Pengelolaan Hius Paus (*Rhincodon typus*, Smith 1828) berdasarkan Struktur Populasi di Perairan Kwatisore, Kabupaten Nabire, Provinsi Papua Tengah

Management of Whale Shark (*Rhincodon typus*, Smith 1828) Fish Based on Population Structure in Kwatisore Waters, Nabire Regency, Central Papua Province

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ABSTRAK

Penelitian terhadap hiu paus (*Rhincodon typus*) dilakukan di perairan Kwatisore, bagian dari kawasan Taman Nasional Teluk Cenderawasih. Observasi lapangan dilakukan pada bulan September hingga Desember 2016. Tujuan penelitian adalah untuk mengetahui pengelolaan ikan hiu paus berdasarkan struktur populasi, yaitu identifikasi individu, jenis kelamin, panjang dan bekas luka. Variabel observasinya adalah struktur populasi. Pengumpulan data dilakukan dengan metode observasi langsung yang terbagi dalam 2 waktu observasi, yaitu observasi langsung oleh peneliti pada pukul 06.00-17.59 dan observasi tidak langsung oleh nelayan bagan pada pukul 18.00-05.59. Pada pengamatan langsung, pengambilan data ID setiap individu dilakukan dengan memotret sirip dada kirinya, yaitu pada area antara pangkal insang ke-5, titik tertinggi insang ke-5, dan ujung belakang sirip dada. Hasil dokumentasi diidentifikasi menggunakan *software I3S2.0*. Bintik putih di area tersebut menjadi kunci utama identifikasi setiap hiu paus. Melalui beberapa kali pengulangan pengamatan ID, dapat diketahui jumlah, jenis kelamin, ukuran, dan kecenderungan kemunculannya. Hasil penelitian menunjukkan ditemukannya 23 individu yaitu semuanya berjenis kelamin jantan. Teridentifikasi terdiri dari 17 individu lama dan 6 individu baru. Rata-rata panjang individu yang ditemukan adalah 3 - 4 meter. Setiap individu mempunyai frekuensi kemunculan yang berbeda-beda. Frekuensi kemunculan tertinggi adalah individu ID016 dengan panjang 6 m dan ID047 dengan panjang 3 m. Bekas luka yang ditemukan pada masing-masing tubuh hiu paus terdapat pada bagian mulut (53%), ekor (17%), dan sirip dada kanan (12%). Hiu paus harus dilestarikan secara alami pada suatu wilayah perairan tertentu, Komitmen seluruh pemangku kepentingan untuk mengembangkan sistem pengelolaan kolaboratif dalam pengelolaan sumber daya hiu paus dan habitatnya.

Kata Kunci: Populasi, Hiu Paus, Pengelolaan, Kwatisore

ABSTRACT

The study of the whale shark (*Rhincodon typus*) was conducted in the waters of Kwatisore, part of the Cenderawasih Bay National Park area. Field observations were conducted in Sept to Dec 2016. The objective of the study was to examine management based on population structure, were individual identification, gender, length and wound marks. The observation variable was the population structure. Data collection was done by a direct observation method which was divided into 2 observation times, direct

observations by researchers at 06.00-17.59 and indirect observations by bagan fisherman at 18.00-05.59. In the direct observations, the ID data of each individual was taken by photographing its left pectoral fin, in the area between the base of the 5th gill, the highest point of the 5th gill, and the back tip of the pectoral fin. Documentation results were identified using software I3S2.0. The white spots in the area are the primary key in the identification of every whale shark. Through several repetitions of ID observations, it would be found the number, gender, size, and trend of appearance. The results showed that the discovery of 23 individuals, all males. The identified consisted of 17 old individuals and 6 new individuals. The average length of the individual found was 3 - 4 m. Each individual had a different frequency of appearance. The highest appearance frequency was an individual with ID016 with a length of 6 m and ID047 with a length of 3 m. The marks of injury found on each whale shark body were in the mouth (53%), tail (17%), and right pector fin (12%). Whale sharks must be naturally conserved in a certain area of waters, Commitment from all stakeholders to develop a collaborative management system for managing whale shark resources and their habitat.

Keywords: *Whale Shark, Population, Kwatisore, Management.*

INTRODUCTION

Whale sharks (*Rhincodon typus*, Smith 1828) are still considered to be the world's species that inhabit tropical marine waters and most of them live in warm climates (Compagno 1984; Wolfson 1986; Taylor 1994; Colman 1997). These are the largest aquatic vertebrates in the world found in temperate waters, for example, in New Zealand, and they appear during warm temperatures (Wolfson 1986; Paulin *et al*. 1989; Stevens 1994; Colman 1997). Similar to most other elasmobranchii groups, whale sharks have innate biological characteristics such as large body size, slow growth, and relatively long gonadal maturity, which are all limiting factors of repopulation. Therefore, the population of whale sharks is slow to restore and vulnerable to extinction from excessive exploitation (Casey *et al*. 1992).

The protection of whale sharks is very urgent as they are increasingly being captured. Joung *et al*. (1996) reported that whale fins and whale meat are the main targets since they are highly-demanded products, especially in South east Asia. It is increasingly difficult to monitor and control the activities that could threaten whale sharks in developing countries. Several studies have reported that there were catch activities (Grace 1985; Roberts 1997; Roberts *et al*. 1997) in January 1991 and May 2001. Colman (1997) concluded that the knowledge of coastal community on the biological and ecological aspects of whale sharks is very limited, leading to irresponsible exploitation of whale sharks. Therefore, it is necessary to protect these giant animals by studying their population structure. Casey *et al*. (1992) previously stated that the presence of these animals was at high risk. According to Colman (1997) the comfort of whale sharks is threatened, both in terms of behavior and ecology. Based on the above facts, the World Conservation Union (IUCN) has put these cartilaginous fish into the IUCN Red List and provides a conservation status of EN (endangered, precarious or threatened). Several countries such as India, the Maldives, Australia, the Philippines, Malaysia, the United States and Honduras have undertaken various shark protection measures (Fowler and Cavanagh 2001; Chen and Phipps 2002). Indonesia itself through Ministerial Decree No. KP. 18 Year 2013 has fully protected whale sharks.

The migration regions of whale sharks in Indonesia to date are the waters of Sabang, Probolinggo,

Situbondo, Bali, Nusa Tenggara, Alor, Flores, North Sulawesi, Maluku and Papua. They appear seasonally, for example, in Probolinggo and its surrounding waters, the appearance of whale sharks is between December to March (Noviyanti *et al.* 2015, Kamal *et al*. 2016). Surprisingly, in the waters of Kwatisore, which is one of the areas within the Cenderawasih Bay National Park (TNTC), Papua, whale sharks are found throughout the year (WWF 2014). However, until now, the information on the structure of the whale shark population (number, size, gender, and wound marks/other specific characteristics) in Kwatisore waters is limited. This study focused on the whale shark population structure in the waters of Kwatisore. This is expected to be a source of information that is serialized and accurate related to the existence of these animals for the purpose of management efforts, especially related to sustainable conservation practices and policies.

This study aimed (1) to identify the population structure of whale sharks (*R.typus*) in terms of numbers, lengths, gender and marks of injury and (2) to know the trend of whale shark appearance based on ID. The results of this study can serve as a source of reference for all stakeholders involved in the management of whale sharks in the Cenderawasih Bay National Park. Information on population structure can be useful for its utilization strategy and protection.

MATERIALS AND METHODS

This research was conducted for 4 months, from September to December 2016, in the waters of Kwatisore, the Cendrawasih Bay National Park (TNTC), Nabire District, Papua Province, at the coordinates of $03^0$14'53.84 "E and $134^0$56'26" S. (Figure 1). Observational variables in this study included the whale shark population structure (number, length, gender, and wound marks and frequency of whale shark appearances based on ID. The method used in this research was observation method with the purpose of seeing directly the objects studied in the field: whale shark population structure and frequency of whale shark appearances.

Whale shark monitoring was done every Monday to Friday on each *bagan*. Observations were made directly and indirectly. The direct observations were from 6:00 to 18:00 local time, assisted by a whale shark monitor (TPHP), while the indirect observations were made by each *bagan* fisherman by taking a note of each whale shark appearance and the time on a data sheet given. Observations by *bagan* fishermen were from 18.00 to 05.59 local time. Photo ID was taken while interacting with whale sharks. Photo ID is a method used to identify each individual whale shark. Photo ID differentiates one individual from the others through the white spotted patterns of the whale sharks suspected to be unique to each individual and will not change throughout the year (Speed *et al*. 2007). The main features of Photo ID were the left side of gill edge to the pectoral fin tip. In addition, Photo ID was also performed on the right side of whale shark pectoral fin and its sex to complement the identification key. Every spotted shark was photographed and its Photo ID recorded. Each individual was identified using the Paint NET program and the Interactive Individual Identification System (I3S2). Interviews were conducted with each *bagan* fisherman to find out the trend of whale shark appearances and the types of wounds on their bodies.

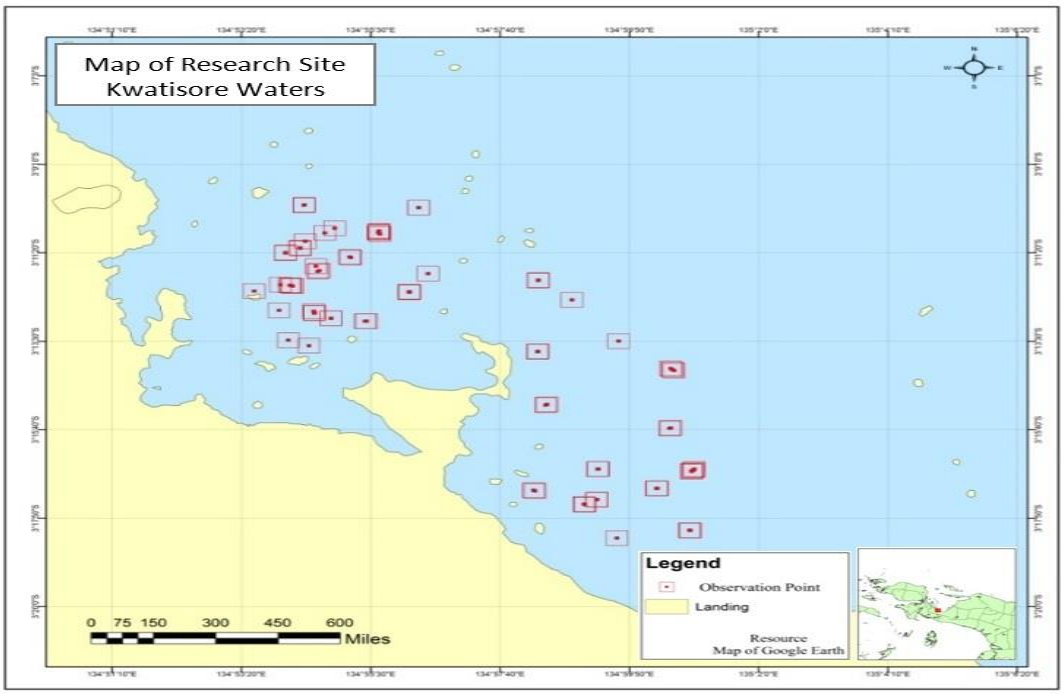

Figure 1. Map of Research Sites in Kwatisore Waters. Red squares and points inside them indicate the points where The tools and materials used in this study are presented in Table 1 below.

Table 1. Tools and Materials Used

No	Tool and Materials	Use
1	Underwater Camera	As a tool to take a Photo ID of whale sharks
2	*GPS*	To take coordinates at each point of whale shark appearance.
3	*GIS*	To draw a research site map based on the points of whale shark appearances
4	Snorkling Equipment	As a tool when taking a Photo ID.
5	Application of Paint.NET	Left-side and right-side of pectoral fin processing from the Photo ID of whale sharks.
6	*Software I3S2.0*	As an application used for the identification of whale shark-based individual on white spots on the left pectoral fin.

Data Analysis

ID Based Whale Shark

The collected data was then tabulated using a descriptive method that was analyzed using Microsoft Excel 2007 and displayed in the form of tables and drawings. The captured Photo ID was processed using Paint NET to crop, rezise, and rotate. The photos that had been processed with Paint.NET were identified with Interactif Individual Identification System (I3S2). The three main reference points, namely at the top and bottom of the last gill and the pectoral fin tip, were selected based on each white spot between the three reference points and the database was built on the results of the analysis.

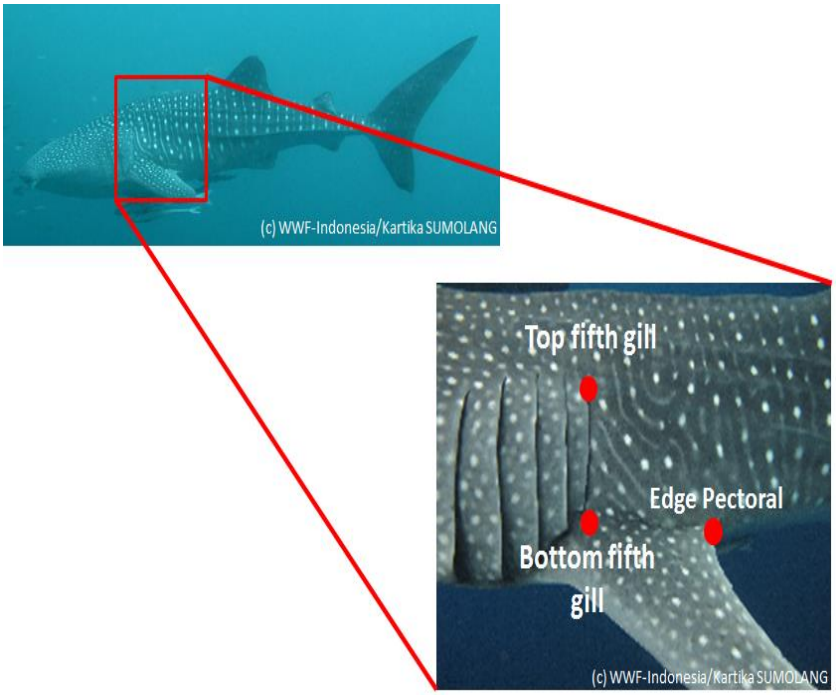

Figure 2. Photo ID Taking and Whale Shark Identification Pattern (WWF 2010).

Frequency of Whale Shark

The appearance data of whale sharks were taken at each observation point. The recording of the appearance trend took place when the photo ID was captured. This was done to analyze the trend of appearance and the length of whale sharks based on ID.

Wound Marks on Whale Sharks

Wound marks on the whale shark were observed directly during interaction for Photo ID taking in order to identify the types of wounds on the whale's body parts. In addition, interviews were conducted for each *bagan* fisherman and community to determine the factors that caused injuries to the body of whale sharks. The results were reported descriptively and displayed in the graphical form with the percentage of each injury.

RESULT AND DISCUSSION

Identification of Whale Shark Morphology

Fish morphology is the outer part of the fish body that has some special features and can be used as a key identification in distinguishing individuals or species. The same is true with a whale shark, where the researches which have already been done around the world show that whale sharks are made up of one population which spread almost all over the world. Based on the results of the morphological observations of whale sharks in the waters of Kwatisore, these fish have almost the same morphological characteristics, making them very difficult to distinguish individually. However, there is something interesting on their left pectoral fins after ID observation were done based on the Photo ID method which can be used as an identification key. Photo ID is a method used to identify different individual whale sharks. Photo ID differentiates one individual from another through the white spotted pattern on the whale shark body suspected to be unique in each individual and will not change throughout the year (Speed *et al*. 2007). More details can be seen in Table 2 below.

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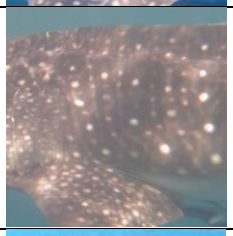
Table 2 Morphological Difference of Whale Shark Individual

No	Left pectoral fin	Number of Dots	Body Length (m)	Color
1		18	2	Bright brown
2		15	4	Brown
3		12	5	gray
4		19	6	Dark brown

ID Based Whale Shark

The results of Photo ID indicated that of 23 identified whale sharks, they had a different ID_Based. The shape of the spotted pattern of each individual whale shark is very unique and distinct. The spotted pattern is the primary key in the identification process. The results of the frequency analysis of the individual appearance of whale sharks for each ID_Based varied greatly (Figure 3). The length of each individual whale shark influenced how often these sharks appeared. For instance, 2 m long whale sharks did not appear at the surface as often as the whale sharks with a length of 3-7 m. Whale sharks with a length of 1.5-2 m had the highest appearance rate in a depth of 7-15 m. The highest appearance frequency was an individual whale shark with ID016 which had a length of 6 m and an individual whale shark with ID047 with a length of 3 m (Figure 3). The results of observations conducted in the Cristmas Islands, the Indian Ocean, by looking at individual whale sharks based on the photo results both above and below the surface of the waters, revealed that whale sharks with a length of 1-3 m seldom appeared to the surface of the waters. Even most individual whale sharks observed were adolescent whale sharks with a length (TL) of 4.60 m (Colman 1997).

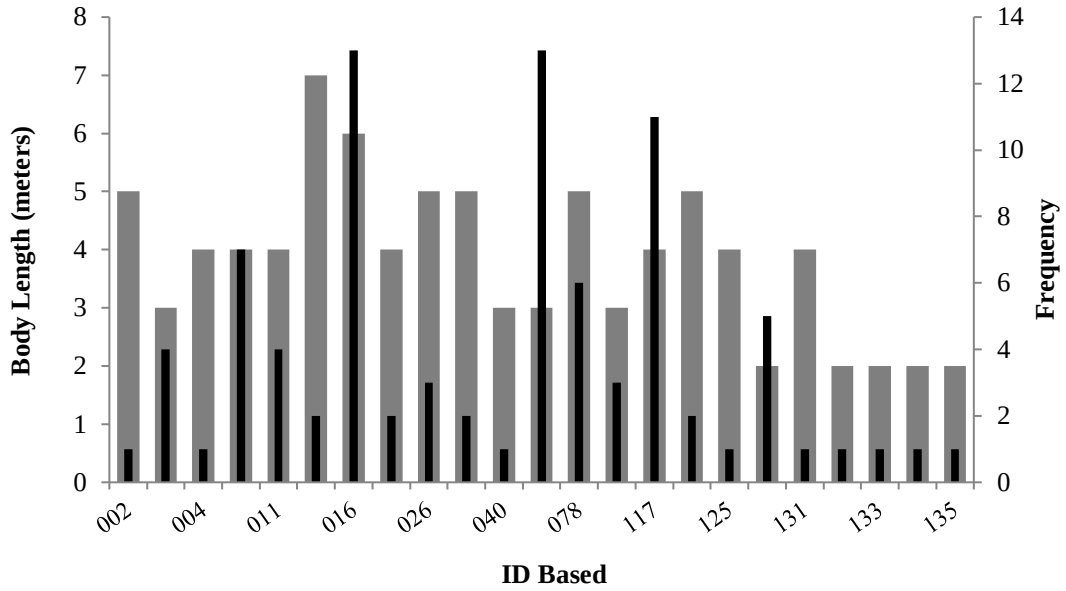


Figure 3 Length of Body (gray) and Apperance Frequency of Whale Shark (black) based on ID (in the period of September - December 2016).

Whale Shark Composition

23 whale sharks were found in Kwatisore waters from September to December 2016. Out of the 23, 17 had previously been identified (old) and 6 had just been identified (new). The results indicated that there were 6 new individuals out of the 129 individuals listed in ID-Based whale sharks in Kwatisore waters (WWF 2011-2015; Suruan et al., 2015), making the total number of individual whale sharks identified in Kwatisore waters amount to 135 Individuals.

The difference in the number of whale sharks found is allegedly influenced by food availability factors caused by high rainfall. According to Tjasyono (1997), the influence of El-Niño is strong in areas affected by the monsoon system. The monsoon pattern is characterized by a uni-modal rainfall pattern (one peak of the rainy season). During the six months, the rainfall is relatively high for the regions of Sumatra, Java, Bali, Lombok, Nusa Tenggara and Papua, where the west monsoon winds practically coincide with the rainy season. This is because the west monsoon carries a lot of water vapor from the western part of Pacific waters. This climate pattern occurs from October to March. In addition, the equatorial pattern is characterized by rain patterns with bi-modal forms (two peak rain) which usually occur around March and October when the sun is near the equator (Tjasyono 1997).

The above statement proves that whale sharks are mostly found from October to December due to the large number of nutrient (N) elements from land carrying into the waters because of the prolonged rainy season, compared to from April to September during the prolonged drought (Tjasyono 1997).

Length and Sex of Whale Sharks

Based on the measurements of the length of each individual whale shark found, the estimated average size of whale sharks found was 3 - 4 m with a total of 7 individuals (Figure 4). The rest with other sizes only ranged from 1 to 6 individuals. The size of 3 - 4 m in length was the size of the adolescent phase for each individual whale shark. According to Norman & Stevens (2007), based on whale shark morphology, clasper size for all male individuals with a length

(TL) of <7 m is not yet categorized as adult. Only 9.3% male whale sharks of 7 and 8 m long (TL) were found to be adults. It is predicted that the length of a whale shark at the beginning of gonadal maturity is 8.0 m. While 95% of male whale sharks reach gonadal maturity at a length (TL) of 9.0 m and female whale sharks reach > 10 m (Joung et al 1996).

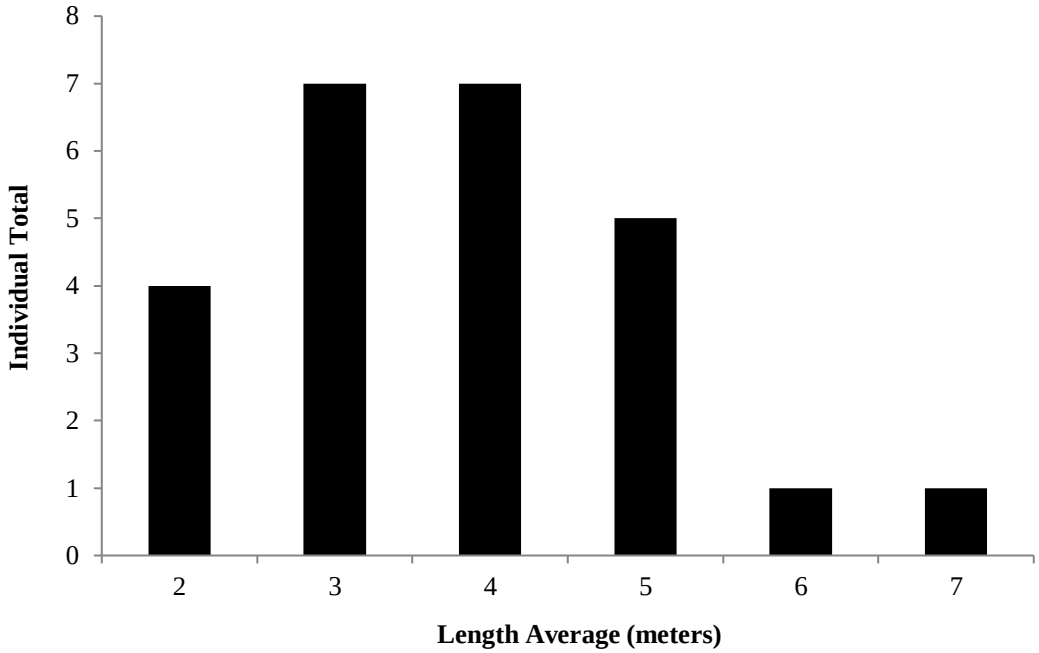


Figure 4 Relationship of Length (m) and Number of Whale Shark Individuals (fish).

Wounds Marks on Whale Sharks

Based on direct observations and Photo ID, each individual whale shark had different wound marks on their body parts. Some of the observed injuries were in the mouth, body, tail tip, tail base, left pectoral fin and right pectoral fin. The results of the analysis showed that the highest percentage of injury was in the mouth (53%), followed by the tail tip (17%), and right pectoral fin (12%) (Figure 5). According to Suruan et al. (2016), whale shark wounds are generally caused by interactions with *bagan* fishermen. The cuts on the lips and pectoral fins are usually caused by a fishing line that is usually left afloat when fishermen are waiting for fish to get hooked in the fishing line, so that sometimes the hook from the fishing rod is snagged on the body parts of whale sharks. In addition, injuries in some parts of the body are generally caused by sharp objects used by fishermen at the time of removing whale sharks trapped in the net. Its large size and slow movement usually cause the whale sharks to be hit or to crash into a fishing boat, resulting in injuries to parts of the body.

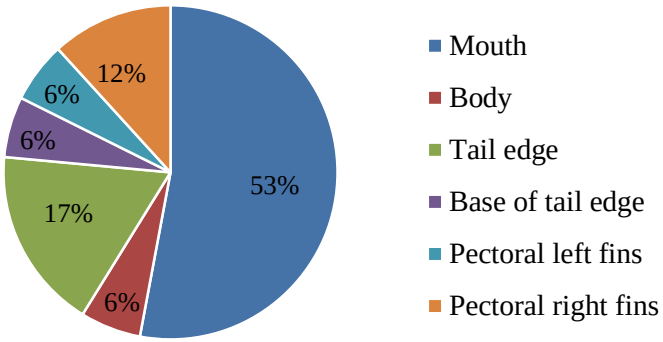


Figure 5. Wounds Presentation Marks of Whale Shark

Management of whale shark in Kwatisore waters

This study yields information on whale shark populations based on individual occurrences during the study. found 23 individuals with a length of 3-4 m and all were male. The presence of scars in individuals was found, where the highest were on the mouth (59) %, tip of the tail (17%) and right pectoral fin (12%). This threatens the sustainability of the whale shark population. To manage whale shark resources in the waters of Kwatisore, it is necessary to know the issue of utilization of these resources. It was found that there was tourist behavior that was unfriendly to whale shark resources and the handling of bagan fishermen when feeding and releasing whale sharks when they were trapped in bagan. With the high number of whale sharks found in traditional use zones/around bagan fishermen, it has the potential to develop marine tourism. There must be a strategy, management of tourism activities that are environmentally friendly and an education or awareness program for fishermen in Bagan to handle whale shark resources in Bagan.

Some guidelines for appropriate management of whale shark resources are:

1. Outreach to local communities (kwatisore) in involvement as tour guides who understand the behavior of whale shark resources and local culture as tools in developing whale shark tourism in their area.
2. Capacity building for chartered fishermen regarding the importance of whale sharks in the marine ecosystem and how a healthy population of whale sharks results in healthier fish populations so that the catches and profits are greater for fishermen.
3. Local communities and local fishermen need to be warned about the negative effects of the fishing gear used on the existence of whale shark resources.
4. Provide appropriate training to key actors (local communities as tour guides and charter fishermen) to become marine rangers and be given incentives to compensate them for being involved in maintaining whale shark resources and their ecosystems.
5. There are District and Provincial government regulations in regulating the number of tourist visits and types of tourist activities that can be carried out in the existing charts.
6. Involvement of all parties as a commitment from all stakeholders to develop a collaborative system for managing whale shark resources and their habitat in Kwatisore waters, TNTC, Central Papua Province, adopting collaborative management.

Conclusion

1. There were 23 individuals of Whale sharks identified during the study, consisting of 17 old individuals and 6 new individuals, with an average length ranging from 3 to 4 m and all individuals were male. The number of wound marks on each individual whale shark identified varied greatly. The highest number of the injuries found in the mouth (59%), at the tail tip (17%) and right pectoral fin (12%).
2. The highest appearance frequency was individual whale sharks with ID016 with a length of 6 m and individual whales with ID047 with a length of 3 m.
3. Commitment from all stakeholders to develop a collaborative system for managing whale shark resources and their habitat in Kwatisore waters, Cenderawasih Bay National Park, Central Papua Province, adopting collaborative management.

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