Market surveys of elasmobranch fisheries resources in the Tun Mustapha Park, Sabah, Malaysia

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ABSTRACT

Tun Mustapha Park is a unique, multiple use, marine managed area located in the northern part of Sabah, Malaysian Borneo. Elasmobranchs (sharks and rays) are one of the fisheries resources in this area, as elsewhere in Sabah. They are caught by both commercial and artisanal fishers. In this study, a total of 40 species of elasmobranchs comprising 17 sharks and 23 rays were recorded. A few of them were recorded in high abundance (more than 5 but less than 30 individuals per sighting). These were Oriental Bluespotted Maskray (*Neotrygon orientalis),* Bluespotted Fantail Ray (*Taeniura lymma),* Sharpnose Whipray (*Maculabatis macrura*), Whitespotted Whipray (*Maculabatis gerrardi)*, Milk Shark (*Rhizoprionodon acutus)* and Spot-tail Shark (*Carcharhinus sorrah)*. There are concerns about the status of the elasmobranch populations, which are generally dwindling globally.

KEYWORDS

biodiversity, abundance, sharks and rays, elasmobranch, fisheries

INTRODUCTION

Elasmobranchs (Class Chondrichthyes) are fishes with a cartilaginous skeleton and are often described as a group having a slow growth rate, late sexual maturity, long reproductive cycle and long lifespan (Castro et al., 1999). Elasmobranchs play an important role in the ecosystem, especially the larger species which control the overall structure of the system (Bornatowski et al., 2014). Any reduction in the population of these species carries risks of broader ecosystem degradation (Myers et al., 2007). Aside from their ecological value, they also possess economic value. The biggest threat to elasmobranch fisheries is overexploitation, mainly because of their *K*-selected life-history strategies (Spaet & Berumen, 2015).

Few elasmobranch species are targeted by fishers (Walker, 1998), and most elasmobranchs are incidentally captured in fisheries targeting the more productive teleost fish species, such as tunas or ground fishes (Stevens et al., 2005). Despite that, fishing pressure on chondrichthyans has been increasing parallel to teleosts due to depletion and/ or management restrictions (Dulvy et al., 2014). Moreover, the demand for some elasmobranchs has been on the rise because of the increasing value of their meat, livers, gill rakers (Fowler et al., 2002) and especially fins, which are regarded as a delicacy and are actually among the most expensive fishery products (Rose, 1996).

The Tun Mustapha Park (TMP) is mainly located within Sabah's East Coast Fishing Zone, with a small area also falling within the West Coast Fishing Zone. This unique marine managed area also serves as fishing grounds for artisanal and commercial fishing. Commercial fishing boats operating in this area use mainly trawl and purse seine fishing gears, while artisanal fishers use monofilament gill nets and hook and line (Manjaji-Matsumoto & Jumin, 2011; Beliku & Saleh, 2013; Manjaji-Matsumoto et al., 2017).

In this study, the biodiversity of elasmobranchs within the TMP was monitored, including efforts to estimate their abundance, and to quantify the importance of elasmobranchs as a fisheries resource.

MATERIALS AND METHODS

Study Site

The Tun Mustapha Park (TMP) is the first multiple-use park in Malaysia where conservation, sustainable resource use and development co-exist under a single management system (Jumin et al., 2017). Gazetted in May 2016, it is situated in the northern region of

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Sabah, Borneo, and is the largest marine park in Malaysia until September 2018 only; whereafter the title of biggest MPA in Malaysia went to Luconia Shoals in Sarawak after being gazetted by the State. It is a unique marine managed area bounded by the South China Sea to the west and the Sulu Sea to the east and encompasses the waters of three districts in the state of Sabah: Kudat, Marudu and Pitas (Sabah Parks, 2018).

The present study focused on elasmobranch landings in markets within the TMP, which included markets in Kudat, Pitas and Banggi Island (Fig. 1).

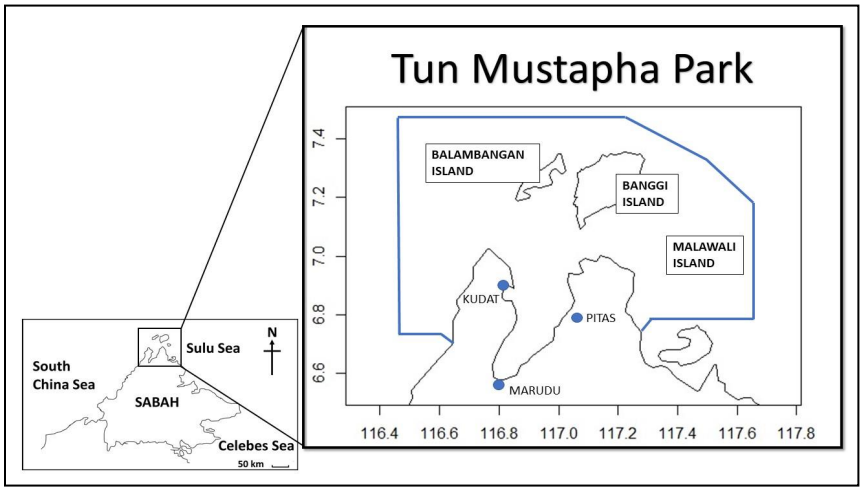

Figure 1. Study site in the Tun Mustapha Park, Sabah, Northern Borneo.

Market Surveys

The surveys were conducted between May 2017 and April 2018 as part of an on-going study of the elasmobranchs of Sabah. Market surveys were conducted once every two months (except November) in 2017 and every month (except February) in 2018 in local markets and fish landing sites. The markets include Kudat Fish Market and Central Market, Karakit Fish Market in Banggi Island, and Taka, Pinggan-Pinggan and Kanibongan Markets in Pitas. The fish landing sites include Angkasa Lama and Angkasa Baru in mainland Kudat. Visits to markets in Kudat were done only in the morning, 0700 – 0900 h, while visits infish landing sites were done from 0700 - 0900 h and from 1400 - 1600 h, with each lasting about an hour depending on the number of elasmobranchs landed. The visits to the fish markets in Pitas and Banggi were conducted opportunistically.

Data Collection

The biodiversity assessment was conducted by applying the Rapid Fishery Assessment by Market Survey (RFAMS) method of White et al. (2014) to record the elasmobranch biodiversity data from the fish markets and fish landing sites. However, only species occurrences, abundance estimates, size, sex and retail price were recorded in this study.

All elasmobranchs encountered in the survey were identified to species level and most of the individuals were measured to the nearest centimetre (cm) using total length for sharks and disc width for rays. The total length was measured from the tip of the snout to the extremity of the upper caudal fin when the sharks were in relaxed position whereas the disc width was measured as the widest distance between left and right edges of pectoral fins of the rays. All the specimens were sexed by the presence or absence of claspers, and the maturity of males was assessed by the degree of calcification of the claspers (juvenile= non-calcified claspers, sub-adult= partially calcified claspers, adult= fully calcified claspers).

Photographs of representative specimens of each species were taken. Specimens were occasionally saved (purchased) as vouchers. Species identifications followed Last et al. (2010; 2016a).

The conservation status of each species was checked using the online resource of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2014).

RESULTS

Fish Market Survey

Elasmobranchs landings in the TMP were sold daily in Kudat, Pitas and Banggi Island. Table 1 lists the fish markets and landing sites surveyed. Kudat Fish Market had the highest number of elasmobranchs sold in the TMP area; most of the fishes sold were purchased from Angkasa Lama, the largest fish landing site. During the time of landing, most of the elasmobranchs were purchased by fishmongers and restaurant owners directly or transported to other markets.

Unstructured interviews with the market workers were conducted opportunistically. Majority of the elasmobranchs sold in the Pitas markets were delivered from landing sites in Kudat. Most of the

Table 1. List of fish markets and fish landing sites around the Tun Mustapha Park (TMP) area, their respective active time/landing time and their capacity.

Market/ Landing site	Active Hours/ Landing time	Capacity
Kudat Fish Market 6°52'42"N 116°50'56"E	0800 h – 1000 h, 1500 h - 1700 h	- Largest fish market in TMP area. - Fish sold mostly coming from Angkasa Lama Fish Landing Site. - Elasmobranchs sold daily.
Kudat Central Market 6°52'47"N 116°50'58"E	0700 h – 0900 h	- Busiest market in Mainland Kudat. - The fishes sold are mostly from artisanal fishers.
Karakit Fish Market 7°06'38"N 117°05'09"E		- The only fish market on Banggi Island. - There is no specific operation time.
Taka Market 6°43'14"N 117°02'14"E		- Small roadside market. - Fishes sold are from Kudat area.
Pinggan-Pinggan Market 6°04'49"N 116°56'23"E		- Small market with only a few stalls selling fish. - Fishes sold are from Kudat area.
Kanibongan Market 6°39'07"N 117°13'13"E		- Small market. - Fish sold are caught from the nearby Kanibongan river.
Angkasa Lama Fish Landing Site 06°52′47.3″N 116°50′43.7″E	1400 h – 1600 h	- Fish landed are sold to markets in and out of TMP area.
Angkasa Baru Fish Landing Site 6°52'37"N 116°50'54"E	0800 h – 1000 h	- Fewer landings as compared to Angkasa Lama.

sharks recorded from the markets and landing sites had their fins removed and the fins were collected to be sold for a higher price compared to the rest of the body parts. According to the fishmongers, prices differ by species, size and moon phase, because there are less fishing boats going out to the sea during full moon. This made the amount of catches less, and therefore the fishes tended to fetch a higher price than usual.

Species Composition

Based on the 42 surveys conducted from May 2017 to April 2018, only some of the species were observed across all sampling months. Overall abundance peaked in May 2017 with 25 species recorded from 18 genera and 9 families, while the lowest was in March 2018 with 15 species recorded from 14 genera and 10 families (Fig. 2). The latter,

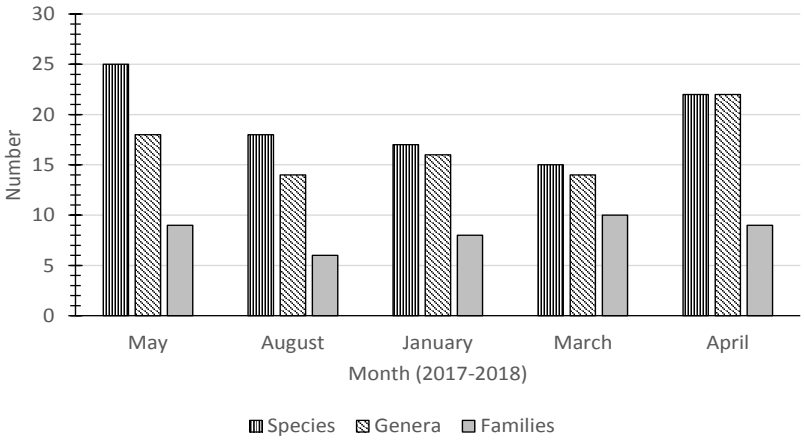

Figure 2. Number of elasmobranch species, genera and family by month collected.

Table 2. Elasmobranch species, recorded throughout the study period May 2017 to April 2018: percentage of total of all species, their respective range of retail price and conservation status. (Conservation status: DD=data deficient, LC=least concern, NT=near threatened, VU=vulnerable, EN=endangered, NE=not evaluated)

Family	Species	% of landings	Price Range (RM/kg)	Price Range (USD)	Conservation Status
Hemiscylliidae	*Chiloscyllium plagiosum*	1.3	n/a	n/a	NT
	Chiloscyllium punctatum	4.9	RM4- RM10 /kg	$1.02-$2.56/kg	NT
Stegostomatidae	*Stegostoma fasciatum*	0.2	n/a	n/a	EN
Hemigaleidae	*Chaenogaleus macrostoma*	0.7	n/a	n/a	VU
	Hemigaleus microstoma	1.8	n/a	n/a	VU
	Hemipristis elongata	0.9	RM4 /kg	$1.02/kg	VU
	Paragaleus tengi	0.4	RM4 - RM8 /kg	$1.02-$2.05/kg	DD
Triakidae	*Mustelus widodoi*	0.4	RM8 /kg	$2.05/kg	DD
Carcharhinidae	*Carcharhinus limbatus*	1.1	RM4 - RM7 /kg	$1.02-$1.79/kg	NT
	Carcharhinus melanopterus	1.1	RM8 /kg	$2.05/kg	NT
	Carcharhinus sealei	2.0	RM7 - RM8.5 /kg	$1.79-$2.17/kg	NT
	Carcharhinus sorrah	5.6	RM6 - RM9 /kg	$1.53-$2.31/kg	NT
	Carcharhinus tjutjot	1.3	n/a	n/a	NE
	Loxodon macrorhinus	0.4	n/a	n/a	LC
	Rhizoprionodon acutus	5.8	RM4 - RM8.5 /kg	$1.02-$2.17/kg	LC
	Triaenodon obesus	1.1	RM8 /kg	$2.05/kg	NT
Sphyrnidae	*Sphyrna lewini*	3.8	RM5 /kg	$1.28/kg	EN
Rhinidae	*Rhynchobatus australie*	3.1	RM8 /kg	$2.05/kg	VU
	Rhynchobatus laevis	1.1	n/a	n/a	VU
Rhinobatidae	*Rhinobatos formosensis*	0.2	RM8 /kg	$2.05/kg	NE
Glaucostegidae	*Glaucostegus typus*	1.1	RM8 - RM10 /kg	$2.05-$2.56/kg	VU
Dasyatidae	*Brevitrygon walga*	3.4	RM3 - RM5 /kg	$0.77-$1.28/kg	NT
	Hemitrygon parvonigra	1.3	RM8 /kg	$2.05/kg	DD
	Himantura leoparda	0.4	RM8 /kg	$2.05/kg	VU
	Himantura uarnak	2.9	RM8 /kg	$2.05/kg	VU
	Himantura undulata	0.4	n/a	n/a	VU
	Maculabatis gerrardi	7.2	RM7 - RM8 /kg	$1.79-$2.05/kg	VU
	Maculabatis macrura	7.9	RM3 - RM5 /kg	$0.77-$1.28/kg	DD
	Neotrygon orienatalis	23.6	RM5 - RM8 /kg	$1.28-$2.05/kg	NE
	Pastinachus ater	0.2	n/a	n/a	LC
	Pastinachus gracilicaudus	1.3	RM6 - RM8 /kg	$1.54-$2.05/kg	NE
	Pateobatis fai	0.4	n/a	n/a	VU
	Pateobatis jenkinsii	0.9	RM8 /kg	$2.05/kg	VU
	Taeniura lymma	8.1	RM5 /kg	$1.28/kg	NT
	Taeniurops meyeni	0.2	n/a	n/a	VU
	Telatrygon biasa	0.9	RM6 /kg	$1.54/kg	NE
	Urogymnus granulatus	0.4	RM8 /kg	$2.05/kg	VU
Aetobatidae	*Aetobatus ocellatus*	0.9	n/a	n/a	VU
Rhinopteridae	*Rhinoptera jayakari*	0.2	n/a	n/a	NE
Mobulidae	*Mobula kuhlii*	1.8	RM5 - RM8 /kg	$1.28-$2.05/kg	DD

however, may be an artefact of fewer surveys conducted in this month due to time constraints.

In total, there were 40 species of elasmobranchs from 29 genera and 13 families recorded during the survey (Table 2). Of the 40 species, 17 were sharks and 23 species were rays (Table 2). Landings were predominantly comprised of rays (67% rays, 33% sharks). The family Dasyatidae, represented 59% of the total numbers of the elasmobranch landings with 16 out of the 40 species recorded. Four of the most dominant species were also from the Dasyatidae family, which comprised 47% of all elasmobranchs recorded.

The most abundant species, the Oriental Bluespotted Maskray (*Neotrygon orientalis*) (24%) represented almost a quarter of the elasmobranch landings and had been sighted 32 times over the survey period. More than 28 individuals were sighted in more than 5 occasions. The Bluespotted Fantail Ray (*Taeniura lymma*) and Sharpnose Whipray (*Maculabatis macrura*) were next most abundant species, each contributing around 8% of the total landings, followed by the Whitespotted Whipray (*Maculabatis gerrardi*) which accounted for 7% of the total landings.

Milk Shark (*Rhizoprionodon acutus*), Spot-tail Shark (*Carcharhinus sorrah*), Scalloped Hammerhead (*Sphyrna lewini*), Scaly Whipray (*Brevitrygon*

walga), and Bottlenose Wedgefish (*Rhynchobatus australie*) were the minor important species, with relative abundances ranging between 3-5% of the total landings. The other 31 species together represented 31% of the total landings, which were only a little higher than the total landings of the Oriental Bluespotted Maskray.

DISCUSSION

The elasmobranchs landed in the TMP were heavily dominated by dasyatid rays. One of the species of this family is the Oriental Bluespotted Maskray (*Neotrygon orientalis*), which was normally represented by about 4 – 9 individuals per sighting and sometimes more than 28 individuals per sighting but rarely 3 individuals or less. This species was also the most sighted elasmobranch, with 32 sightings in 42 total surveys. However, this species is listed as "Data Deficient" in the IUCN Red List of Threatened Species. On the other hand, it is noted that this recently described species (Last et al., 2016b) had been identified as *Dasyatis kuhlii* and *Neotrygon kuhlii* in earlier records from this area (e.g. Manjaji, 2002; Manjaji-Matsumoto & Jumin, 2011) prior to the revision of the species.

There are also two endangered species recorded and fished in the TMP. The two species are the Zebra Shark (*Stegostoma fasciatum*) and the Scalloped Hammerhead (*Sphyrna lewini*). Although the Zebra Shark was recorded only once throughout the survey period, the Scalloped Hammerhead is actually one of the minor important species, contributing to almost 4% of the total landings recorded, suggesting that a better management strategy should be implemented on this species.

Alarmingly, more than 50% of the species landed are either vulnerable or near threatened (vulnerable= 37.5%, near threatened= 22.5%). It was also reported that there are no fisheries specially targeting sharks in Malaysia (Ali et al., 2004), suggesting all the elasmobranch landings were bycatch. Hall (1996) defined 'unsustainable bycatches' as species that are not currently at risk but if they continue to be caught as bycatch, the population would decline. He also stated that 'critical by-catches' are by-catches of species that are in danger of extinction and this would be the case for the Scalloped Hammerhead and Zebra Shark.

Elasmobranchs are important as fishery resources because they are traditionally consumed by the community in the TMP area especially in Pitas and Kudat. Sharks and rays are used to make 'Sagol' or 'Sinagol', an important dish for local communities because it is considered as traditional food for the Bajau and Suluk in Sabah. Hence, there will always be demand for elasmobranch flesh.

Results of this study have shown that there are various elasmobranchs being fished in the TMP, some of the species have high extinction risks which calls for better management of these species. The government is taking appropriate steps in this direction with the Sabah State Fisheries Department proposing to include four species of sharks and two species of rays in Fisheries (Control of Endangered Species of Fish) Regulations 1999 which falls under Fisheries Act 1985 (Borneo Post Online, 2017). Currently, only Whale Shark (*Rhincodon typus*) and all rays of the family Pristidae (sawfishes) are protected under the Act. Given the conservation status of many of the species, more species should be included in the Act to prevent these populations from collapsing.

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