Transactions on Science and Technology, **3**(2-2), 444-448, 2016
ISSN: 2289-8786

An Assessment of the Carrying Capacity of Sipadan Island Park, Sabah, Malaysia

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Received: *27 April 2016*
Revised: *2 July 2016*
Accepted: *1 August 2016*
Online: *28 October 2016*

Keywords:
Carrying capacity of dives; diver and dive frequency; iconic fishes; ecotourism; Sipadan Island Park; Marine Protected Area

ABSTRACT

Sipadan Island is a small oceanic island in Malaysia, and renowned as one of the world's top ten dive destination. However, it was only recently that the island was gazetted as a Marine Protected Area. The aim of this study is to assess the carrying capacity of Sipadan Island Park. The objectives are to enumerate diver and dive frequency, and to record the presence and sighting rate of iconic fishes in each of the 11 established dive sites on Sipadan. The study was carried out monthly over a 12-month period in 2011 and 2012. In that period, we recorded a total of 66,243 dives, of which, more than one third (35%; n=23,215 dives) was in Barracuda Point alone. In comparison, the least popular dive site - West Ridge–North Point - recorded just 154 dives. Thus, Barracuda Point, along with three other sites are found to have greatly exceeded the carrying capacity of a dive site. Iconic fishes are present throughout the year, and their sighting rate was similar in all months ($p>0.05$). However, our data showed a significant correlation between popular dive sites and sightings of iconic fish ($p<0.05$).

Introduction

Sipadan Island is a small Malaysian tropical oceanic island, and is internationally renowned as a top diving destination since the early 1990's (LESTARI UKM, 2004). However, the island was only fully gazetted as a Marine Protected Area (MPA) in 2015. The concept of a carrying capacity or 'safe limit' based on 'limits of acceptable change' defined as the number of individual dives a reef can sustain without irreparable degradation (Trade Environmental Database, 1996). This value is generally considered to be between 5,000–6,000 dives per site per year. Beyond this number, damage to the reef will be significantly escalated. However, it is recognized that this number much depends on the behaviour of the divers (Hawkins & Roberts, 1997). Sipadan's main attractions are the large schooling fishes, specifically the Barracudas and Big Eye Trevallies, the large number of sea turtles and numerous cartilaginous fishes (Isley *et al.*, 2005). The aim of this study is to assess the carrying capacity of Sipadan Island Park. The objectives are to enumerate diver and dive frequency, and to record the presence and sighting rate of three iconic fish species, i.e. the Great Barracuda (*Sphyraena barracuda*), Big Eye Trevally (*Caranx sexfasciatus*) and Bumphead Parrotfish (*Bolbometopon muricatum*), of Sipadan as a factor of dive site preferences.

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Methodology

The sampling sites are based on the 12 established dive sites on Sipadan. However, the number of sampling sites is reduced to 11, after we decided to combine two adjacent and closely located sites (Figure 1). These two are West Ridge and North Point, combined and renamed West Ridge-North Point. Data was collected through interviews, and underwater observations through scuba diving, for the period from March 2011 to February 2012 (12 months). Prior to conducting the interviews, we received the consent of each respondent to fill in a questionaire, before proceeding by giving a thorough explaination about the questionaires. This was to ensure that the respondents understood the contents of each question. The accuracy of the questionnaire data were also verified by ground truthing by discreetly scuba dive with the respondents. Questionnaires were given to dive master and tourists to fill in and were collected after their dives. The same approach was used to find out about iconic fish sightings by the divers. Divers are randomly selected during their dive breaks. To avoid confusion, images of the three iconic fish species were placed at the jetty and all dive operators' boat as well as in the questionnaire form itself. Dive frequency was determined from the number of dives at each dive site. The presence of iconic fish sighting were analysed using SPSS at 95% confidence interval ($p<0.05$). Prior to analyses, all variables were tested for normality and homogeneity of variances. One-way ANOVA was performed, followed by Tukey multiple comparison tests (Tukey HSD) to make specific contrast in spatial and temporal variation of frequency of fish sightings.

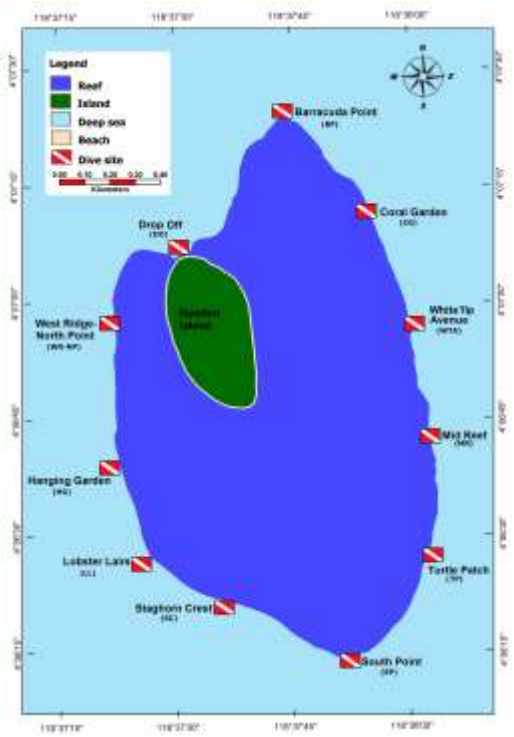


Figure 1. Sipadan Island, with the 11 established dive sites.

Results and discussions

A total of 66,243 dives were recorded in the period of 12 months. Based on Figure 2, the highest dive frequency is Barracuda Point (BP) with a total of 23,215 dives (35.05%). Followed by South Point (SP) with 9,902 dives (14.95%) and both Mid Reef (MR) and Drop Off (DO) recorded 7,861 dives (11.87%) and 7,275 dives (10.98%) respectively (Figure 2). There were 4 dive sites recorded between 1,000 to 5,000 dives; Turtle Patch (TP) with 4,954 dives (7.48%), Coral Garden (CG) with 4,469 dives (6.75%), 4,315 dives (6.51%) for White Tip Avenue (WTA) and Hanging Garden (HG) with 3,035 dives (4.58%) for the same study period. There were 3 dive sites which recorded less than 1,000 dives. Staghorn Crest (SC), 822 dives (1.24%), Lobster Lairs (LL), 241 dives (0.36%) and the lowest, West Ridge-North Point, 154 dives (0.23%).

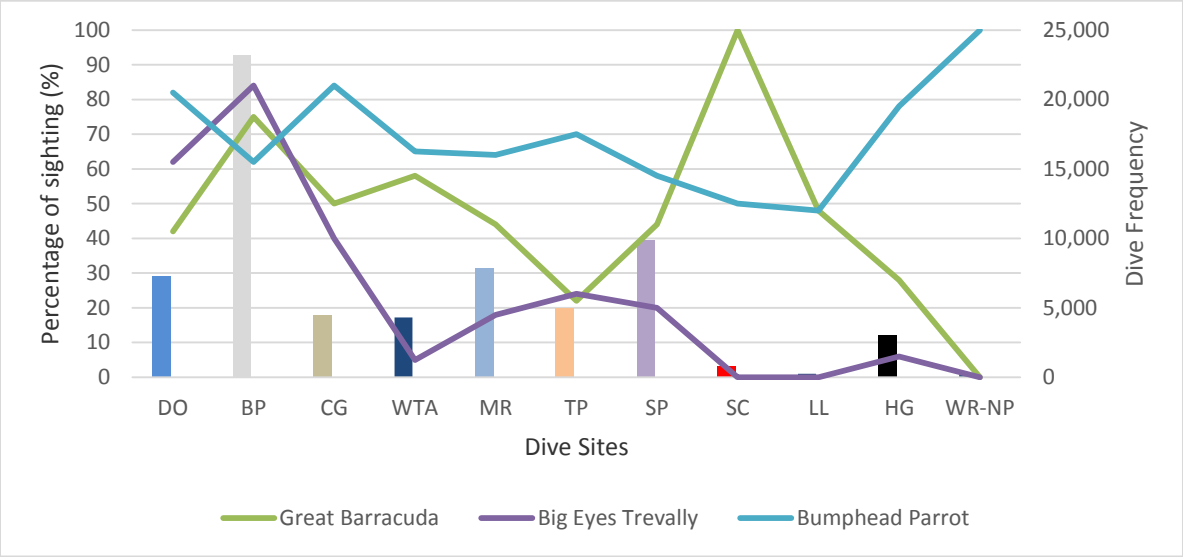
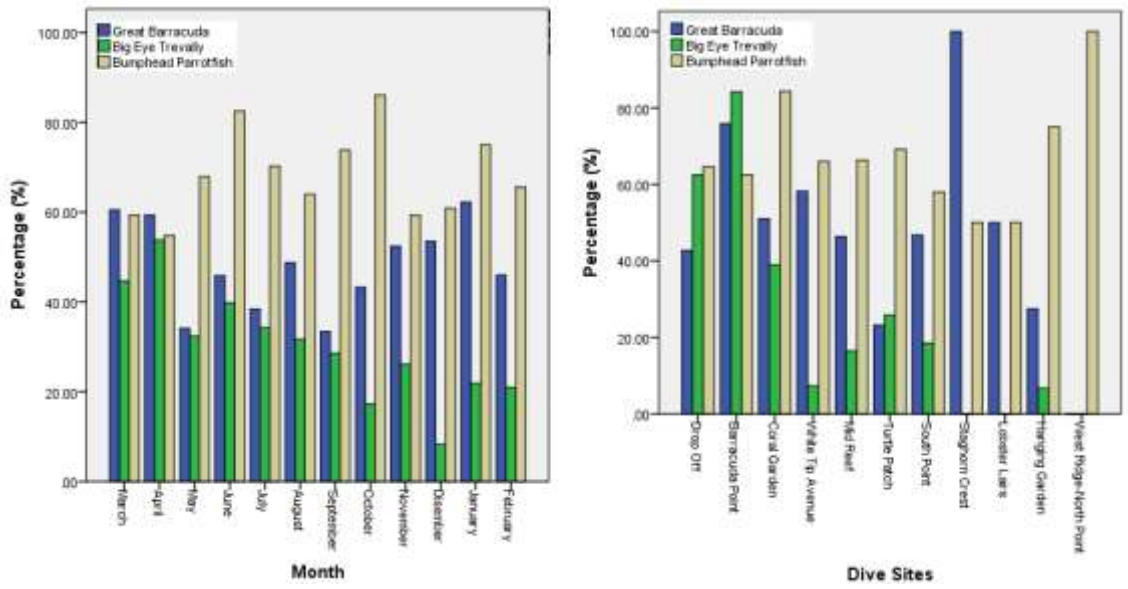


Figure 2. Frequency of dives (bar chart) and percentage of iconic fishes (line) sighting at the established dive sites in Sipadan Island.

Temporal and spatial variation in the frequency of fish sightings is illustrated in Figure 3 (a) and (b), respectively. In general, the percentage of dives with fish sighting based on months, ranged between 35% to 60%, 10% to 58 % and 58% to 90%, for Great Barracuda (GB), Big Eye Trevally (BET) and Bumphead Parrotfish (BPF), respectively. The frequency of fish sightings recorded in Bumphead Parrotfish was significantly higher ($p<0.05$) than the Great Barracuda and Big Eye Trevally. However, no significant difference ($p>0.05$) was observed in frequency of fish sighting in all the three species throughout the year.

For spatial variation, significant difference ($p<0.05$) was observed in frequency of fish sighting for Great Barracuda, Big Eye Trevally and Bumphead Parrotfish throughout the dive site. The frequency of fish sighting recorded for Great Barracuda was significantly higher ($p<0.05$) at White Tip Avenue, Barracuda Point and Staghorn Crest, while significantly lower ($p<0.05$) at West Ridge-North Point, Turtle Patch, and Hanging Garden. The occurrence of Big Eye Trevally was significantly

higher ($p<0.05$) at Barracuda Point, Drop Off and Coral Garden. In contrast, the frequency of iconic fish sightings for Bumphead Parrotfish did not show remarkable differences, and was slightly higher at West Ridge-North Point.



(a) Temporal (b) Spatial

Figure 3. (a) Frequency of dives in each dive site related to months. (b) Temporal variation in frequency of iconic fish sighting.

The data analysis on iconic fish sighting recorded is significant ($p<0.05$) in certain dive sites. In Sipadan, Great Barracuda and Big Eye Trevally can only be seen regularly in certain dive sites. Both these fishes don't move around Sipadan Island as much as the Bumphead Parrotfish. According to Kobayashi *et al.* (2011), Bumphead Parrotfish species is highly mobile with a range of up to 6 km. that is why we can spot more of this species throughout all dive sites compared to Great Barracuda and Big Eye Trevally. The high frequency of Bumphead Parrotfish may be because of its high abundance or that Semporna waters is a possible spawning ground of this species (Daw, 2004). No significant ($p>0.05$) temporal variation in the frequency of fish sighting for all the three iconic fish species in Sipadan demonstrated that all the three species do not migrate out of Sipadan. The result also suggests the chances of divers to see the fishes are equal throughout the year. Barracuda Point is the best dive site in terms of frequency of iconic fish sighting, which explains the higher preference of divers to dive in this area. The abundance of some coral fishes in one site over other could be related to habitat preference, current direction and the physical characteristics of the dive site and food availability (Brooker *et al.*, 2013).

Conclusion

Dive frequencies in the reef of Sipadan Island are not equally spread out throughout all the established dive sites. Four most popular sites are Barracuda Point, South Point, Mid Reef and Drop Off. These 4 dive sites use more than recommended figure. The presence of iconic fishes plays a great role in the dive site popularity. All four dive sites recorded high presence of Great Barracuda and Big Eye Trevally compared to other less or non-popular dive sites. Bumphead Parrotfish presence can be found in almost all dive sites equally due to their high mobility ability.

Acknowledgements

We are very grateful to Sabah Parks and the various dive resorts in the Semporna area for their assistance, particularly during field sampling. A big thank you to Sabah Parks Director, Dr. Jamili Nais and Deputy Director, Dr. Maklarin Lakim for their support during this project. We also would like to express gratitude to our diver's team namely Elvin Michael Bavoh and Mohd. Nara Ahmad for their hardwork and assistance during this study. Last but not least, we would like to acknowledge Prof. Dr. Ridzwan Abdul Rahman, formerly the Director of Borneo Marine Research Institute, Universiti Malaysia Sabah for his contributions in the initial stages of this project. This project was carried out as part of the Master of Science research project by the first author.

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