The influences of environmental changes on tourist aesthetic assessment of the Great Barrier Reef

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ABSTRACT. Tourists often travel to experience the natural beauty of a destination and as an example, the Great Barrier Reef (GBR) in Australia, attracts millions of tourists every year due to its outstanding underwater beauty. Recently, parts of the GBR have been become degraded from warming sea temperatures and other local anthropogenic influences. These environmental changes in the reef ecosystem may possibly result in negative impacts on tourist perceptions of GBR beauty, which in turn may reduce tourism visitation. In order to address this topical issue, our study applied conjoint analysis method to quantify the impacts of environmental changes on tourist aesthetic assessment. It is found that fish-related changes have more important influences on tourist aesthetic assessment than coral-related changes. Also, four tourist segments with different beauty lenses were identified. Hence, this study provides evidence to support a subjective approach to aesthetic research and suggests implications to improve GBR marketing and conservation programs.

Keywords: aesthetic assessment, conjoint analysis, Great Barrier Reef, natural beauty, World Heritage, tourists.

Introduction
The beauty of a destination is instrumental not only in stimulating travel but also in influencing tourist evaluations of travel experiences (Kirillova, Fu, Lehto, & Cai, 2014). Tourists often search for and use aesthetic information to make a destination choice (Vogt, Fesenmaier, & MacKay, 1994) because appreciation of natural beauty is an important driver for visitation (Awaritefe, 2004; Beh & Bruyere, 2007; Yoon & Uysal, 2005). Hence, aesthetic qualities of a place have been included in destination image research (Echtner & Ritchie, 1993; Kock, Josiassen, & Assaf, 2016; O’Leary & Deegan, 2005) and visitor studies (Hazen, 2009) to explain tourist behaviours. Also, tourist aesthetic assessment of experiences with natural attractions can influence overall
satisfaction and revisit intentions (Chi & Qu, 2008; del Bosque & San Martín, 2008; Lee, Jeon, & Kim, 2011).

Therefore, investigating the determinants of tourist aesthetic judgment is necessary to improve the capacity of effectively managing nature-based attractions such as the Great Barrier Reef (GBR). The GBR is an iconic tourist destination in Australia, which attracts millions of tourists every year (Packer, Ballantyne, & Hughes, 2014). Aesthetic values are the most appreciated aspect of the GBR (Johnston, Smith, & Dyke, 2013). In fact, “beautiful” was the most frequently cited word in a major survey of what first comes to mind about the GBR, according to survey of 9,000 participants by the Social and Economic Long-Term Monitoring Program survey (SELTMP 2013). Survey participants rated the aesthetic values of the GBR higher than economic values (Marshall et al., 2016). Therefore, a decrease in tourist aesthetic assessment of the GBR could negatively influence tourists’ interest in the Reef with implications for both visitation behaviours and Reef protection (Coghlan & Prideaux, 2009).

As a result of anthropogenic effects, environmental changes such as reduced water clarity, declining coral cover, coral bleaching and increased marine debris, have recently impacted the GBR beauty (Great Barrier Reef Marine Park Authority, 2014). This situation raises the question of how these changes affect tourist aesthetic assessment of GBR underwater scenery. Meanwhile, research on tourist aesthetic assessment of water-related environments remains limited (Johnston & Smith, 2014; White et al., 2010) and it is argued that the aesthetics of underwater environments are possibly the least studied of all landscapes (Haas et al., 2015; Tribot et al., 2016).

Against this background, our study aims to address this practical issue in the tourism industry, as well as fill the knowledge gap within the tourism literature. The overarching goal of studying underwater aesthetics of the GBR is achieved by pursuing
three specific aims. Our first aim is to identify key determinants of tourist aesthetic judgment. Advanced technology such as eye-tracking was employed following a comprehensive literature review to select the most relevant aesthetic attributes of GBR underwater scenery. Our second aim is to quantify the influences of environmental changes related to key aesthetic attributes of the Reef on tourist aesthetic judgment. Conjoint analysis, which is a widely-used method in consumer and tourist preference research (Chen, Hsu, & Lin, 2010; Green & Srinivasan, 1990; Suh & McAvoy, 2005), was applied to investigate tourist aesthetic preference for Reef environments. Our third aim is to translate our research findings into practical suggestions for GBR managers to improve marketing and conservation initiatives.

LITERATURE REVIEW

There are two main paradigms in conceptualising beauty: objective versus subjective. The objective approach derives from the 18th century Kantian idea of disinterestedness and picturesque. Objective beauty is inherent in the physical landscape and hence is not subject to an observer’s evaluation (Beardsley, 1975). From this perspective, tourist perception and appraisal of an aesthetic object involve the recognition of its intrinsic, objective beauty (Hagman, 2002). In the 20th century, there was a paradigmatic shift to a subjective understanding of individual aesthetic appreciation and judgment (Todd, 2009). It was posited that the aesthetic judgment of natural beauty varies among the audience because natural landscapes cannot be framed or separated from the viewers (Hepburn, 1966). The subjectivist paradigm regards beauty as a product of the mental processes of the beholders; a response formed based on personal values and beliefs (Kant, 1790; Kirillova et al., 2014). The objectivist paradigm underlies the prior expert surveys of the physical landscape, while the subjectivist paradigm supports studies of observer preferences for objects (Lothian, 1999). These two approaches have been
applied in aesthetic research resulting in the identification of various environmental and individual determinants of human aesthetic assessment.

**Determinants of human aesthetic assessment of natural landscapes**

The literature on human aesthetic assessment of landscapes has flourished since the 1970s and reflected the two beauty paradigms discussed above: the objective stream focusing on environmental factors versus the subjective stream focusing on individual differences. In these studies, human aesthetic assessment and environmental preference are used interchangeably (Kirillova et al., 2014). The objective approach is based on the assumption that there is a significant convergence in human aesthetic judgment (Dinsdale & Mark Fenton, 2006). Environmental factors can explain a significant proportion of human aesthetic preference (Haas et al., 2015). However, from a subjective approach, aesthetic judgment reflecting a human response to a scene involves one’s prior knowledge, experiences, values, emotional state and desires (Datta, Joshi, Li, & Wang, 2006). Hence, individual differences in aesthetic judgment need to be considered.

From an objective approach, the four-domain model of Kaplan, Kaplan, and Brown (1989) is an influential framework used to study environmental determinants in landscape preferences. The model 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 landscape studies adopted this model but focused only on a small number of factors such as naturalness, openness, vegetation or landcover by green plants, water spaces, colour contrast, diversity and human elements (see Table 1). Among these environmental determinants, diversity and naturalness of landscapes are two key factors
which can explain a considerable proportion of changes in viewers’ aesthetic judgments (Frank, Fürst, Koschke, Witt, & Makeschin, 2013).

The objective research stream provides a general picture of human preference of landscape environments. For example, people rate more highly the aesthetics of natural landscapes which have wider views, water spaces, high colour contrast and diversity (Van den Berg, Vlek, & Coeterier, 1998; Yao et al., 2012). The presence of human elements can also have positive or negative impacts depending on how these elements are developed and maintained in harmony with nature (Breiby, 2014; Sevenant & Antrop, 2010).

In contrast, the subjective approach to human aesthetic judgment offers more details on how human aesthetic judgment varies among the audience due to individual characteristics (see Table 1). Specifically, individual familiarity or experiences with judged landscapes (DeLucio & Múgica, 1994; Strumse, 1996; Van den Berg et al., 1998); their profession (Rogge, Nevens, & Gulinck, 2007; Van den Berg et al., 1998); their actual living environment (Sevenant & Antrop, 2010); environmental behaviour and attitudes (DeLucio & Múgica, 1994; Howley, 2011; Howley, Donoghue, & Hynes, 2012; Sevenant & Antrop, 2010) and demographic characteristics, such as age and level of education (Howley et al., 2012; Sevenant & Antrop, 2010; Strumse, 1996) are important factors determining one’s aesthetic judgment.

**Table 1: Determinants of human aesthetic judgment (i.e. landscape preference)**

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturalness/ scenery</td>
<td>(Breiby &amp; Slåtten, 2015; Coeterier, 1996; Frank et al., 2013; Johnston &amp; Smith, 2014; Nassauer, 1995; Sevenant &amp; Antrop, 2010; Strumse, 1996; Van den Berg et al., 1998; van der Jagt et al., 2014)</td>
</tr>
<tr>
<td>Openness/wilderness</td>
<td>(Arriaza et al., 2004; Chen, Sun, Liao, Chen, &amp; Luo, 2016; Coeterier, 1996; Strumse, 1994; Yao et</td>
</tr>
</tbody>
</table>
In the tourism literature, aesthetic judgment of a place has been investigated in a series of articles by Kirillova and colleagues. By revising relevant models of human aesthetic judgment, a more comprehensive model with nine aesthetic factors (scale, time, condition, sound, balance, diversity, novelty, shape and uniqueness) was recently proposed to study tourist aesthetic judgment of a place (Kirillova et al., 2014). These factors were classified along two dimensions: concrete-abstract and objective-subjective and then tested in the context of tourist experiences with a destination (Kirillova, 2015; Kirillova & Lehto, 2016). Among six reconstructed factors (locale characteristics, scope, upkeep, accord, perceived age, and shape), upkeep, accord, and scope were

<table>
<thead>
<tr>
<th>Factor</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation or land cover</td>
<td>(Arriaza et al., 2004; Fyhri et al., 2009; Rogge et al., 2007; Yao et al., 2012)</td>
</tr>
<tr>
<td>Water spaces</td>
<td>(Arriaza et al., 2004; Coeterier, 1996; White et al., 2010)</td>
</tr>
<tr>
<td>Colour or colour contrast</td>
<td>(Arriaza et al., 2004; Chen et al., 2016; Coeterier, 1996; Lindemann-Matthies, Junge, &amp; Matthies, 2010; Yao et al., 2012)</td>
</tr>
<tr>
<td>Diversity or variety or complexity</td>
<td>(Arriaza et al., 2004; Breiby &amp; Slåtten, 2015; Frank et al., 2013; Kirillova et al., 2014; Schirpke, Tasser, &amp; Tappeiner, 2013; Van den Berg et al., 1998; van der Jagt et al., 2014)</td>
</tr>
<tr>
<td>Human elements (i.e. presence, care/ maintenance, cleanliness, disturbance, harmony)</td>
<td>(Arriaza et al., 2004; Breiby, 2014; Coeterier, 1996; Fyhri et al., 2009; Sevenant &amp; Antrop, 2010; van der Jagt et al., 2014; Yao et al., 2012)</td>
</tr>
</tbody>
</table>

**Individual factors**

<table>
<thead>
<tr>
<th>Factor</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiarity and past experiences with judged scenes</td>
<td>(DeLucio &amp; Múgica, 1994; Strumse, 1996; Van den Berg et al., 1998)</td>
</tr>
<tr>
<td>Profession (i.e. locals farmers, local non-farmers and visiting cyclists, experts)</td>
<td>(Rogge et al., 2007; Van den Berg et al., 1998)</td>
</tr>
<tr>
<td>Actual living environment (i.e. aesthetic distance between tourist destination and hometown)</td>
<td>(Kirillova, 2015; Sevenant &amp; Antrop, 2010)</td>
</tr>
<tr>
<td>Environmental behaviour and attitude</td>
<td>(DeLucio &amp; Múgica, 1994; Howley, 2011; Howley et al., 2012; Sevenant &amp; Antrop, 2010)</td>
</tr>
<tr>
<td>Others (age, education level, organisation membership, etc.)</td>
<td>(Howley et al., 2012; Sevenant &amp; Antrop, 2010; Strumse, 1996)</td>
</tr>
</tbody>
</table>

Source: Summarised by the authors
significantly related to tourist aesthetic judgment. Tourist aesthetic assessment of the same place can also differ depending on the aesthetic distance between their home environment and the visited place (Kirillova, 2015).

**Determinants of underwater aesthetics**

Only a limited number of studies have investigated human aesthetic assessment of underwater scenes (Haas et al., 2015). Human preference for underwater scenes has however been studied in relation to marine conservation behaviours (Polak & Shashar, 2013; Stokes, 2007) or human well-being (health improvement) (Cracknell, White, Pahl, & Depledge, 2017; White, Cracknell, Corcoran, Jenkinson, & Depledge, 2014). Underwater scenes were rated similarly to rural, green landscapes in terms of their ability to stimulate aesthetic preference, affective responses, and perceived restoration (White et al., 2014). Indeed, environmental determinants of human aesthetic judgment of underwater scenes are similar to those used in landscape studies. Biodiversity is a key factor that influences human aesthetic judgment of underwater scenery (Tribot et al., 2016). Underwater scenes characterised by species richness and abundance are rated more positively in terms of attractiveness (Cracknell et al., 2017). Fish and coral contribute most to diver enjoyment of reef systems (Uyarra, Watkinson, & Cote, 2009).

In contrast, reduced water visibility due to poor weather can have a significant impact on tourist overall evaluation (Coghlan & Prideaux, 2009). Water quality and coral assemblages have also been identified as important environmental attributes contributing to aesthetic values of GBR underwater beauty (Johnston & Smith, 2014).

On the basis of the literature review, a subjective approach is applied in this study to understand tourist aesthetic assessment of natural underwater scenery (Kirillova et al., 2014; Lothian, 1999). Hence, both environmental factors (diversity,
colour, water quality) and tourist characteristics (gender, age, travel experiences to GBR, and snorkelling or diving experiences) are examined in this study.

**METHODOLOGY**

This study applies conjoint analysis to explore how environmental changes influence tourist aesthetic assessment of the Great Barrier Reef as a typical case of natural underwater scenery. Conjoint analysis methodology has been widely used in consumer research to explore consumer preference for product and service attributes (Green & Srinivasan, 1990), food package design (Ares & Deliza, 2010; Silayoi & Speece, 2007), and website design (Chen et al., 2010). In tourism, conjoint analysis has also been applied to understand tourist preference regarding tourism activities (Dellaert, Borgers, & Timmermans, 1995; Suh & McAvoy, 2005), restaurant services (Koo, Tao, & Yeung, 1999), hotel attributes (Huertas-García, Laguna García, & Consolación, 2014), ski resort attributes (Carmichael, 1996), and travel packages (Chiam, Soutar, & Yeo, 2009). The advantage of conjoint analysis is to quantify the relative importance weights of different attributes that contribute to human preference (Green & Srinivasan, 1990).

The application of conjoint analysis method in this study involved two stages: research design and data collection (Green & Srinivasan, 1978; Suh & McAvoy, 2005). The first stage was to identify key environmental attributes that influence tourist aesthetic judgment of the GBR. Based on a comprehensive literature review and an eye-tracking study, four key attributes of GBR aesthetics were selected and manipulated by Photoshop to design different aesthetic scenery combinations. In the second stage, a survey with a big sample size (705 participants) was conducted to test respondents’ aesthetic assessment toward these designed combinations.
Stage 1: Research design

This stage involved the selection of key aesthetic attributes and the design of different attribute combinations for testing. After the literature review, eye-tracking technology was employed to examine key aesthetic attributes in the context of 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 deemed effective in identifying important visual attributes of GBR underwater scenes (Scott, Le, Becken, & Connolly, under review). In the eye-tracking study, 66 participants were recruited to assess 21 GBR pictures on a 10-point aesthetic scale (1-Not beautiful at all, 10-Extremely beautiful) and rate an area of interest (the area that attracts their attention the most) on the same scale.

Some key findings of the eye-tracking study were as follows. First, a strong correlation between picture beauty and the beauty of the main area of interest in the picture was found. Second, the areas of interest in these pictures were turtle, coral, fish and human elements. Third, colourful pictures were rated more beautiful than less colourful pictures, and colourful features were rated more beautiful than less colourful features (Scott et al., under review). The eye-tracking experiment confirmed the role of diversity, water quality and colour in determining tourist aesthetic assessment (Arriaza et al., 2004; Chen et al., 2016; Cracknell et al., 2017; Johnston & Smith, 2014; Tribot et al., 2016; Yao et al., 2012). Turtle, coral and fish were considered as key aesthetic attribute of the GBR.

Following the eye-tracking experiment, it was assumed that the presence of a beautiful object such as turtle or fish could significantly improve the beauty of GBR underwater scenes. This hypothesis was tested in a preliminary study. The image of a swimming turtle was added to two overtly unattractive GBR scenes (dead coral) used in the previous eye-tracking experiment (see Figure 1). These pictures were each rated by
six new participants. While the Picture 1 was still considered as an ugly one with an average score of 3 out of 10-point beauty scale, the average beauty score of Picture 2 increased from 3.6 for the original picture (without turtle) to 7 out of 10-point beauty scale. The reason was revealed in the after-rating interviews with participants, Picture 1 looked fake (Most participants said “It must be photoshopped”) while Picture 2 looked natural/ original in their opinion. This pilot test highlighted the importance of using carefully-photoshopped images in aesthetic research.

![Photoshopped Picture 1](image1) ![Photoshopped Picture 2](image2)

**Figure 1: Photoshopped pictures in the preliminary test of Great Barrier Reef aesthetics.**

Building on the literature review and this eye-tracking research outcome, three main environmental factors (biodiversity, water quality and colour) were selected for further examination. Fish, coral, turtle and colour were key attributes to be manipulated. Biodiversity was examined by the presence or absence of coral and marine species (turtle and fish). The influence of colour was tested by two ways: (1) colour attributes (colourful versus non-colourful fish and coral) and (2) picture colour contrast (high versus low) which partly reflected water visibility. High colour contrast related to a high level of water visibility and low colour contrast represented a low level of water visibility. In brief, four environmental attributes (colour, coral, fish and turtle) were manipulated as follows: picture colour contrast (high versus low), coral (no coral, non-colourful coral, colourful coral); fish (no fish, non-colourful fish, colourful fish); turtle
(presence versus absence). These four attributes and their levels give rise to 24 possible combinations (2 x 3 x 3 x 2).

As conjoint analysis produces information overload on respondents for a larger number of attribute combinations (Green & Srinivasan, 1990), the Orthoplan subroutine in SPSS was used to produce an orthogonal main-effects design, which ensures the absence of multi-collinearity between attributes (Silayoi & Speece, 2007). Following nine attribute combinations recommended by SPSS Orthoplan, nine pictures were designed by Photoshop (Figure 2). Environmental attributes for manipulation (fish, coral, turtle) were selected from four GBR original pictures downloaded from the Tropical Tourism North Queensland website. In order to avoid possible bias, potential environmental determinants of tourist aesthetic judgment such as openness, naturalness, human elements, were kept similar in these nine photoshopped pictures. Ten experts reviewed the material and provided feedback on nine photoshopped pictures until they were considered natural.
Stage 2: Data collection

The authors designed an online survey including three main sections using the Qualtrics\(^1\) platform. After completing Section 1, which contained demographic questions (such as gender, age), participants were asked to rank nine photoshopped pictures from the most beautiful picture (Ranked 1) to the least beautiful picture (Ranked 9) in Section 2. The nine pictures were shown to participants in random order to avoid any bias related to picture positions. At the end of the survey (Section 3), participants were invited to answer an open-ended question on determinant factors of

\(^1\) Qualtrics is a well-known company providing online survey platform and survey service (www.qualtrics.com)
their aesthetic judgment ("From your point of view, what are the factors that make a picture of Great Barrier Reef beautiful?"). Respondents also completed two questions related to their travel experiences to the Great Barrier Reef, and diving and snorkelling experiences.

The survey was launched online in October 2017 targeting Australians. A total of 705 survey completions were recorded. Participants were evenly distributed among six age groups: 12.5% were between 18 and 24 years old; 19.9% were between 25 and 24 years old; 17.7% were between 35 and 44 years old; 17.0% were between 45 and 54 years old; 15.5 were between 55 and 54 years old; and 17.4% were above 65 years 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. Data were imported into IBM SPSS statistics software (version 24) for conjoint analysis.

RESULTS

Aesthetic attributes of GBR underwater scenes
The conjoint analysis results indicated that the presence of fish was the most important attribute in determining tourist aesthetic judgment. The relative importance weight (importance value) of fish in determining tourist aesthetic assessment was the highest (32%) (Table 2). This meant that the presence of fish made the greatest impact on participants’ aesthetic assessment. Coral was the second most important attribute (25.1%), followed by colour contrast (22.23%) and the presence of a turtle (20.64%).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Level</th>
<th>Utility score</th>
<th>Importance value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>No fish</td>
<td>-1.191</td>
<td>32.03</td>
</tr>
</tbody>
</table>
Utility scores provide more detail on how environmental changes influence respondents’ aesthetic judgment. A positive score means positive influence on respondents’ aesthetic judgment, while a negative score represents a negative influence (Green & Srinivasan, 1978). Based on positive utility scores, colourful fish, colourful coral, the presence of turtle and high colour contrast contributed positively to a GBR picture beauty (Table 2). Non-colourful coral scored a nearly neutral utility (0.043), which suggests that in general the presence of non-colourful coral (dead or bleaching coral) may not necessarily have negative impacts on tourist aesthetic judgment. In contrast, non-colourful fish had a negative utility (-0.63). This shows that the presence of non-colourful fish in GBR pictures may be negative. The utility scores for turtle, fish and coral absence were negative, clearly stating that species richness plays an important role in determining tourist aesthetic judgment. Hence, GBR pictures showing underwater sceneries with colourful species and good water quality would be considered as beautiful.

**Individual differences in aesthetic judgment**

We tested whether socio-demographic characteristics (age, gender) and familiarity with the scenery (GBR experiences and diving and snorkelling experiences) could affect tourist aesthetic assessment of underwater scenes. ANOVA were performed to determine the influence of the four variables (age, gender, travel experiences, and
diving and snorkelling experiences) on how potential visitors evaluate GBR sceneries (see Table 3). Fish-related changes played a more important role in determining older participants’ aesthetic assessment because the relative importance weight of the fish attribute increased in accordance with participant age. In contrast, the relative importance weight of coral went in opposite direction with age, this reflected the fact that younger respondents were more concerned about coral-related changes in evaluating GBR aesthetics. Interestingly, those respondents who had previously visited the GBR one or two times, attributed a lower importance weight to coral attributes when assessing GBR beauty, than very experienced visitors (visited GBR more than three times) or people who had never been to GBR.

### Table 3: ANOVA results on the relative importance weights of four beauty attributes among respondents (%).

<table>
<thead>
<tr>
<th>Age</th>
<th>Contrast Mean</th>
<th>Sig.</th>
<th>Fish Mean</th>
<th>Sig.</th>
<th>Coral Mean</th>
<th>Sig.</th>
<th>Turtle Mean</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24 years old</td>
<td>23.90</td>
<td>0.474</td>
<td>27.32</td>
<td></td>
<td>29.24</td>
<td></td>
<td>19.51</td>
<td></td>
</tr>
<tr>
<td>25-34 years old</td>
<td>22.25</td>
<td></td>
<td>29.36</td>
<td></td>
<td>27.73</td>
<td></td>
<td>20.66</td>
<td></td>
</tr>
<tr>
<td>35-44 years old</td>
<td>22.34</td>
<td></td>
<td>30.88</td>
<td></td>
<td>26.20</td>
<td></td>
<td>20.58</td>
<td></td>
</tr>
<tr>
<td>45-54 years old</td>
<td>22.37</td>
<td></td>
<td>33.77</td>
<td></td>
<td>23.91</td>
<td></td>
<td>19.94</td>
<td></td>
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<tr>
<td>55-64 years old</td>
<td>21.62</td>
<td></td>
<td>34.76</td>
<td></td>
<td>21.75</td>
<td></td>
<td>21.85</td>
<td></td>
</tr>
<tr>
<td>65+ years old</td>
<td>21.28</td>
<td></td>
<td>35.51</td>
<td></td>
<td>22.13</td>
<td></td>
<td>21.06</td>
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<table>
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<th>Gender</th>
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<tr>
<td>Male</td>
<td>22.13</td>
<td></td>
<td>32.17</td>
<td></td>
<td>24.99</td>
<td></td>
<td>20.70</td>
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<tr>
<td>Female</td>
<td>22.32</td>
<td></td>
<td>31.90</td>
<td></td>
<td>25.20</td>
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<td>20.56</td>
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<td>Other</td>
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<td>27.28</td>
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<td>22.72</td>
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<th>Orth</th>
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<tbody>
<tr>
<td>Never</td>
<td>22.34</td>
<td></td>
<td>31.82</td>
<td></td>
<td>25.85</td>
<td></td>
<td>19.98</td>
<td></td>
</tr>
<tr>
<td>One or two times</td>
<td>22.43</td>
<td></td>
<td>32.33</td>
<td></td>
<td>23.48</td>
<td></td>
<td>21.75</td>
<td></td>
</tr>
<tr>
<td>More than 3 times</td>
<td>20.41</td>
<td></td>
<td>32.21</td>
<td></td>
<td>27.01</td>
<td></td>
<td>20.63</td>
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<th>Orth</th>
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<tbody>
<tr>
<td>Never</td>
<td>22.45</td>
<td></td>
<td>32.69</td>
<td></td>
<td>24.77</td>
<td></td>
<td>20.07</td>
</tr>
<tr>
<td>One or two times</td>
<td>22.44</td>
<td></td>
<td>31.61</td>
<td></td>
<td>24.63</td>
<td></td>
<td>21.30</td>
</tr>
<tr>
<td>More than 3 times</td>
<td>20.68</td>
<td></td>
<td>30.32</td>
<td></td>
<td>27.75</td>
<td></td>
<td>21.23</td>
</tr>
</tbody>
</table>

Note: Significant factors are marked by grey shading.
* Significant at 0.01 level
** Significant at 0.05 level
Tourist segmentation by aesthetic assessment

As age and GBR experiences differentiate respondents’ aesthetic judgment, it may exist several visitor segments who assess the beauty of GBR underwater scenes in different ways. Hence, cluster analysis was performed using the relative importance weights of the four tested aesthetic attributes (fish, coral, turtle, and colour contrast). Among different options, the four-cluster solution provided the best fitting model interpretation (see Figure 3). Cluster 2 was the biggest segment containing 309 participants (43.8% of the sample). This cluster was named “diversity preference” as the relative importance weights were of similar values for all four beauty attributes. The remaining sample was divided into three segments of similar size (from 16.9% to 20.1%) and labelled depending on the highest importance score attribute: coral preference (Cluster 1), fish preference (Cluster 3) and turtle preference (Cluster 4).

Figure 3: Relative importance weights of Great Barrier Reef beauty attributes by four segments.

ANOVA analysis was performed to examine differences between these segments regarding utility scores. All utility scores for aesthetic attribute levels
significantly vary among four identified tourist segments (see Table 4). In particular, non-colourful coral had an ambiguous impact on tourist aesthetic judgment across four potential visitor segments. Coral in an unhealthy state (non-colourful coral) had a negative influence on the aesthetic judgment of tourists in fish preference and turtle preference groups. In contrast, utility scores for non-colourful coral were positive in the case of tourists in diversity preference and coral preference groups. This may explain why the average utility score of non-colourful coral for the whole sample was relatively neutral.

### Table 4: Utility scores of beauty attributes by four segments

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Attribute level</th>
<th>Diversity preference (n=309; 43.8%)</th>
<th>Coral preference (n=142; 20.1%)</th>
<th>Fish preference N= 135; 19.1%</th>
<th>Turtle preference (n=119; 16.9%)</th>
<th>All respondents (n=705)</th>
<th>ANOVA Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast</td>
<td>Low</td>
<td>-1.38</td>
<td>-0.79</td>
<td>-0.924</td>
<td>-1.00</td>
<td>-1.114</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>1.38</td>
<td>0.79</td>
<td>0.92</td>
<td>1.00</td>
<td>1.114</td>
<td></td>
</tr>
<tr>
<td>Fish</td>
<td>No fish</td>
<td>-1.2427</td>
<td>-0.56</td>
<td>-1.87</td>
<td>-1.04</td>
<td>-1.191</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Non-colourful fish</td>
<td>-0.6807</td>
<td>-0.32</td>
<td>-0.86</td>
<td>-0.61</td>
<td>-0.630</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colourful fish</td>
<td>1.92</td>
<td>0.87</td>
<td>2.73</td>
<td>1.65</td>
<td>1.822</td>
<td></td>
</tr>
<tr>
<td>Coral</td>
<td>No coral</td>
<td>-1.08</td>
<td>-2.01</td>
<td>-0.41</td>
<td>-0.71</td>
<td>-1.080</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Non-colourful coral</td>
<td><strong>0.016</strong></td>
<td><strong>0.28</strong></td>
<td><strong>-0.79</strong></td>
<td><strong>-0.34</strong></td>
<td><strong>0.043</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colourful coral</td>
<td>1.067</td>
<td>1.73</td>
<td>0.49</td>
<td>0.75</td>
<td>1.037</td>
<td></td>
</tr>
<tr>
<td>Turtle</td>
<td>No turtle</td>
<td>-0.85</td>
<td>-0.75</td>
<td>-1.00</td>
<td>-1.01</td>
<td>-1.012</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Turtle presented</td>
<td>0.85</td>
<td>0.75</td>
<td>1.00</td>
<td>1.76</td>
<td>1.012</td>
<td></td>
</tr>
</tbody>
</table>

Finally, demographic characteristics of respondents across the four visitor segments were examined (Table 5). As respondent age moderated how potential visitors evaluated GBR beauty (see Table 2), age was also related to a respondent’s segment profile. Those in the fish preference segment were more likely to be aged over 45 years old (70.4%) while those in coral preference group is more likely to be younger (nearly 62% of coral preference participants were under 45 years old). There was a fairly balanced distribution of participant ages in diversity preference and turtle preference segments.

### Table 5: Demographic profiles of four potential visitor segments
Diversity preference (n=309; 43.8%)  
Coral preference (n=142; 20.1%)  
Fish preference (n= 135; 19.1%)  
Turtle preference (n=119; 16.9%)  
All tourists (n=705)  

<table>
<thead>
<tr>
<th>Age</th>
<th>Diversity preference</th>
<th>Coral preference</th>
<th>Fish preference</th>
<th>Turtle preference</th>
<th>All tourists</th>
<th>ANOVA Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24 years old</td>
<td>12.9</td>
<td>21.1</td>
<td>2.2</td>
<td>12.6</td>
<td>12.5</td>
<td>0.000</td>
</tr>
<tr>
<td>25-34 years old</td>
<td>21.0</td>
<td>23.2</td>
<td>14.1</td>
<td>19.3</td>
<td>19.9</td>
<td></td>
</tr>
<tr>
<td>35-44 years old</td>
<td>19.1</td>
<td>17.6</td>
<td>13.3</td>
<td>19.3</td>
<td>17.7</td>
<td></td>
</tr>
<tr>
<td>45-54 years old</td>
<td>16.8</td>
<td>16.2</td>
<td>20.7</td>
<td>14.3</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>55-64 years old</td>
<td>15.2</td>
<td>10.6</td>
<td>23.0</td>
<td>13.4</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>65+ years old</td>
<td>14.9</td>
<td>11.3</td>
<td>26.7</td>
<td>21.0</td>
<td>17.4</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.913</td>
</tr>
<tr>
<td>Male</td>
<td>48.2</td>
<td>50.7</td>
<td>47.4</td>
<td>50.4</td>
<td>48.9</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>51.5</td>
<td>49.3</td>
<td>52.6</td>
<td>49.6</td>
<td>50.9</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td><strong>Travel experiences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.160</td>
</tr>
<tr>
<td>Never</td>
<td>59.2</td>
<td>60.6</td>
<td>56.3</td>
<td>47.9</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>One or two times</td>
<td>34.0</td>
<td>31.7</td>
<td>37.8</td>
<td>42</td>
<td>35.6</td>
<td></td>
</tr>
<tr>
<td>More than 3 times</td>
<td>6.8</td>
<td>7.7</td>
<td>5.9</td>
<td>10.1</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td><strong>Diving or snorkelling experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.077</td>
</tr>
<tr>
<td>Never</td>
<td>55.0</td>
<td>49.3</td>
<td>58.5</td>
<td>48.7</td>
<td>53.5</td>
<td></td>
</tr>
<tr>
<td>One or two times</td>
<td>35</td>
<td>33.1</td>
<td>31.9</td>
<td>35.3</td>
<td>34.0</td>
<td></td>
</tr>
<tr>
<td>More than 3 times</td>
<td>10</td>
<td>17.6</td>
<td>9.6</td>
<td>16.0</td>
<td>12.5</td>
<td></td>
</tr>
</tbody>
</table>

Note: Significant factors are marked by grey shading.

**Confirmatory qualitative study of GBR aesthetic attributes**

Respondents in our survey were asked to answer an open-ended question at the end of the survey (“From your point of view, what are the factors that make a picture of Great Barrier Reef beautiful?”) in order to gain greater insight of potential visitors’ aesthetic assessment (multiple responses accepted). All participant answers were recorded and transcribed 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 & 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, Zhang, Le, & Moyle, 2017; Tseng, Wu, Morrison, Zhang, & Chen, 2015).
Following these steps, a concept map representing five major themes was developed. These five themes were classified in order of importance: 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). Three of these factors (colours, diversity of marine features, and water quality) were specifically tested in this study. Water quality was partly examined through colour contrast (high versus low) and key attributes such as coral, fish, and turtle were also included.

Figure 4: Thematic analysis of participants’ beauty factors for the Great Barrier Reef.
DISCUSSION

**Determinants of tourist aesthetic assessment of the reef**

In this study, four underwater attributes (fish, coral, turtle, colour contrast) were manipulated by Photoshop to represent different combinations of GBR underwater sceneries. Conjoint analysis was performed to quantify their relative importance weights of these attributes in determining tourist aesthetic judgment. Unsurprisingly, it is found that biodiversity plays an important role in determining the reef beauty. The absence of any sea features (fish, turtle, coral) negatively influenced respondents’ aesthetic assessment (see Table 2). In general, respondents showed an aesthetic preference for underwater scenes with species richness. This finding is consistent with earlier studies of underwater aesthetics (Cracknell et al., 2018; Cracknell et al., 2017; Polak & Shashar, 2013; Tribot et al., 2016; White et al., 2017), destination aesthetics (Kirillova et al., 2014) and landscape preference research (Breiby & Slätten, 2015; Frank et al., 2013; van der Jagt, Craig, Anable, Brewer, & Pearson, 2014). Fish and coral which contributed the most to divers’ enjoyment of the reef (Uyarra et al., 2009) are also the two most important attributes of GBR aesthetics in this study.

Moreover, colour and water visibility had significant effects on tourist aesthetic judgment. On the one hand, the presence of colourful fish and coral improved the beauty of GBR images. This finding is supported by evidence of human preference for brightly colourful objects (Heerwagen & Orians, 1993; Junge, Jacot, Bosshard, & Lindemann-Matthies, 2009; Lindemann-Matthies & Bose, 2007). 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 in GBR pictures can increase viewers’ aesthetic assessment (Scott et al., under review). On the other hand, picture colour contrast, which aimed to reflect water visibility, had a
significant influence on tourist aesthetic assessment. The role of water visibility in determining tourist aesthetic assessment is also confirmed in another study of the GBR (Marshall et al., In press). Our research findings could help to explain why reduced water visibility had a negative impact on tourist satisfaction of GBR visit (Coghlan & Prideaux, 2009).

Specifically, the most important attribute of the GBR aesthetics in our study was fish. Human appreciation of fish species beyond simply keeping fish as a source of food has been well recorded (Bridges, 1970; Cracknell et al., 2018). The desire to engage with fish is a key reason explaining why people have fish tanks at home and have regular visits to aquaria (Gusset & Dick, 2011). Fish encounters deliver psychological benefits such as calming, relaxation, and stress-reduction effects (Kidd & Kidd, 1999; Langfield & James, 2009); as well as physiological benefits such as nutrition and health improvement (Edwards & Beck, 2002; Katcher, Friedman, Beck, & Lynch, 1983).

Coral was found as the second most important aesthetic attribute of the GBR. Most research has proven that the health and resilience of reef are important determinants of GBR aesthetics (Coghlan & Prideaux, 2009). The reef is studied through distinct lenses, from being immersed underwater and intimately connecting with marine life, to flying above and witnessing the panorama of patterns of reefs, water, and islands (Johnston & Smith, 2014). Our research finding is supported by studies indicating human preference for fish over coral (Leujak & Ormond, 2007; Polak & Shashar, 2013; Williams & Polunin, 2000). However, the opposite trend (human preference for coral over fish) has also been recorded (Shafer & Inglis, 2000). These contradictory findings in aesthetic research regarding human preference for fish and coral may be explained by individual differences. It is found in our study that respondents’ age is related to their preference toward fish and coral (see table 3).
As a subjective approach to tourist aesthetic judgment was applied in this study, individual differences regarding demographic characteristics (age, gender) and past experiences (travel experiences to GBR and diving and snorkelling experiences) were considered. There were no differences between males and females in assessment the GBR aesthetics. Age had an important influence on tourist aesthetic judgment. Older tourists were more likely to belong to a “fish preference” group and attached a higher importance weight to fish when assessing GBR beauty. In contrast, coral changes had a stronger impact on younger tourists’ aesthetic judgment. The role of age in differing individual aesthetic judgment has been reported in other studies (Howley, 2011; Howley et al., 2012; Sevenant & Antrop, 2010; Strumse, 1996).

Indeed, tourist travel experiences to GBR (their familiarity with GBR), also moderated coral preference in tourist aesthetic assessment. In comparison with other groups (potential visitors and experienced visitors who have more than three times visiting the GBR), visitors who have been to the GBR once or twice attributed a lower important weights to coral while evaluating the GBR aesthetics. Our finding confirms the role of tourist familiarity with the scene in differing tourist aesthetic preference (DeLucio & Múgica, 1994; Strumse, 1996; Van den Berg et al., 1998). Tourist familiarity should be considered in future aesthetic research as a segmentation criteria.

**Practical implications for GBR aesthetics management**

Our study has important implications for GBR marketing and conservation programs. It provides more evidence to confirm that biodiversity of the GBR ecosystem has a potent influence on tourist aesthetic judgment. GBR is famous for its outstanding reef, which is home to various types of sea animals. Among these aesthetic attributes, fish-related changes may have stronger impacts on tourist aesthetic assessment than coral changes,
in particular for older tourists. From the tourist point-of-view, “a coral reef without fish is like a playground without the laughter” (Marshall et al., In press, p. 24).

Therefore, colourful fish can play the role of flagship animals in promoting GBR aesthetics and conservation behaviours thanks to its charismatic characteristics (Marshall, Marshall, & Smith, 2017; Skibins, Dunstan, & Pahlow, 2017). The reason is because conservation efforts are frequently motivated by people’s aesthetic preferences, particularly for charismatic megafauna. Tourist aesthetic preferences may influence their intention to value and protect some species or groups of animals (Brady, 2006; Stokes, 2007). Therefore, images of colourful fish should be used more frequently in GBR promotion materials (including website, pictures, and videos) in order to attract tourists to GBR as well as to encourage their conservation behaviours on site.

Obviously, fish and other sea animals could not survive when their home (the reef) is damaged (Great Barrier Reef Marine Park Authority, 2014). Therefore, GBR conservation messages should highlight how anthropogenic effects threaten the life of beautiful and charismatic sea animals (such as colourful fish) by harming their natural habitat.

Our research raises the importance of incorporating tourist aesthetic assessment into environmental management. Even though tourists may not be able to have accurate assessments of the reef health, they are sensitive to changes in the reef beauty. Tourism industry may benefit from the fact that tourist might not notice how badly the reef is affected by anthropogenic effects in the short-term. However, environmental changes related to the reef health, such as the loss of coral cover, the disappearance of fish and sea animals or reduced water quality, can negatively influence tourist aesthetic judgment in the long-term. It exists a significant correlation between tourist aesthetic assessment and the reef health evaluated by experts (Marshall et al., 2017). Therefore,
aesthetics could be used as a conservation planning criterium in order to maintain aesthetically pleasing places, which attract and sustain the number of tourists, with the argument that tourism ultimately supports conservation (Liburd & Becken, 2017; Brady, 2006; Marshall et al., 2017).

**Limitations and potential research directions**

This study is subject to several limitations which should be addressed in future research. First, only four beauty attributes were examined in this study. Future studies should investigate other aesthetic factors identified in the literature review such as naturalness, abundance and richness of coral and marine animals, and human elements to provide a more comprehensive understanding of tourist aesthetic judgments. Second, only three types of marine features, coral, fish and turtles, were included in this study, but other charismatic species including sharks, dolphins or giant clams should be considered in future studies (Jefferson, Bailey, Richards, & Attrill, 2014).

Third, our research studied tourist aesthetic assessment of the GBR, which is a typical example of tropical water. However, human aesthetic assessment of temperate water would be very different and should be subject of investigation in future research. For example, respondents demonstrated an aesthetic preference for images of temperate water sceneries with low species richness (Cracknell et al., 2017). Hence, diversity may not be an important determinant of tourist aesthetic assessment in the context of temperate water.

Fourth, future aesthetic research should apply a subjective approach and consider more individual factors. In our study, respondents’ age differentiated “fish preference” tourists from other segments (diversity preference, coral preference, and turtle preference), it remains unclear which factors lead to differences in tourist aesthetic judgment among these segments. It would be necessary to test other individual factors
such as respondents’ profession (Rogge et al., 2007; Van den Berg et al., 1998); actual living environment (Kirillova, 2015; Sevenant & Antrop, 2010); environmental behaviour and attitude (DeLucio & Múgica, 1994; Howley, 2011; Howley et al., 2012; Sevenant & Antrop, 2010), and demographic characteristics (such as education level, nationality, and organisation membership) (Howley et al., 2012; Sevenant & Antrop, 2010; Strumse, 1996) to explain the formation of different visitor aesthetic segments. This research direction can result in interesting implication related to tourist segmentation for marketing and conservation purpose.

Fifth, cross-culture research on tourist aesthetic judgment is another potential research direction. As only Australian respondents were recruited in this study, respondents’ cultural backgrounds have not been examined. However, tourist aesthetic assessment, which is considered as a human reaction towards aesthetic scenery, can vary across cultures (Hekkert & Leder, 2008). For example, tourists from different cultural backgrounds have different attitudes toward nature, animals and environmental issues (Packer et al., 2014) which, in turn, influence their aesthetic judgment of the same scenery (DeLucio & Múgica, 1994; Howley, 2011; Howley et al., 2012; Sevenant & Antrop, 2010).

Finally, this study focuses only on the visual aspects while tourist aesthetic assessment should engage all senses (Kirillova et al., 2014). The aesthetic values of GBR should be studied beyond visual aspects and include all sensory aspects in future studies (Johnston & Smith, 2014). The use of modern technologies such as video and virtual reality to engage more senses in aesthetic research can expand our knowledge of tourist aesthetic judgment. Tourist interviews on site may be another effective way to explore tourist aesthetic assessment and appreciation.

CONCLUSION
Our study aims to address a topical issue in the tourism industry as well as to fill a research gap in the aesthetic research literature. One the one hand, environmental changes are threatening nature-based attractions such as the GBR. Hence, it is necessary to investigate how environmental changes could influence tourist aesthetic assessment of the GBR for both destination marketing and conservation purposes. On the other hand, there is still limited understanding of human aesthetic assessment toward underwater sceneries despite a rich volume of landscape aesthetic research. Our research contributes to expand our knowledge in this area.

By applying conjoint analysis, our study can quantify the influences of environmental changes on tourist aesthetic assessment. Due to resource limitations, only four aesthetic attributes (fish, coral, turtle, and colour contrast) were studied, but future aesthetic research of underwater scenery could investigate a broader suite of attributes. As fish-related changes have stronger influences on tourist aesthetic assessment than coral changes, colourful fish images should be used more frequently in designing marketing and conservation messages for the Great Barrier Reef.

Our results support a subjective approach to aesthetic research: tourist aesthetic assessment is complex and depends on one’s innate aspects regarding biological/evolutionary mechanisms, cultural influences, and learning histories (Bourassa, 1990; White et al., 2014). Individual factors such as age and familiarity with the scenes are found to explain differences in tourist aesthetic assessment of the GBR scenery. Other individual factors should be investigated in future research to have a more comprehensive understanding of tourist aesthetic assessment.

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