

Coral Reef Fishes Biomass Estimation Using Visual Observation at Pulau Sembilan Archipelago

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Abstract: Pulau Sembilan archipelago has been proposed to be the first Marine Park in Perak. We conducted a study of coral reef fishes in the island cluster to determine the reef fish's status. This study was conducted using the SCUBA survey with an area of 250 square meters each. Small pelagic fish species and coral reef indicator species were recorded during our study. Cryptic and small fishes such as goby and blennies were excluded. Each transect was placed parallel to the shoreline at a five-meter depth. Divers swam along the transect and count the number of fishes, fish species and estimated the fish size. The number of damselfish topped at all study locations with a frequency of over 76% followed by *Pterocaesio chrysozona* (11.9%) while other fishes were below 3%. Commercially valuable fishes for human consumption such as *Caesio teres* and *Cephalopolis formosa* were found at 1.33% and 1.29% respectively. The total fish biomass was calculated at 740 kg/ha. Pulau Payung Kecil (PPK) had the highest species diversity compared to other sites. Fishes from the family Syngnathidae like seahorses and pipefish were also observed during the sampling in the reef habitat. The highest H' diversity index was at PPK (0.5) followed by PP (0.4), PA (0.3) and PSK (0.3). The lowest value was at PR1 (0.1). Pulau Payung (PP) had the highest number of fish species compared to other islands. We conclude that this area needs attention for coral fishes conservation and the proposed marine park will help protect the marine resources.

Keywords: Pulau Sembilan, Fish Species, Shannon Weiner Index, Biomass, Commercial Fish

Abstrak: Kepulauan Pulau Sembilan telah dicadangkan untuk menjadi Taman Laut pertama di Perak. Kami menjalankan kajian ikan terumbu karang di gugusan pulau untuk menentukan status ikan terumbu. Kajian ini dijalankan menggunakan tinjauan SCUBA dengan keluasan 250 meter persegi setiap satu. Spesies ikan pelagik kecil dan spesies penunjuk terumbu karang direkod semasa kajian. Ikan tersembunyi dan kecil seperti goby dan blennies dikecualikan. Setiap transek diletakkan selari dengan garis pantai pada kedalaman lima meter. Penyelam berenang di sepanjang transek dan mengira bilangan ikan, spesies ikan dan menganggarkan saiz ikan. Bilangan ikan damsel mendahului di semua lokasi kajian dengan kekerapan melebihi 76% diikuti oleh *Pterocaesio chrysozona* (11.9%) manakala ikan lain berada di bawah 3%. Ikan yang bernilai komersial untuk kegunaan manusia seperti *Caesio teres* dan *Cephalopolis formosa* didapati masing-masing pada 1.33% dan 1.29%. Jumlah biojisim ikan dikira pada 740 kg/ha. Pulau Payung Kecil (PPK) mempunyai kepelbagaian spesies yang paling tinggi berbanding tapak lain. Ikan daripada keluarga Syngnathidae seperti kuda laut dan ikan paip turut diperhatikan semasa persampelan di habitat terumbu. Indeks kepelbagaian H' tertinggi ialah pada PPK (0.5) diikuti oleh PP (0.4), PA (0.3) dan PSK (0.3). Nilai terendah ialah pada PR1 (0.1). Pulau Payung (PP) mempunyai bilangan spesies ikan tertinggi berbanding pulau-pulau lain. Kami membuat kesimpulan bahawa kawasan ini memerlukan perhatian untuk pemuliharaan ikan karang dan cadangan taman laut akan membantu melindungi sumber marin.

Introduction

Pulau Sembilan Archipelago is surrounded by deep trenches and fast-flowing current limiting the underwater visibility. The reefs are usually only dived during neap tide and dry season. Selection of diving location and time are crucial when organizing a dive trip there. Our study was conducted in September 2020 to gather the information needed to support the proposal to gazette this archipelago as a Marine Park for the state of Perak.

Reef fishes are important as one of the coral reef condition indicators. The fishes contribute to the fish catches and landing consequently ensuring the balance of the ecosystem food chain. A survey on the fish species composition, density and frequency is a way to categorize the condition of the reef (Schmitt et al., 2002). The information obtained support the management and conservation of marine ecosystems.

The methods for conducting coral reef fish biomass studies varies from catching using nets, traps or harpoon (Mukhashen, 1992). Recently underwater photography or video filming were also introduced. These methods do not threaten the fish resources and are commonly used in marine parks or conservation areas (Nasir et al., 2017). Experience observers also used visual counts (Allen, 1999). Visual survey technique requires a skilled researcher, able to identify reef fishes quickly and also make fish size estimates in situ (Yusuf et al., 2001; Nasir et al., 2017).

Chew et al. (2008) identified 24 families of fish larvae at Pulau Sembilan mainly from the family Carangidae, Engraulidae, Gobiidae and Signatidae. However, the density was lower near the islands compared to the open water further away (Chew et al., 2008). On the other hand, 72 species of coral reef fishes have been recorded around nearby Pangkor Island and mainly from the family Pomacentridae, wrasses (Labridae), goby (Gobiidae) and grouper (Serranidae) (Chew et al., 2008). As a comparison, researchers from Indonesia recorded a total of 108 species of coral fishes around Ternate Island (Utama et al., 2019).

This study was designed to find out the fish biomass and diversity between the islands in the archipelago using visual observation. We will also determine the number and species of commercial fish available. Next, by using the fish species and number, the diversity index of the reef fishes at the archipelago will be determined.

Materials and Methods

Pulau Sembilan archipelago consists of 12 islands including rocky outcrops. The islands are unpopulated except Pulau Lalang which has a temporary station for the Perak State Park ranger (Figure 1). Sixteen sites were selected for this survey covering all the islands (Table 1). We surveyed using underwater visual observation focusing on the commercial and coral related fishes (Schmitt et al. 2002; Hodgson et al. 2006). The fishes were categorized into; a) commercial demersal and pelagic species, b) coral-related fishes and c) other valuable and conspicuous fishes. In this study, small and cryptic fishes were not recorded. These include goby fish and blennies found in this area. Species were identified using references (Allen, 1999).

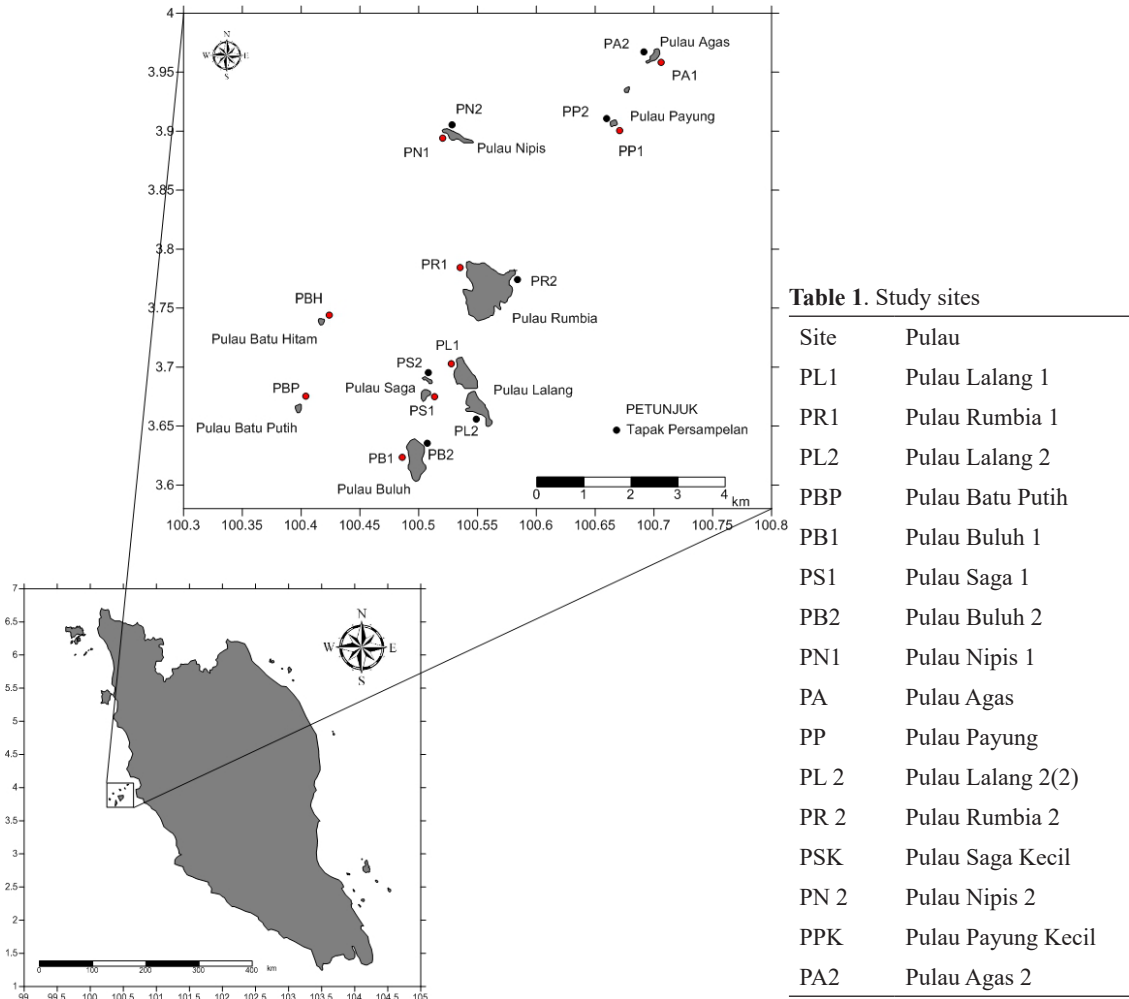


Figure 1. Map of Pulau Sembilan Archipelago

Observations were made using transects as a guide for the survey area covered. The transect length used was 50 m and 5 m wide with an area of 250 m². Observations were made along the transect without dividing it into several parts due to the limited observation distance and the same fish appeared to be repeated over the transect several times. A diver swims along the transect observing the fishes and stop a few times to write down the observations.



Figure 2. Survey method and the visibility of the water

The initial dive determined the number of common fish species as a guide for the survey list preparation. During the survey, the number of fish was counted and the size of each species was estimated using a measuring stick. The average size of each fish species was recorded for biomass calculation (Kulbicki et al., 2005).

The number of fishes was used to calculate the biodiversity index for each site. Shannon Weiner Index, Evenness and Simpson Reciprocal Index (Zar, 2010). The indices were plotted using excel software and were used for discussion in this report.

Results

Twenty-seven fish species were recorded during this study (Table 2). Damsel fishes were dominant at every site followed by *Pterocaesio* sp. The damsels were related to the corals, especially the branching *Acropora* sp.

Table 2. Fish species and observation percentages.

	Species	% observation
1	<i>Neopomacentrus azysron</i>	76.44
2	<i>Pterocaesio chrysozona</i>	11.85
3	<i>Neoglyphidodon nigroris</i>	2.79
4	<i>Caesio teres</i>	1.33
5	<i>Cephalopolis formosa</i>	1.29
6	<i>Siganus canaliculatus</i>	0.88
7	<i>Amphiprion sandaracinos</i>	0.81
8	<i>Scolopsis ciliatus</i>	0.81
9	<i>Scolopsis vosmeri</i>	0.64
10	<i>Chaetodon octofasciatus</i>	0.54
11	<i>Halichoeres nebulosus</i>	0.51
12	<i>Siganus javus</i>	0.45

13	<i>Lutjanus vitta</i>	0.38
14	<i>Scolopsis trilineatus</i>	0.35
15	<i>Thalassoma lunare</i>	0.18
16	<i>Epinephelus boenack</i>	0.16
17	<i>Pempheris</i>	0.16
18	<i>Chaetodon colare</i>	0.12
19	<i>Zanclus cornutus</i>	0.10
20	<i>Pomacanthus annularis</i>	0.05
21	<i>Scarus</i>	0.04
22	<i>Lutjanus lemniscatus (juv)</i>	0.03
23	<i>Abudefduf vaigiensis</i>	0.03
24	<i>Gnathanodon speciosus</i>	0.02
25	<i>Heniochus acuminatus</i>	0.02
26	<i>Sargocentron</i>	0.02
27	<i>Diodon</i>	0.02

Neopomacentrus azyron., *Pterocaesio chrysozona.* *Neoglyphidodon nigroris*, *Caesio teres* and *Cephalopolis formosa* were the most abundant fishes (Figure 2). The diversity of fishes in the Pulau Sembilan archipelago was at an H' average of 0.19 (Figure 3). In addition, only 27 species were among the main and most common species that can be seen around the transects. In terms of number, damselfish topped at all study locations with the frequency of observations recorded exceeding 76%. *Pterocaesio* fish followed this by 11.9%. The percentage of findings of other fishes were below 3%. Commercially valuable fishes for human consumption such as *Caesio teres* and *Cephalopolis formosa* were found with rates of 1.33% and 1.29%. Two types of groupers recorded were *Cephalopolis formosa* and *Epinephalus boenack*. However, only *C. formosa* was found to be larger than 15 cm. The murky water conditions and bad weather affected the survey activities. Heavy rain and high cloud cover made observation difficult.

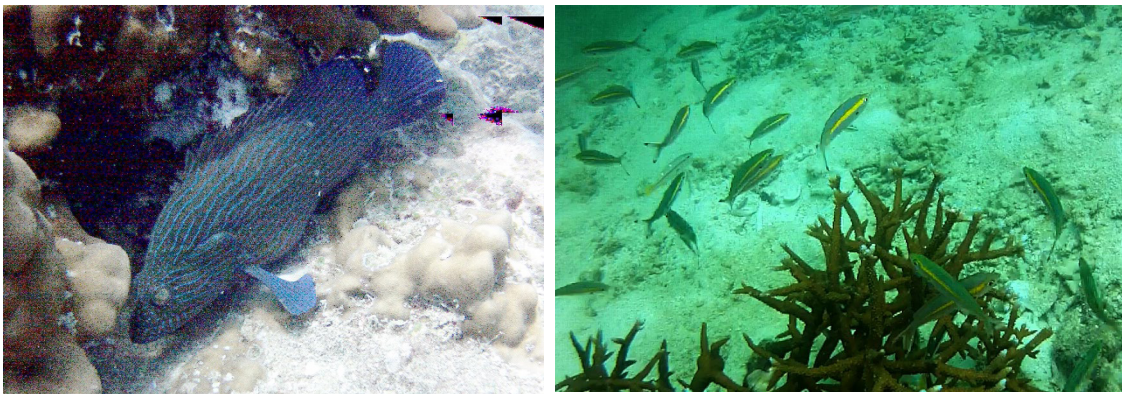


Figure 2. Two of the common fish species *Cephalopolis formosa* and *Pterocaesio sp.*

Sea horses and Pipefishes from the Syngnathidae species were not recorded during the study as they were not found around the transect. Observations outside the transect found that there were more than 3 species of seahorses here. There were also several species of pipefish fish from the same

family.

The blennies and gobies were not recorded because the numbers were high, small and cryptic, which made it difficult to estimate quickly. This species was also not a target species during this study.

The highest number of fish recorded in PP with the number of fish of 1.6872 fish/m². This is followed by PA with the number of fish of 1.6696 fish/ m² and PPK with the number of fish of 1.3704 fish/ m². Throughout the study, it was found that the number of damsels and Pterocaesio fish outnumbered other fishes by more than 10 times. The calculation of the number of fish can be done with two conditions, namely without damsel and pterocaesio fishes or with both species combined. The number of fishes counted without damsel and Pterocaesio showed the highest number of study locations were PPK and PS1. While the calculation of the number of fish including the two species showed the top locations were at PP and PPK.

The total number of fish counted during the study was 12,742 for the whole survey trip. The average number of fish per location was 0.16 individuals/m². The largest number of fish recorded were damselfish.

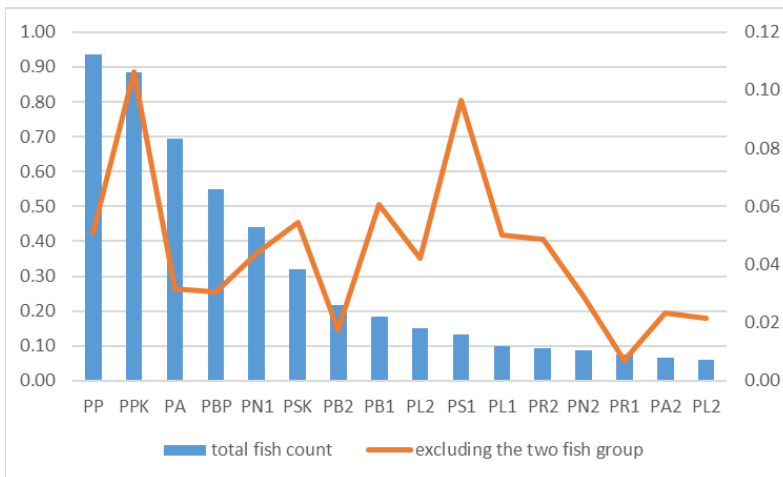


Figure 3. The total fish count in the blue bar and excluding damsel and pterocaesio fish (orange line)

Fish biomass

The biomass of fish during the study was 0.018 kg /m³. The average biomass per study location was 0.004 kg/m³ and 0.006 kg/m³ for trip 1 and trip 2. The fish biomass recorded during the study at the study location during the first week of sampling was higher than the second week. This may be due to several factors such as the number of transects, water clarity and weather during the study. Overall, the highest fish biomass was recorded in three locations namely PPK, PB2, and PP. PPK apart from having a high diversity of species also provides a high amount of biomass compared to other places.

Diversity Index

The highest H 'index diversity was at PPK (0.5) followed by PP (0.4), PA (0.3) and PSK (0.3). The lowest value was at PR1 (0.1) (Figure 2). The highest Simpson Reciprocal Index were at PL1 and PS1 this index indicates a stable habitat and has a high niche diversity (Figure 2). This

reduces competition in habitat utilization as well as provides opportunities for more species to live together. In contrast, a low index indicates unstable habitat, low niche diversity and high competition for places

The number of fishes exceeding 15 cm body length

Commercially useful species on the reefs of Pulau Sembilan were *C. formosus*, *Caesio teres* and *Lutjanus sp.* However, the number of commercial-sized fish was between 21.7 and 16.8 per location. PS 1, PL 2 and PA2 recorded larger fish individuals compared to other locations (Figure 2). *Cephalopolis formosus*, *Caesio teres*, *Pterocaesio digramma* larger than 15 cm were found in PS 1. *Cephalopolis formosus* and *Caesio teres* were larger than 15 cm in PL 2.

Discussion

The number of fish species during this study was low (27 species) compared to other studies conducted around Pulau Sembilan and Pangkor. This was due to the limited target fishes observed. Yusuf, et al., (2009) reported 75 fish species during their survey. Several species of small and cryptic fishes like gobi and blennies were not recorded. Seahorses species were not found along the transect however there were several seahorse species found outside the transect during randomized observations. The coral reef of the Pulau Sembilan archipelago was abundant in seahorses and pipefish species (Lim & Chong, 2015). In addition, murky water conditions with low observation distance and water currents prevented better observations. Fish from the snapper species were rare and only small individuals from the species *L. biguttatus* and *L. vitta* were observed.

The overall fish biomass from both study trips was 0.074 kg/m². Mukhashen (1992) reported high species diversity in their study on an Indonesian reef area with the biomass of fish caught using fishing method recorded at 0.61 kg/standard catch with the main species consisting of *Lutjanus lutjanus* (Big eye snapper) and *Pterocaesio chrysozona* (gold band fusilier). Nasir et al., (2017) and Utama et al., (2019) reported biomass between 0.0060 - 0.0116 kg/m² and 0.0042 kg/m² in a study conducted on the coral reefs of Batee Island, Indonesia.

Table 3. Biomass of this study compared to studies elsewhere

Studies	Coral reef of Pulau Batee, Indonesia (Nasir et al., (2017)	Pulau Sembilan, Perak (this study 2020)	Ternate Island, Indonesia (Utama et al., 2019)
Fish Biomass	0.0060 - 0.0116 kg/m ²	0.074 kg/m ³	0.00420 kg/m ²

More than 12,000 fish were counted during this study in the waters of Pulau Sembilan. The biomass exceeded the reported biomass in other areas by other researchers for example Nasir et al., (2017). The most numerous individuals found were fishes from the damsel group. Apart from damsel fish, other fishes present in the transect were semipelagic fishes such as yellow and blue-backed fusilier (*Caesio teres*) and gold band fusilier fish (*Pterocaesio chrysozona*). Ranking results differed if the total number of fishes was calculated without the two main species namely damsel and pterocaesio. The results of this study showed that these reefs were dominated by planktivory fishes such as damsel and fusilier which contribute to more than 50% of the recorded biomass. Locations influenced by the number of damsels may indicate areas that are important as nursery areas or feeding areas of predatory fish.

Large and commercially valuable fishes observed were grouper *Cephalopolis formosus*, *Caesio terra* and *Gnathanodon speciosus*. During this study, the largest fish recorded was *Scarus sp.*

which was larger than 30 cm in length. This may be due to low visibility and fishes did not approach researchers using SCUBA equipment.

The Simpson index values showed that Pulau Payung Kecil (PPK) was the highest compared to other places. This was followed by Pulau Payung and Pulau Agas. This may be due to the higher diversity of niches that accommodated various types of fishes with lesser competition for habitat space.

Conclusion

Our study showed that Pulau Sembilan has high fish biomass compared to other places referred to. The fish biomass recorded was at 740 kg/ha. Pulau Payung Kecil and Pulau Payung were high in fish species diversity compared to other islands within this archipelago, which may be due to the coral reef complexity. A diverse group of fishes inhabits the coral reef of the Pulau Sembilan archipelago and needs protection that is crucial to protect the fishery resources.

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