (Haas et al., 2015; Johnston & Smith, 2014), eye-tracking technology
is effective in identifying important visual aesthetic attributes of GBR underwater scenes (Scott, Zhang, Le, & Moyle, 2017). Sixty-six participants were recruited in the eye-tracking experiment to assess 21 GBR pictures on a 10-point aesthetic scale (1-Not beautiful at all, 10-Extremely beautiful). The eye-tracking experiment revealed a significant correlation between attention and aesthetic scores of the GBR pictures (Scott, Le, Becken, & Connolly, Published online). Pictures showing colourful fish, colourful coral, turtle and high water visibility attract more attention and gain higher aesthetic scores. Fish, coral, turtle and water visibility are hence selected as key aesthetic attributes of the GBR underwater scenery for further examination (Esparon et al., 2015; Uyarra et al., 2009).

**Stage 2: Preliminary research**

Following the eye-tracking experiment, it is hypothesised that the presence of an aesthetically attractive feature, such as turtle or fish, can significantly improve tourist aesthetic assessment of GBR underwater scenery. This hypothesis was tested in a preliminary study. The image of a swimming turtle was added to two overtly unattractive GBR images rated by participants in the previous eye-tracking experiment (see Figure 1). These pictures were each rated by six new participants. The photoshopped picture 1 was still rated similarly at 3 out of 10-point beauty scale as the original picture. Meanwhile, the average beauty score for picture 2 significantly increased from 3.6 for the original picture (without turtle) to 7 out of 10-point beauty scale for the photoshopped version (with turtle). The reason for somewhat mixed results was revealed in the after-rating interviews with participants: Picture 1 looked fake (e.g. “It must be photoshopped”) while Picture 2 looked natural/original. This preliminary study highlights the caution in photoshopping images used for follow-up research.

**Stage 3: Survey material design**

Building on the literature review and eye-tracking research outcomes, four aesthetic attributes (turtle, fish, coral and contrast) were manipulated to explore how environmental changes related to biodiversity, water quality and colour are aesthetically evaluated by tourists. Biodiversity was examined by manipulating the presence/absence of coral and marine species (turtle and fish). Colour was investigated by comparing colourful versus non-colourful fish and coral. Picture contrast was adjusted to reflect high versus low water visibility: high (low) contrast picture is related to high (low) water visibility by enhancing (reducing) the clarity of picture elements. In brief, four aesthetic attributes (contrast, coral, fish and turtle) were manipulated as follows: picture contrast (high vs. low), coral (no coral, non-colourful coral, colourful coral); fish (no fish, non-colourful fish, colourful fish); turtle (presence vs. absence).
These four attributes and their levels give rise to 36 possible combinations ($2 \times 3 \times 3 \times 2$), possibly leading to information overload on respondents (Green & Srinivasan, 1990). Therefore, the Orthoplan subroutine in SPSS was used to produce an orthogonal main-effects design, ensuring the absence of multicollinearity between attributes (Silayoi & Speece, 2007). Following nine attribute combinations recommended by SPSS Orthoplan, nine pictures were created by photo-shopping GBR key aesthetic attributes (Figure 2). In order to avoid possible bias, these nine

![Figure 2. Orthogonal main-effects design for conjoint analysis.](image-url)
pictures include similar attributes (fish, coral, turtle, background) extracted from four GBR original pictures. Other potential determinant factors of tourist aesthetic judgment such as openness, naturalness, human elements, were kept constant. Ten experts were invited to review the materials and provided feedback to improve the materials until all pictures were well photoshopped (i.e. looking natural).

Stage 4: Questionnaire design and data collection

The survey questionnaire included three main sections: section 1 containing demographic questions (such as gender, age), section 2 consisting of the image ranking task (i.e. participants were asked to rank nine GBR pictures from the most beautiful picture to the least beautiful picture) and section 3 including one open-ended question on determinant factors of their aesthetic judgment (“From your point of view, what are the factors that make a picture of Great Barrier Reef beautiful?”) and two questions related to their travel experiences to the Great Barrier Reef, and diving and snorkelling experiences. In section 2, nine GBR pictures to be ranked were shown to participants in random order to avoid any bias related to picture positions.

The survey was launched under the ethical approval GU 2017/537 in October 2017, targeting Australians over 18-year old living in all states of the country. A total of 705 survey completions were recorded after one month of data collection. Participants were evenly distributed among six age groups: 12.5% were between 18- and 24-year old; 19.9% were between 25- and 34-year old; 17.7% were between 35- and 44-year old; 17.0% were between 45- and 54-year old; 15.5 were between 55- and 54-year old; and 17.4% were above 65-year old. Regarding gender, 48.9% were female, 50.9% were male, and 0.1% belonged to other genders. Of the respondents, 40% had previously visited the GBR, and 46.5% had some diving or snorkelling experience.

Stage 5: Data analysis

Quantitative data collected from the survey were imported into IBM SPSS statistics software (version 24). Conjoint analysis was performed to calculate the importance value and the utility of each aesthetic attribute. Next, MANOVA analysis was performed to test individual differences in aesthetic assessment between different respondent groups of age, gender, visit experiences, diving/snorkelling experiences. MANOVA is appropriate to investigate several theoretically related dependent variables and to reduce the likelihood of a Type I error and controls for correlations among the dependent variables (Andereck, Valentine, Knopf, & Vogt, 2005).

Qualitative data collected from the open-ended question in the questionnaire survey was imported to Leximancer software for thematic and content analysis. This software enables counts of word frequency, as well as analysis of the meanings within passages of text, by extracting the main concepts and ideas (Scott and Smith, 2005). Several steps in Leximancer operation were used to develop concept maps: (1) eliminating meaningless words such as “and,” “or,” “etc.”; (2) grouping and coding similar words as a concept; (3) repeating the second step with modifications to achieve satisfactory coding of text meanings; and (4) visualising relevant concepts into different themes (Scott et al., 2017; Tseng, Wu, Morrison, Zhang, & Chen, 2015).

Results

Tourist aesthetic assessment of environmental changes in the GBR ecosystem

Conjoint analysis results clarify how environmental changes are aesthetically evaluated by tourists (Table 1). The importance value represents the relative contribution of one attribute to tourist aesthetic assessment compared to others. Fish is the most important attribute of the Reef
aesthetics based on importance value (32%), indicating that fish-related changes have the greatest impact on tourist aesthetic assessment. Coral is the second most important aesthetic attribute (25.1%), followed by picture contrast (22.23%) and turtle (20.64%).

Utility scores provide more details on the influences of attribute-related changes on tourist aesthetic assessment. A positive score means a positive influence, while a negative score represents a negative influence (Green & Srinivasan, 1978). Colourful fish, colourful coral, the presence of turtle and high picture contrast have positive contributions to the GBR aesthetics based on positive utility scores. Non-colourful coral has a nearly neutral utility (.043), showing that in general non-colourful coral decreases tourist aesthetic assessment compared to colourful coral scenery, but increases tourist aesthetic assessment compared to no coral scenery. In contrast, non-colourful fish has a negative utility (−0.63), indicating negative aesthetic appeal of non-colourful fish in GBR pictures. The utility scores for no turtle, no fish and no coral are all negative, clearly stating that the absence of any sea feature reduces tourist aesthetic assessment of the Reef. Pictures showing a bio-diverse reef ecosystem are more beautiful in tourists’ eyes.

**Individual differences in aesthetic judgment**

MANOVA analysis was performed to test whether socio-demographic characteristics (age, gender) and familiarity with GBR underwater scenery (GBR experiences and diving and snorkelling experiences) could affect tourist aesthetic assessment of underwater scenes (Table 2). Among independent variables, age has a significant impact on tourist aesthetic assessment ($p < .01$). The importance weight of fish-related changes in determining tourist aesthetic assessment increases while the importance weight of coral-related changes decreases when tourists get older (see Figure 3). Even though travel experiences with the GBR has also a statistically significant influence on the importance weight of coral ($p = .05$) but the effect size is limited ($\eta^2 = .008$). Hence, travel experiences do not play a considerable role in differentiating tourist aesthetic assessment.

**Confirmatory research on environmental determinants of GBR aesthetics**

Thematic analysis of qualitative data using Leximancer software resulted in a concept map representing five major themes: colours (359 occurrences), coral and other marine features (325 occurrences), diversity of marine life (175 occurrences), water quality (167 occurrences) and natural beauty (109 occurrences; Figure 4). Most participants mentioned more than one aesthetic factor. The most frequently mentioned theme is colour, indicating participants’ aesthetic preference for bright and vibrant colours of sea features (in particular fish) and blue seawater. The two next themes indicate that tourist perceived beauty of the Reef is strongly influenced by the diversity of sea life (e.g. the presence of coral and other marine features). Another considerable theme is water quality reflecting tourist aesthetic preference for GBR underwater images showing clean,
Table 2. MANOVA results.

**MANOVA Model (Age):** $V = 0.919$, $F = 4.01$, $p = .000$

<table>
<thead>
<tr>
<th></th>
<th>18–24 years</th>
<th>25–34 years</th>
<th>35–44 years</th>
<th>45–54 years</th>
<th>55–64 years</th>
<th>65+ years</th>
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<td><strong>Colour</strong></td>
<td>23.9</td>
<td>22.25</td>
<td>22.34</td>
<td>22.37</td>
<td>21.62</td>
<td>21.28</td>
</tr>
<tr>
<td><strong>Fish</strong></td>
<td>27.32</td>
<td>29.36</td>
<td>30.88</td>
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<td>34.76</td>
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<tr>
<td><strong>Coral</strong></td>
<td>29.24</td>
<td>27.73</td>
<td>26.2</td>
<td>23.91</td>
<td>21.75</td>
<td>22.13</td>
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**Means**

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<th>Colour</th>
<th>Fish</th>
<th>Coral</th>
<th>Turtle</th>
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**Means**

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<th>Coral</th>
<th>Turtle</th>
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| **Means with the same superscript are not significantly different at the .05 level.**
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**MANOVA Model (Gender):** $V = 0.999$, $F = 0.66$, $p = .999$

<table>
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<th>Female</th>
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<tr>
<td><strong>Turtle</strong></td>
<td>20.7</td>
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**MANOVA Model (Travel experiences):** $V = 0.986$, $F = 0.1079$, $p = 0.115$

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<th>More than 3 times</th>
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<td>22.34</td>
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<td>32.33</td>
<td>32.21</td>
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<td><strong>Turtle</strong></td>
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<td>21.75</td>
<td>20.63</td>
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<th>Turtle</th>
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| **Means with the same superscript are not significantly different at the .05 level.**
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**MANOVA Model (Diving/snorkelling experiences):** $V = 0.987$, $F = 1.513$, $p = 0.170$

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<tr>
<td><strong>Coral</strong></td>
<td>24.77</td>
<td>24.63</td>
<td>27.75</td>
</tr>
<tr>
<td><strong>Turtle</strong></td>
<td>20.07</td>
<td>21.3</td>
<td>21.23</td>
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**Means**

<table>
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<th>Fish</th>
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| **Means with the same superscript are not significantly different at the .05 level.**
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Figure 3. Importance values of GBR aesthetic attributes across age groups (%).
clear and blue sea water. The last theme is natural beauty. Participants appreciate the naturalness of the GBR scenery characterised by beautiful and healthy reef features (i.e. coral and a wide range of marine species, or sea animals). Therefore, environmental changes such as degrading water quality/clarity, decreasing number of sea animals and unhealthy Reef elements negatively influence tourist aesthetic assessment of the GBR, threatening tourism growth in the Reef regions.

Discussion

The current research advances the literature by exploring how environmental changes in the GBR ecosystem are evaluated aesthetically by tourists. The contributions of key aesthetic attributes (fish, coral, turtle, water quality) to the reef beauty are quantified, showing that they have different aesthetic appeal. Results indicate that tourist aesthetic assessment of the GBR is subjective and varies across age groups. Research outcomes are hence discussed in relation to the literature to suggest marketing and conservation implications for GBR stakeholders.

Advancing knowledge of tourist aesthetic assessment

This study contributes to tourism literature by providing insights into tourist aesthetic assessment of underwater scenery. First, the disappearance of any feature (fish, turtle and coral)
decreases tourist aesthetic assessment, confirming the vital role of biodiversity in determining tourist perceived beauty of the Reef. Tourist aesthetic preference for bio-diverse environments including underwater sceneries (Cracknell, Pahl, White, & Depledge, 2018; Cracknell et al., 2017; Polak & Shashar, 2013; Tribot et al., 2016; White et al., 2017) and landscapes (Breby & Slätten, 2015; Frank et al., 2013; van der Jagt et al., 2014) indicates a link between multiple ecosystem services (Swaffield & McWilliam, 2013). It is worth noting that the current study investigates a prescribed set of variables representing key features of the reef and does not account for the diversity of species within these variables (e.g. fish abundance).

Second, the presence of colourful features positively increase tourist aesthetic assessment of underwater scenery compared to non-colourful features (see Table 1), aligning with previous research on human aesthetic preference for brightly colourful objects (Junge, Jacot, Bosshard, & Lindemann-Matthies, 2009; Lindemann-Matthies, Briegel, Schüpbach & Junge, 2010). Given that bright colours have signalled food sources for humans throughout evolution (Heerwagen & Orians, 1993; Lindemann-Matthies et al., 2010), the presence of colourful features makes underwater scenery more aesthetically attractive (Haas et al., 2015; Scott et al., in press).

Interestingly, fish colour is related to aesthetic appeal but does not necessarily signal its economic value. Non-colourful fish characterised by silver colour in this study represents the many pelagic species (a term meaning fish swimming in schools above the coral reefs). Non-colourful fish have, on average, negative aesthetic appeal, but many of these types of fish are important economically. For example, the Queensland school mackerel (Scomberomorus queenslandicus) forms the basis of a commercial fishery on the Great Barrier Reef (Begg, Cameron, & Sawynok, 1997). In contrast, colourful fish of the Reef (e.g. Maori Wrasse or clownfish), which is more aesthetically appealing because of their blue and yellow colours (Marshall et al., 2018), have negligible value for the fishing industry.

Moreover, colourful coral has positive aesthetic appeal while non-colourful coral does not. Coral near the water surface is characterised by a display of colour (Kaufman, 2005; Marshall, 2000) but the coral colour appears duller with increasing water depth. Hence, coral in deep water or coral in an unhealthy state such as bleaching and dying is less aesthetically appealing due to its fade colours. However, underwater scenery containing non-colourful coral may still be aesthetically appreciated by tourists if colourful fish and other sea animals (e.g. turtle) are present (see Table 1).

Third, water visibility significantly influences tourist aesthetic assessment of GBR underwater scenery. Reduced water visibility negatively influences tourist aesthetic assessment, and thus, decreases tourist satisfaction with GBR visit experiences (Coghlan & Prideaux, 2009). Water quality is an important determinant of the Reef beauty (Marshall et al., 2019), providing an important lever to encourage the involvement of the government and other production industries in pollution control in favour of sustainable tourism development.

Overall, the current research reveals tourist aesthetic preference for fish over coral. Human appreciation of fish species beyond simply keeping fish as a source of food has been previously recorded (Bridges, 1970; Cracknell et al., 2018). From a tourist perspective, “a coral reef without fish is like a playground without the laughter” (Marshall et al., 2019, p. 12). Tourists have more empathy and connection with fish because they are unlikely to consider coral as a living organism (Marsden, 2018). Fish are more lively and active, providing psychological benefits such as calmness, relaxation and stress-reduction (Kidd & Kidd, 1999; Langfield & James, 2009). Such an engagement quality of fish is a key reason explaining why people have fish tanks at home and make regular visits to aquaria (Gusset & Dick, 2011). Tourist aesthetic preference for fish over coral is supported by a number of studies (Giglio, Luiz, & Schiavetti, 2015; Leujak & Ormond, 2007; Williams & Polunin, 2000) while the opposite trend (human preference for coral over fish) has also been recorded (Shafer & Inglis, 2000). However, there is agreement that fish and coral are key aesthetic elements of the Reef, contributing viewers enjoyment (Uyarra et al., 2009).
Furthermore, the current research supports a subjectivist approach in studying human aesthetic assessment. Tourist aesthetic assessment is complex and depends on innate biological/evolutionary mechanisms, learned cultural influences and individual histories (Bourassa, 1990; White et al., 2014). This study shows that tourist aesthetic assessment of GBR underwater scenery varies across age groups, aligning with other landscape studies (Howley, 2011; Howley et al., 2012; Sevenant & Antrop, 2010; Strumse, 1996). The importance value of fish attribute increases along with participants’ age, indicating that older tourists are more sensitive to fish-related changes in appreciating the GBR aesthetics (see Table 2). In contrast, coral-related changes have a stronger impact on younger tourists’ beauty assessment. This is possibly because young tourists access more regularly environmental education and conservation information and hence more aware of coral bleaching (Connell, Fien, Lee, Sykes, & Yencken, 1999).

**GBR aesthetics as a key criterion for sustainable tourism development**

This study shows that tourist aesthetic assessment is sensitive to environmental changes in the reef ecosystem even though they may not be able to have accurate assessments of the reef health. The link between tourist aesthetic evaluations and reef health is not obvious, reflected in somewhat various research findings. Marshall, Marshall, and Smith (2017) found a significant correlation between tourist aesthetic assessment and the reef health evaluated by experts, which is, however, not supported by another research (Vercelloni et al., 2018). Therefore, understanding tourists’ aesthetic assessment of environmental changes in the reef ecosystem is crucial in designing effective marketing and conservation messages targeting tourists whose travel intentions and conservation behaviour are motivated by their aesthetic preference (Kirillova et al., 2014; Skibins et al., 2017).

**Aesthetic tourism marketing for the GBR**

The research findings explain why the use of promotional images showing bio-diverse, colourful underwater scenes with high levels of water visibility are effective in attracting tourists to the GBR regions. Tourists travel, in part, because these GBR images are aesthetically appealing. Mass media coverage of coral bleaching events in 2016 and 2017 had negative impacts on the GBR image as well as tourism development in the Reef regions (Prideaux, Carmody, & Pabel, 2017). Our research findings suggest that tourism marketing organisations such as Tourism and Events Queensland should acknowledge coral bleaching while exploiting other aesthetic aspects of the reef such as its marine life or clean/blue sea water. Despite coral bleaching events, the GBR regions remain aesthetically attractive to tourists when marine animals such as colourful fish, turtle remain (Williams & Polunin, 2000).

**GBR aesthetics for conservation planning**

Aesthetic marketing is just a short-term solution to attract tourists, but conservation planning and tourist conservation support are essential for sustainable tourism development in GBR regions. The current research suggests that colourful fish can play the role of flagship animals in encouraging tourist conservation behaviour such as increasing donations to conservation programs and/or reducing waste during a visit to the GBR. Human conservation efforts are frequently motivated by aesthetic preferences, particularly for charismatic megafauna (Brady, 2006; Skibins et al., 2017; Stokes, 2007). Acknowledging human tendency to protect aesthetically pleasing species, World Wide Fund for Nature (WWF) has adopted the panda as a symbol for conservation programs due to its charismatic characteristics (Leader-Williams & Dublin, 2000). The use of panda images attracts mass media coverage and has influenced the development of protected areas in China (Liu et al., 2016). Similarly, the use of “big 5” flagship species is effective
in inspiring tourist conservation behaviour in African parks (Skibins, Powell, & Hallo, 2016). Tourist aesthetic preference for fish, therefore, can positively inspire their conservation intentions to protect fish and its home, the Reef. Conservation messages of the Reef should go beyond the dominant themes of coral bleaching and coral health. It is necessary to direct the audience attention and media storylines to the bigger picture of Reef health: how anthropogenic effects threaten the life of beautiful and charismatic sea animals (such as colourful fish) by destroying their natural habitat. Human empathy (Marsden, 2018) and compassion (Weaver & Jin, 2016) are effective in motivating tourists’ responsible behaviour.

This study highlights the necessity of further conservation initiatives to improve the global quality of the reef ecosystem. Coral restoration programs have been a mainstay in the conservation portfolio of reef management planning all over the world (Van Oppen et al., 2017) and recently adopted in GBR conservation program. The investment in coral restoration is vital to improve the aesthetic value of reef sites for tourism by repairing the natural habitat of marine animals and thus repopulating the area (Prideaux & Pabel, 2018). Biodiversity plays a vital role in delighting tourists with fish as a satisfier factor and coral as a dissatisfier factor (Coghlan, 2012). Hence, conservation programs for the GBR should build on coral restoration programs with expansions for protecting aesthetically attractive species of the reef and controlling sea water quality. Our research can be used to advocate for further governmental support in implementing a more comprehensive conservation planning that secures sustainable tourism development in the GBR regions.

**Conclusion**

This study investigates tourists’ aesthetic assessment of environmental changes in the GBR underwater ecosystem, suggesting how conservation planning should be implemented to achieve sustainable tourism development. Aesthetics can be used as an important criterion of environmental management in order to maintain aesthetically pleasing places, which attract and sustain the number of tourists, with the argument that tourism ultimately supports conservation (Brady, 2006; Liburd & Becken, 2017; Marshall et al., 2017).

Research on the aesthetics of nature-based destinations is an area that needs further examination, providing valuable implication for conservation planning and sustainable tourism development. First, the potential for mutual development between tourism and the fishing industry should be investigated in future research. This study shows that non-colourful fish, which are of high economic value for the fishing industry, does not necessarily contribute to the reef beauty. Further investigation based on the pioneering study by Tribot et al. (2018) to classify aesthetic and ecological functions of GBR fish is necessary for building a multivalue collaborative strategy for tourism, fishing and conservation. Second, the current research shows significant differences between tourists of different age groups in assessing the Reef beauty, suggesting the caution in adjusting conservation messages to target different age groups (Peake, Innes, & Dyer, 2009). Young tourists are more sensitive to coral-changes, and when their age increases, tourist aesthetic assessment of underwater scenery is more sensitive to fish-changes. Future studies can experimentally test different conservation messages and their effects on different tourist age groups. Third, only the visual aspect of tourist aesthetic assessment is investigated in this study, while tourist aesthetic assessment should engage all senses (Kirillova et al., 2014). Future aesthetic research should investigate all sensory aspects of tourist aesthetic evaluations using modern technologies (e.g. virtual reality) or interviews with tourists on site (Johnston & Smith, 2014).

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