



Assessing perceived crowding of diving sites in Hong Kong



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ARTICLE INFO

Article history:

Received 5 February 2015

Received in revised form

25 June 2015

Accepted 27 July 2015

Available online 4 August 2015

Keywords:

Social carrying capacity

Crowding

Scuba diving

Marine tourism

ABSTRACT

This study has explored perceived crowding of an underwater environment. Two dimensions were assessed: the number of divers seen and the proximity of divers to each other. Data were obtained from a survey of 216 divers who undertook diving in Hong Kong during 2013–14. Photographs depicting four levels of crowding (number of divers) and four levels of diver proximity in different combinations were shown to the respondents for assessing acceptability. Between the two variables, the “number of divers” was the most influential factor to divers’ perceived crowding. Divers’ begin to feel unacceptably crowded if 7–8 divers are visible to them at one time. Based on this, it is likely that the usage of Hong Kong diving sites has already exceeded its social carrying capacity. Implications for future research and diving tourism management for Hong Kong diving sites are also discussed in the paper.

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1. Introduction

Reef based tourism has grown rapidly and attracts millions of people for underwater activities. As an important economic activity (Musa et al., 2006), reef based tourism accounts for more than 15% of gross domestic product in at least 23 countries and territories (Burke et al., 2011). Based on the Professional Association of Dive Instructors (PADI), the world’s largest diving training organization, at least 30 million people have been certified as competent to dive worldwide and over 900,000 new certifications have been added to active divers every year since 2001 (PADI, 2014). As the scuba diving industry grows, much research has been carried out on its impacts. But previous studies have mostly looked only at environmental issues (e.g., Hawkins and Roberts, 1992; Rouphael and Inglis, 1997, 2001; Tratalos and Austin, 2001) rather than managerial and social issues. Previous studies covering Hong Kong have assessed divers’ behaviours and the impact on coral reefs in Hong Kong diving sites and have found that divers in Hong Kong come in contact with marine biota 14.7 times and there is a significant positive correlation between the number of broken coral colonies and the number of divers visiting the site (Chung et al., 2013; Au et al., 2014). However no previous study seems to have addressed the issues of perceived crowding and social carrying capacity from divers’ perspective. According to Stankey and McCool (1984), social

carrying capacity is a management or planning tool that can be implemented to maintain or restore the appropriate and acceptable social conditions of a specific area based on management objectives. Later, Shelby and Heberlein (1987) reckon that crowding is potentially a better evaluative standard than satisfaction because perceived crowding is related specifically to the number of people present. This study, therefore, applies the concept of perceived crowding in defining and managing social carrying capacity of Hong Kong diving sites. Knowledge on the crowding perception of Hong Kong divers and the associated social carrying capacity can inform diving sites operators in Hong Kong on striking a balance between marine conservation and profitability, i.e., the sustainable development of diving tourism.

1.1. Perceived crowding

In 1979, Schmidt and Keating (1979) developed the concept of crowding in their social interference theory. They defined crowding as actual or perceived levels of use which, if exceeded, an individual might consider unacceptable. In order to emphasize an individual’s subjective assessment of permissible density for specific environments, the term “perceived crowding” was proposed (Shelby and Heberlein, 1987). They stated that when people evaluate an area as crowded, they implicitly compared the experienced with their perceptions of standard permissible crowding. They then argued that perceived crowding combined descriptive information (the density or encounter level experienced by the individual) and evaluative information (the density or encounter level negatively

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evaluated by the individual) and usually measured it by self-reporting techniques. This study adopts [Shelby and Heberlein's \(1987\)](#) definition of perceived crowding which has been used in many empirical studies. In sum, perceived crowding in recreational settings is based upon the social densities and individuals' subjective perceptions in various settings. Perceived crowding in an underwater environment is the focus of this paper.

1.2. Factors influencing perceived crowding

Many studies have since been conducted to investigate when, where and why crowding occurs. It is found that the experience of crowding can be affected by number or density of visitors, the type of activities, the spatial interaction or behaviour of visitors and visitors' personalities ([Heberlein and Vaske, 1977](#); [Gramann and Burdge, 1984](#); [Ryan and Cessford, 2003](#)). [Manning et al. \(1996\)](#) used two distance zones (e.g. the foreground and the midground) to evaluate visitors' perceived crowding and the results showed that the proximity of others to the visitor was more likely to lead to the sense of crowding to unacceptable levels felt by visitors. Among these factors, this paper focuses on two most relevant factors to scuba diving, number and proximity of divers and how they influence divers' perceived crowding in an underwater environment.

1.3. Crowding and social carrying capacity

It is difficult to estimate the social carrying capacity of a diving site. [Vaske and Donnelly \(2002\)](#) provide a detailed description of the use of perceived crowding as an evaluative standard of social carrying capacity. They argue that when people judge an area as crowded, they implicitly compare the condition they experience (i.e., impacts) with their perception of what is acceptable (i.e., standards). If they conclude that the area is crowded, it will appear that the existing conditions have already exceeded their standards and that an area may have been carrying more than its capacity. [De Ruyck et al. \(1997\)](#) similarly assert that social carrying capacity is essentially a measure of perceived tolerance of crowding. They define social carrying capacity as the maximum visitor density at which recreationists feel comfortable and uncrowded. The concept of perceived crowding has been widely used as an evaluation criterion for assessing social carrying capacity ([De Ruyck et al., 1997](#); [Vaske and Donnelly, 2002](#)). In another study where perceived crowding is used to define the social carrying capacity of Alcatraz Island ([Manning et al., 2002](#)), a range of daily carrying capacities (from approximately 2500 visitors per day to approximately 4800 visitors per day) for this Island is established. However, crowding is but one of the many variables that may influence divers' satisfaction and their willingness to return to a specific site. Other valid factors include the quality of the coral or fish ([Gazy et al., 2004](#)), the underwater natural scenery ([Musa et al., 2006](#)) and underwater visibility ([McCarthy et al., 2006](#)). However, other things being equal, number of visitors theoretically begins to decline when it goes beyond the maximum tolerable visitor density.

1.4. Crowding in marine environments

Only a limited number of studies have investigated perceived crowding in marine environments in contrast to the large mass of literature on the application of this concept in terrestrial settings. [Davis and Tisdell \(1996\)](#) were among the first to take note of divers' crowding problems and reckoned that there were two possible types of thresholds—biological and crowding thresholds. [Inglis et al. \(1999\)](#) later discovered that scuba divers' crowding evaluations were significantly influenced by the number of people in the images, prior experience and gender of the respondents, and the

presence of safety infrastructure. [Shafer and Inglis \(2000\)](#) also found that the number of people on boats and snorkeling in the water had the least positive influence on snorkelers' enjoyment of the trip. [Lankford et al. \(2008\)](#) conducted a carrying capacity study in Hanauma Bay, Hawai'i, and the results showed that perceived crowding was significantly correlated with the use level, which in Hanauma Bay had already exceeded its capacity. [Szuter et al. \(2011\)](#) first explored the factors influencing scuba divers' perceptions of crowding in underwater settings. They argued that the number and proximity of divers significantly influenced divers' perceived crowding and the number of divers was the strongest determinant. In this study, we verify whether these two factors influence divers' perceived crowding in underwater settings. [Needham \(2013\)](#) found crowding and encounters as important indicators at six coastal and marine sites on the island of Oahu, Hawai'i and the author suggested that all three concepts (i.e., encounters, norms and crowding) should be measured when addressing social carrying capacity issues. [Schuhmann et al. \(2013\)](#) estimated the willingness to pay to avoid high numbers of encounters with other divers in Barbados and Tobago. It was showed that divers might be willing to pay up to US \$4.51 to avoid one diver. [Bentz et al. \(2015\)](#) found that divers choose Azores Islands mainly because they do not want to experience crowding.

1.5. The research questions

Perceived crowding and social carrying capacity of underwater environment have been neglected for a long time. Understanding scuba divers' perceived crowding underwater and developing strategies to assess the impacts on scuba divers and carrying capacity of diving sites will inform plans and policies for managing diving tourism sites such as marine parks. Thus, we have two research questions for this study.

- First, what factors (e.g., gender, number, proximity of scuba divers) influence scuba divers' evaluations of crowding underwater and which is the most important?
- Second, how can a diver's underwater perceived crowding inform capacity management of a specific site, e.g., Hong Kong diving site (HKDS)?

2. Methods

2.1. Study site

Diving sites in Hong Kong are different from most other diving sites in tropical areas ([Fig. 1](#)). The diversity of corals in Hong Kong is considered quite high; a total of 84 hard coral species from 28 genera of 12 families have been recorded. Most coral communities are concentrated in the eastern and northeastern shores where rocky hard bottoms are more extensive and the general water conditions more oceanic ([Morton and Morton, 1983](#); [Hodgson and Yau, 1997](#)). Shores with a higher concentration of corals are usually used as diving sites in Hong Kong ([Fig. 1](#)). Underwater visibility of Hong Kong dive sites (HKDS) varies and is subject to prevailing wind and tidal conditions. While there are no official records about underwater visibility of HKDS, according to diving shops managers and diving masters who frequently dive in HKDS, in the best conditions, underwater visibility can be as far as 15–20 m, while most of the time, it is about 1–5 m. The underwater temperature can be as high as 29.3 °C in summer but it can drop to 17.3 °C in winter ([Environmental Protection Department, 2013](#)). The topography of HKDS is usually flat. Sandy or sandy mud bottom punctuated with corals is usually found at the shallow ends up to about 10 m deep. At approximately 15–20 m, coral merges on a sandy mud seabed.

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