Incidence of ghost nets in the Tioman Island Marine Park of Malaysia

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Received: 16 June 2023 || Revised: 28 Nov. 2023 || Accepted: 06 Feb. 2024

ISSN: 1656-4707
E-ISSN: 2467-5903
Homepage: www.palawanscientist.org

How to cite:
Chelliah AJ, Chen SY, Shahir Y and Dolorosa RG. 2024. Incidence of ghost nets in the Tioman Island Marine Park of Malaysia. The Palawan Scientist, 16(1): 28-37. https://doi.org/10.69721/TPS.J.2024.16.1.04

ABSTRACT

Ghost nets are major contributor to ocean pollution with extensive social, economic and environmental impacts. Ghost nets trap marine life, build up sediment, and smother and damage sensitive bottom habitats such as coral reefs and seagrass beds. Data on ghost nets are widely available for many coastal locations but there has been very limited information from Malaysia specifically Tioman Island. In 2015, Reef Check Malaysia started training local islanders to locate and remove ghost nets from reefs and beaches around Tioman Island. A reporting hotline was set up to gather information on ghost nets. Once vital information was gathered, the local islanders retrieved them and recorded the ghost nets and sent them for proper disposal. A total of 145 ghost nets weighing over 21 t were retrieved from Tioman Island from 2016 to 2022. The volume of ghost nets retrieved showed an increasing trend and were often found in March, April and September. The ghost nets originated from fishermen operating illegally inside the marine protected area (MPA) and legal fishermen operating outside the MPA. Ghost nets find their way to Tioman Island with strong currents and monsoonal winds. Most of the ghost nets retrieved were inside the MPA and on the western side of Tioman Island. Higher human population, shallower waters, shoreline morphology, dominant coral growth design and reef rugosity on the western side of Tioman Island are reasons for higher ghost nets sightings, thus retrieval and management efforts should focus on this side.

Keywords: coral reefs, fishing, protected area

INTRODUCTION

The abandoned, discarded and lost nets, commonly called ghost nets, have been causing injuries and death of marine animals, cause navigational hazards and environmental damage (Macfadyen et al. 2009; Butler et al. 2013; Richardson et al. 2022). Ghost nets are major contributor to ocean pollution, with extensive social, economic, and environmental impacts causing damage to coral reefs, mangroves and seagrass beds (Richardson et al. 2022). Ghost nets break corals, damages vegetation, build up sediment, and smother and damage sensitive bottom habitats such as coral reefs and seagrass beds

(Macfadyen et al. 2009; Balderson and Martin 2015; Laura et al. 2018).

Ghost nets have been reported to cause injury and death of fish, crustaceans, seabirds, marine mammals and reptiles due to entanglement, suffocation and ingestion (Macfadyen et al. 2009; Stelfox et al. 2016). Globally, an estimate of more than 136,000 marine organisms have been caught, injured and killed yearly by ghost nets (WSPA 2014). For instance, in Australia, it is estimated that 1,500 Australian sea lions *Neophoca cinerea* die yearly from entanglement with ghost nets (WWF 2020). In 2018, about 300 turtles were found dead in a single ghost net incident in Mexico (Green Peace 2019). More recently, in January 2023, nine bamboo sharks were found entangled of which four were dead in a single ghost net incident in Tioman Island, Malaysia.

Annually it is estimated that 2,963 km^2 of gillnets, 75,049 km^2 of purse seine nets and 218 km^2 of trawl nets are lost to the ocean (Richardson et al. 2022). A study of the Great Pacific Garbage Patch, an area of marine debris accumulation in the subtropical waters between California and Hawaii, estimated that it contained over 36,000 t of fishing nets (Lebreton et al. 2018). In the Black Sea coasts of Turkey, the number of nets lost yearly was 1,627 panels (Dagtekin et al. 2019). Nearer to this region in the coastal waters of South Korea, it is estimated that 38,535 t of gillnets entered the ocean every year (Kim et al. 2014). A recent study in 2020 in the Gulf of Carpentaria, Australia, recorded over 1,400 pieces of ghost nets (Hardesty et al. 2021). Nearer to Malaysian waters in Sadeng, Indonesia, it is estimated around 40,000 pieces of gillnets are lost annually (FAO 2017).

While many studies have been done about the incidence of ghost nets in North America, Europe, Atlantic and Indian Oceans, little to none has been reported from Africa, Asia and South America (Richardson et al. 2019). Very limited information on the incidence of ghost nets in Malaysia exist, while there is none for Tioman Island, Malaysia.

Tioman Island hosts three marine ecosystems – coral reefs, seagrass beds, and mangrove forests – that create important connectivity in the life cycle of many marine species, including green and hawksbill turtle, blacktip reef shark, sea snake, snapper and other fish which migrate between these ecosystems during the different stages of their life. Tioman Island serves as nurseries to numerous fish and prawns, nesting site and staging ground for green and hawksbill turtle, and also part of the wider and extensive migratory routes for whale sharks and marine mammals such as the false killer whale and Indo-Pacific bottlenose dolphin, which are sighted periodically. Many pods of dolphins are resident around Tioman Island (Chelliah et al. 2022).

In 1994, the waters extending 3.7 km around the island were gazetted by the Department of Fisheries Malaysia as a marine park under the Fisheries Act 1985 where all forms of fishing were prohibited (Lau et al. 2019; PLANMalaysia 2019) in order to protect fish breeding grounds and ensure that fisherman could sustainably reap the benefits from the spillover effect. Today, Tioman Island has a small local population of around 3,500 people, of which more than 75% depend on tourism as their main source of income (PLANMalaysia 2019) and with less than 30 individuals registered as fishers with the Department of Fisheries Malaysia. Over 250,000 tourists visit the island yearly (Tourism Pahang 2019) for its beautiful sandy beaches, crystal clear water and healthy coral reefs. Though only a handful of locals still remain as fishermen, commercial fishing fleets from coastal towns on the peninsular actively fish the waters surrounding the island while international fishing fleets fish the Exclusive Economic Zone boundary less than 75 km away from the shores of Tioman Island. Fishermen in the surrounding waters often use gillnets, trawl nets and purse seine nets. The abandoned, lost and discarded nets from these activities are drifting towards Tioman Island Marine Park causing reef damage and wildlife mortalities. Information about the presence of ghost nets is thus essential in understanding the extent of its threat to the marine life within the Tioman Island Marine Park. This study documented the number, volume and location of ghost nets found and retrieved from Tioman Island Marine Park between 2016 to 2022.

METHODS

Study Site

Tioman Island Marine Park is situated in the South China Sea at 2º48'N and 104º10E (Figure 1), about 50 km from the jetty in Mersing, Johor and 57 km from the jetty in Kuala Rompin, Pahang and is located within the implementation boundary of the Coral Triangle Initiative. The island is approximately 20 km long and about 12 km wide, with a total area of 133 km^2 (PLANMalaysia 2019), a coastline of about 69 km (DMPM 2012) and surrounded by 5.46 km^2 of fringing reefs (Lau et al. 2019) with most of the reefs located on the western side of the island (PLANMalaysia 2019). The eastern side of the island is facing the South China Sea while the western side is facing mainland Peninsular Malaysia. The nearest fish landing sites – Mersing, Endau and Penyabong – are approximately 43 to 55 km away in the Mersing District with fish landings concentrated at Endau (JICA 1993).

In 2014, Reef Check Malaysia, an NGO working towards sustainable management of coral reefs in Malaysia, started a program called "Cintai Tioman" (Love Tioman) on the island. The program is the first long-term community-based project in

Malaysia. The program aims to protect coral reefs around Tioman Island and to improve the livelihoods of the local community. The end goal is to ensure sustainable use of the island's natural resources for the benefit of all stakeholders.

Data Gathering

In the past, ghost net retrieval efforts within the marine protected area were mainly done during annual clean-up events organized by park managers or by dive operators. In 2015, Reef Check Malaysia started training local islanders known as the Tioman Marine Conservation Group (TMCG) to locate and remove ghost nets from reefs and beaches around Tioman Island. A reporting hotline was set up to gather information on ghost nets from dive centers, snorkel guides and tourists. Reports also came in from social media platforms. Once vital information such as the location, size, type and depth of the ghost nets is gathered, the TMCG would retrieve the ghost nets and send them for proper disposal. Weight of nets were recorded using top loading scale at the incinerator, hand held scale or estimation. The documentation started in 2016 until 2022.

Data Analysis

The incidence of ghost nets was determined using descriptive data analysis by summing the number and weight of retrieved ghost nets from 2016 until 2022. The data were graphically presented using Microsoft Excel.

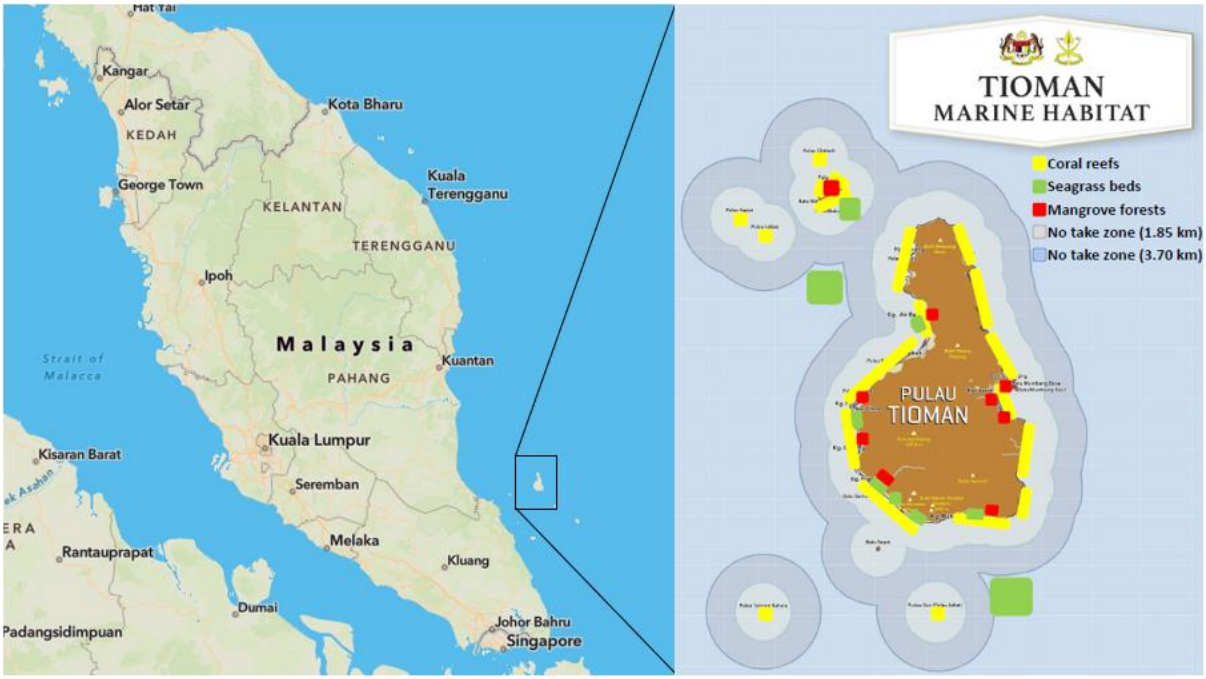

Figure 1: Geographical location of Tioman Island Marine Park, Malaysia.

RESULTS

Volume and Number of Ghost Nets

The volume of ghost nets showed an increasing trend with a drop in 2019, the year before Malaysia was hit by COVID-19 pandemic. From a total of 11 ghost nets in 2016, numbers rose to 39 in 2022. The total weight per year ranged from 1.3 t to 7.3 t (Figure 2). Based on data over the years, ghost nets were often found in March and April as well as in September (Figure 3).

Location and Volume of Retrieved Ghost Nets

Figure 4 shows the locations of ghost nets retrieved around Tioman Island for 2016, 2017, 2018, 2019, 2020, 2021 and 2022, respectively. Most of the ghost nets retrieved were inside the marine protected area no-take zone where coral reefs, seagrass beds and mangrove forests can be found. Though ghost nets were found on reefs and coastlines around the island, some hot spots were identified. Highest numbers and volume of ghost nets were recorded along the western coast of the island including around P. Tulai Candang (Figures 5 and 6).

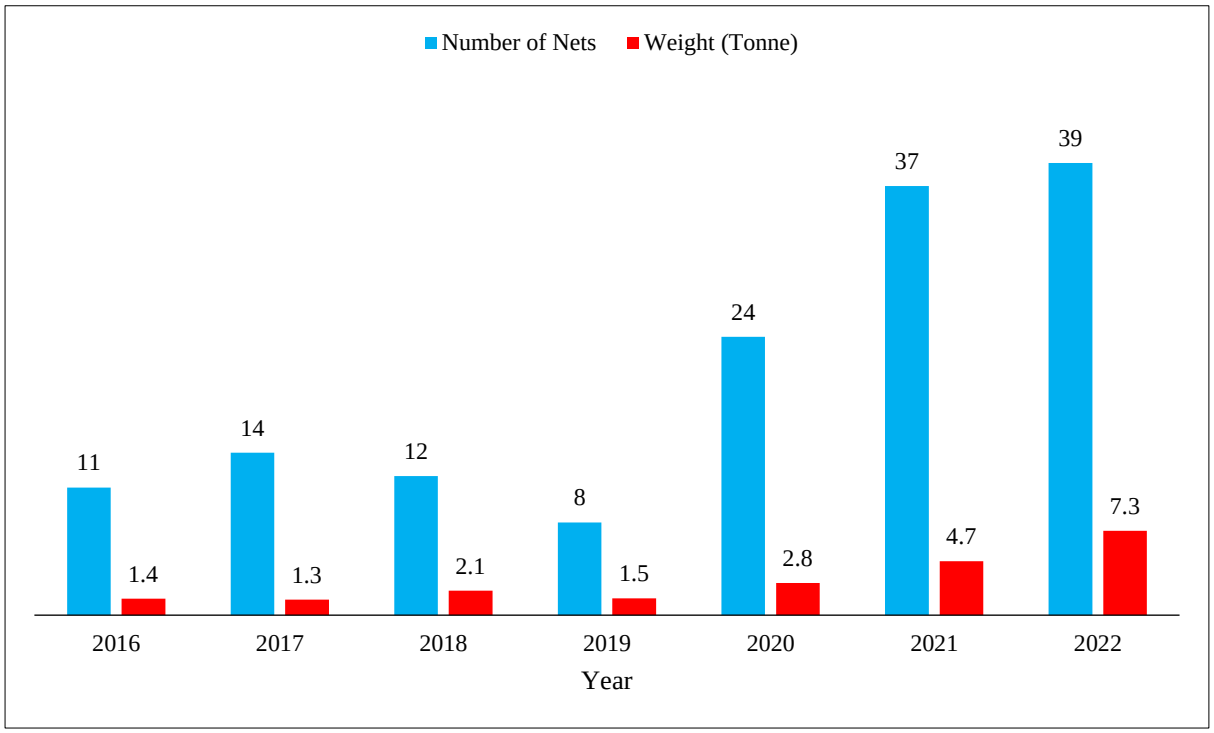

Figure 2. Numbers and total weights (tons) of ghost nets retrieved around Tioman Island Marine Park from 2016 to 2022.

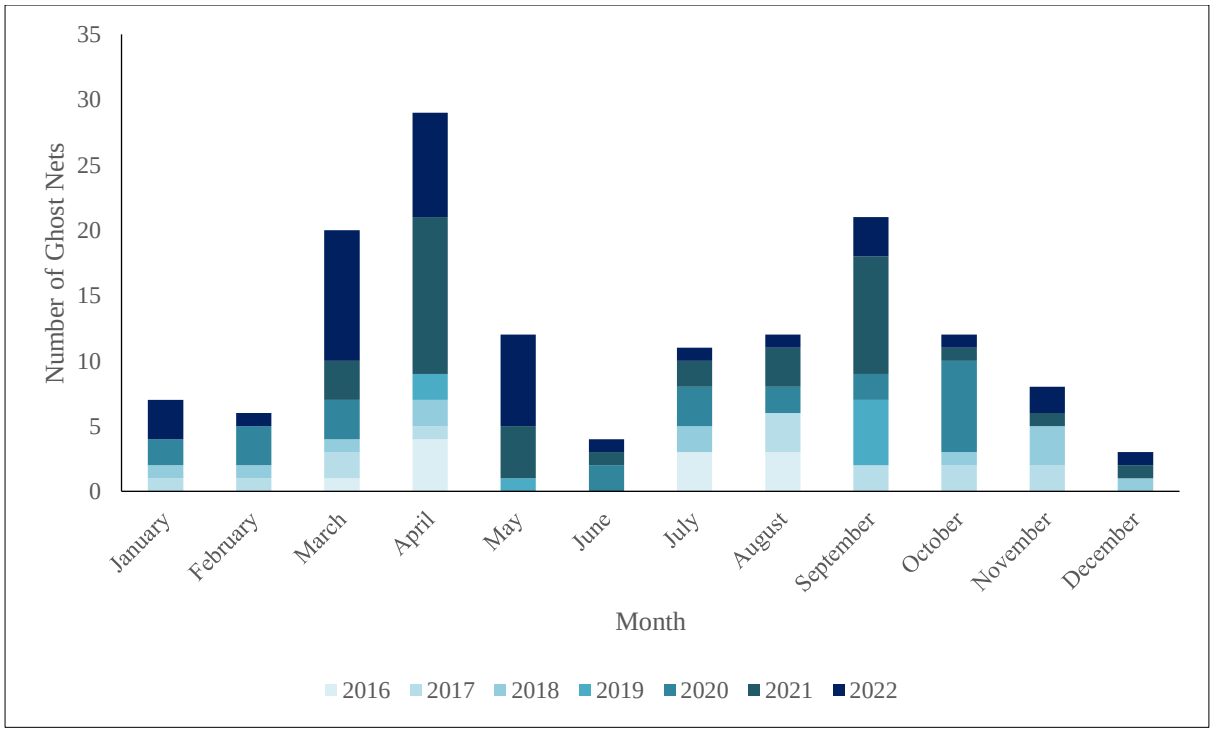

Figure 3. Monthly number of ghost nets retrieved around Tioman Island Marine Park between 2016 to 2022.

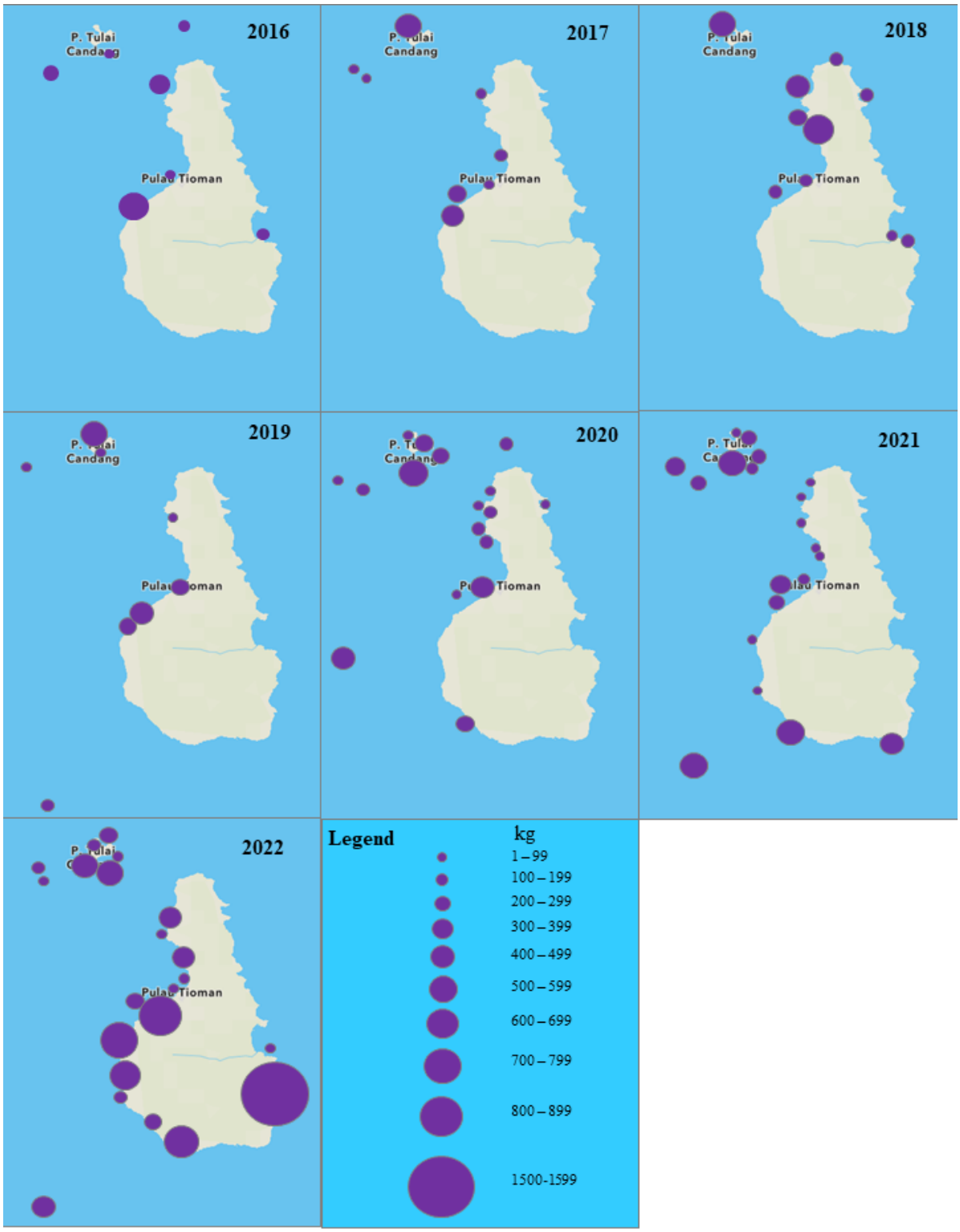

Figure 4.Weight (kg) of ghost nets retrieved around Tioman Island between 2016 and 2022.

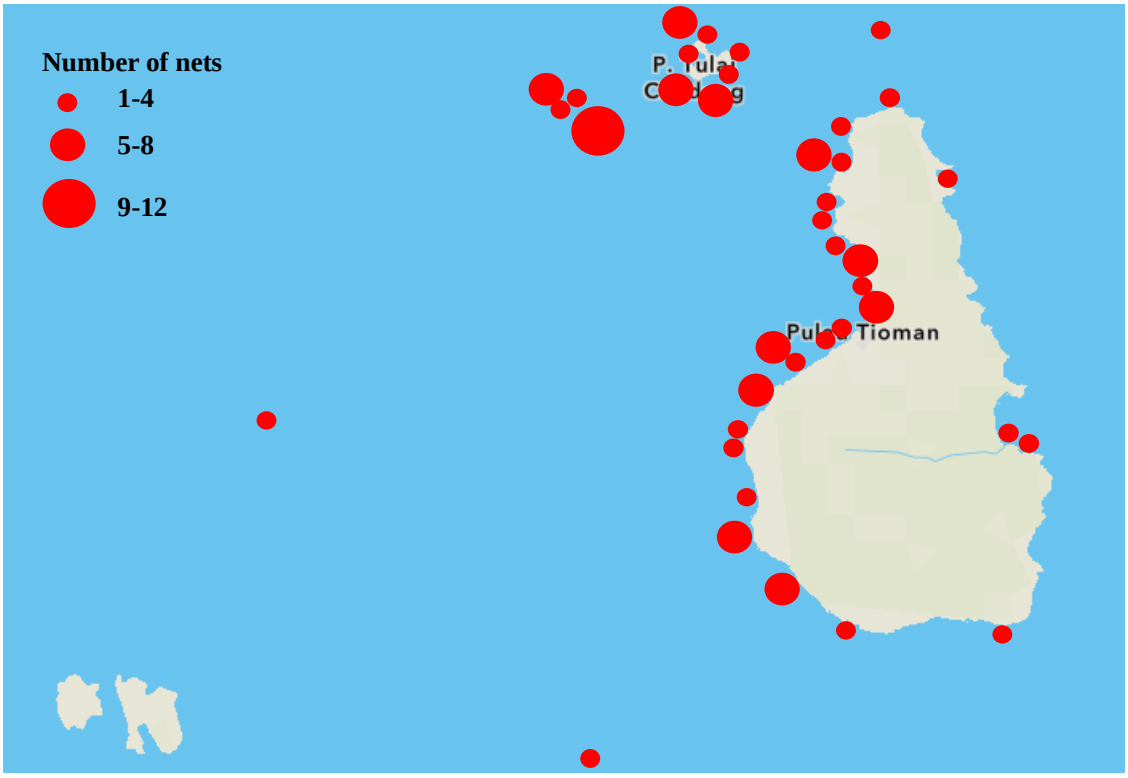

Figure 5. Number of ghost nets retrieved within the period of 2016 and 2022 around Tioman Island.

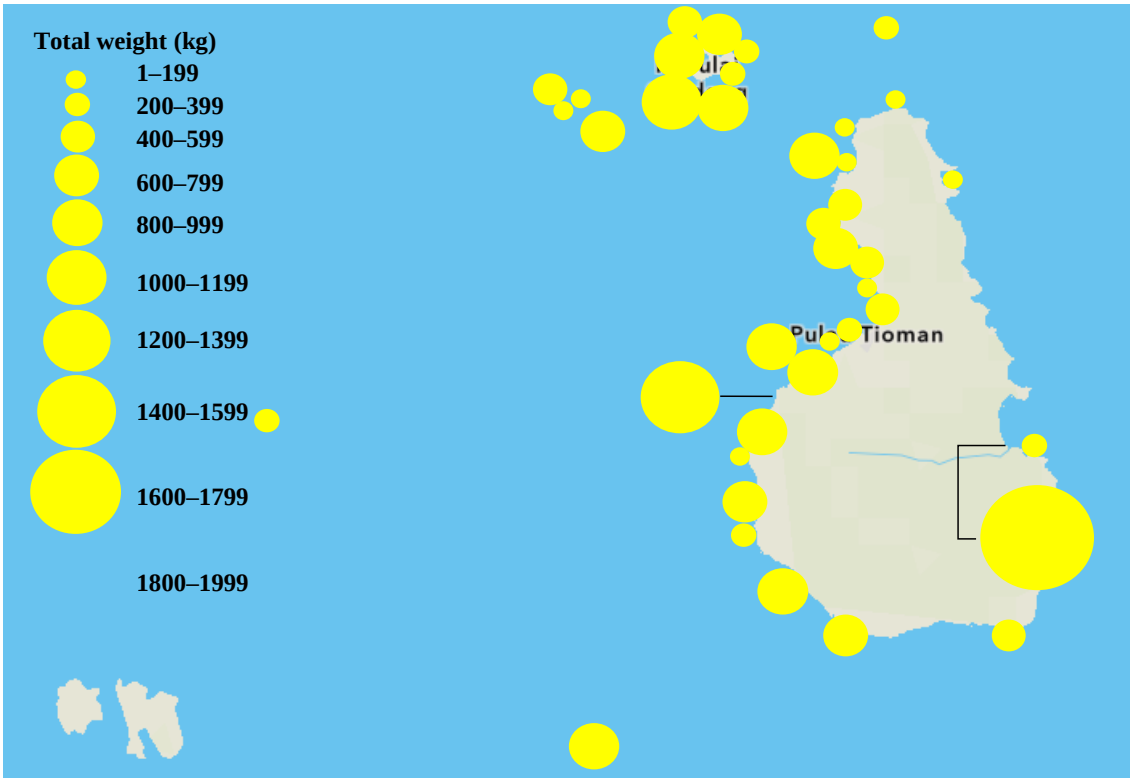

Figure 6. Weight (kg) of ghost nets retrieved within the period of 2016 and 2022 around Tioman Island.

DISCUSSION

Volume and Number of Ghost Nets

Though the Tioman Island Marine Park is set up to safeguard the fishing industry, the industry continues to threaten marine life in the form of ghost nets. Fishing nets are lost from vessels for a variety of reasons including adverse weather, when it is improperly stored and washed overboard, when vessels are inadequately maintained, and when crew are incompetently trained and inexperienced (Macfadyen et al. 2009; Richardson et al. 2018; Richardson et al. 2019). Fishing nets are often abandoned when it is inadequately marked and the cost of gear retrieval is high (Macfadyen et al. 2009; Richardson et al. 2018). Enforcement pressure can also cause illegal fisherfolk to abandon gear in an attempt to flee from authorities (Macfadyen et al. 2009). High disposal costs and availability of shoreside collection facilities are other contributing factors to fishers dumping used nets in the sea (Macfadyen et al. 2009; Richardson et al. 2018).

Ghost nets found around Tioman Island originate from fishers operating illegally inside the marine protected area as well as legal fishers operating outside the marine protected area. With strong currents and monsoonal winds, ghost nets that are abandoned, lost or discarded in the sea, outside the marine protected area, can find their way to Tioman Island ending up entangled on coral reefs and mangroves or washed up on shore. The presence of biofouling organisms such as algae and barnacles on the ghost nets are good indicators that the nets have been in the water for some periods of time. Ghost nets that are abandoned, lost or discarded by illegal fishers inside the marine protected area are usually clean and absent of biofouling organisms.

For most parts of 2020 and 2021, the island was closed to tourism following the Movement Control Order (MCO) to curb the spread of COVID-19. The MCO was first implemented on 18 March 2020 and was converted to conditional MCO (CMCO) from 04 May 2020 onwards. The CMCO continued until 09 June 2020, after which the recovery MCO (RMCO) was activated from 10 June 2020. During RMCO, tourism sector was reopened, however the international borders remained closed except for approved travel (Hashim et al. 2021). In January 2021, MCO was reintroduced and interstate travel was banned. The interstate travel ban was only lifted on 11 October 2021 for fully vaccinated individuals (Kuok 2021), while international borders for travelers from all countries were only reopened on 01 April 2022 (KKM 2022). During this period a spike in ghost nets was recorded. This was mainly due to an increase in fishing activities, including illegal fishing activities within the marine protected area. During MCO, those working in fisheries were considered essential services, and activities related to fishing were allowed to operate (MITI 2020). This means fishers could cross borders and go out to sea and fish. Many who had lost income due to the MCO, turned to fishing during this period but lacked the skills and knowledge regarding the sea, fishing grounds or how to properly use fishing nets. Although the MCO was lifted and tourism resumed in 2022, the number of ghost nets retrieved remained high.

Fish and seafood is the prime animal protein source in the Malaysian diet (Goh et al. 2021) and fish tends to dominate over other animal protein sources (Nik Mustapha and Ahmad Zubaidi 1999; Ibrahim et al. 2014). During the height of COVID-19 pandemic in 2020 and 2021, control measures imposed by many countries had restricted international trade; causing disruptions of supply from the imported fish and fish-related products due to closure of some country borders, forcing local consumers to depend on local fishery resources (Menhat et al. 2021). This probably increased the demand for local fish and fish-related products from local consumers (Menhat et al. 2021) and hence fishing activities.

Although with the increase in volume and number of ghost nets per year during and after the height of COVID-19 pandemic, the number of ghost nets around Tioman Island is considered very low in comparison to other places such as the Black Sea coasts of Turkey – 1,627 panels per year (Dagtekin et al. 2019), South Korea – 38,535 t of gillnets per year (Kim et al. 2014), Sadeng, Indonesia – 40,000 pieces of gillnets per year (FAO 2017) and the Gulf of Carpentaria, Australia – over 1,400 pieces ghost nets in 2020 (Hardesty et al. 2021). Even at Andrott Island Lakshadweep, India which recorded 38 ghost nets in 2020, the number was documented over a 3-week survey period (Sahab et al. 2021) and is considered high compared to Tioman Island.

The Northeast monsoon season in Tioman Island is between November and March (DMPM 2012). The monsoon winds and currents bring ghost nets into the island. However, heavy rainfall and strong winds during this time make the surrounding seas rough, thus hindering ghost net retrieval efforts and causing a backlog of ghost nets to be retrieved. Water activities on the island resume in March and April. As a result, during this period a spike in ghost nets was recorded. High number of ghost nets recorded in September can be attributed to the inter-monsoon phase, the transition period between Southwest monsoon and Northeast monsoon (Mohd Fadzil et al. 2014). During the inter-monsoon phase, heavy rain and strong winds bring ghost nets into the island.

The variation in the number of ghost nets compared to total weight was due to the type and size of ghost nets collected. The type of ghost nets found around Tioman Island were gillnets, trawl nets and purse seine nets with the majority being gillnets. An

average gillnet weighs 20 to 30 kg while a trawl net weighs over 500 kg.

Location of Ghost Nets

The western side of Tioman Island has a larger population and more villages along the coast (Lechner et al. 2020). The reefs are frequently visited by divers and snorkelers (Lau et al. 2019), making the chances of ghost nets sighting higher. The remoteness of the eastern coastline that only has one village and not many diving or snorkeling locations added with the deeper waters along the east coast (Cob et al. 2002) is probably the reason for lower sightings of ghost nets. The shoreline morphology, dominant coral growth design and reef rugosity differ between the east coast and west coast (Lee et al. 2006; Kharina et al. 2016; Shahbudin et al. 2017) and this too might be a reason for lower sightings of ghost nets along the east coast.

Although fishing activities happen all around Tioman Island, the coastal waters between western side of Tioman Island and mainland Peninsular Malaysia are commonly fished by fishers from mainland (JICA 1993) because the western side of Tioman Island is more sheltered from waves and winds compared to the eastern side that is open to and facing the South China Sea (Lechner et al. 2020). The coastal waters are fishing ground for a large fleet of commercial fishing boats especially from Endau and Mersing (JICA 1993). During the southwest monsoon, winds and currents flows toward the western side of Tioman Island (Zuraini and Mohd Fadzil 2016), thus bringing ghost nets into the island. Fishers often rest, take shelter from storms, refill supplies and visit the mosque on the western side of Tioman Island. When anchored, they have been seen mending broken fishing nets and discarding fragments of damaged fishing nets into the water during nets mending.

Proposed Management Efforts

Ghost nets are threat to marine life and can cause severe damage to marine ecosystems. Local government agencies along with marine park managers must work together to overcome this issue to minimize loss of biodiversity and income to both the fishermen as well as tourism operators that depend on healthy marine ecosystems. The reasons for ghost nets ending up in the environment are varied, hence solutions to this problem must be multipronged and transboundary.

Management efforts should look into the prevention of ghost nets. Awareness campaign with fishing communities should be conducted to help them to understand the impacts of ghost nets. Collection bins should be provided at all fish landing ports and incentives could be provided to fishers to encourage them to dispose used or damaged nets responsibly. The sale of fishing nets should be regulated by the Department of Fisheries Malaysia and only registered fishermen should be allowed to purchase fishing nets and old nets must be returned before new ones are allowed to be purchased. Ghost nets are a transboundary issue hence the Malaysian governments must work with neighboring countries to overcome this problem. The use of modern technologies to track and retrieve fishing gears should be explored. On Tioman Island, frequent reef surveys and monitoring should be conducted on the west coast of the island where most ghost nets have been recorded to ensure nets are retrieved quickly and minimal damage is caused to marine life.

FUNDING

The majority of this work was sponsored by Yayasan SIME Darby.

ETHICAL CONSIDERATIONS

This study did not involve the use of any living organisms.

DECLARATION OF COMPETING INTEREST

There are no competing interests to any authors.

ACKNOWLEDGMENTS

We would like to thank Yayasan SIME Darby and the Department of Fisheries Malaysia for their support over the years. We would also like to thank the local community for sending in reports and all the members of the Tioman Marine Conservation Group and Green Fins dive centers that have played a role in ghost net removal efforts. We are also grateful for the comments and suggestions of the anonymous reviewers.

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ROLE OF AUTHORS: *AC – contributed in the conception and design of the work, data collection and writing of the manuscript, CSY – contributed in design of the work, data analysis and writing of the manuscript, SY – contributed in data collection and revising the manuscript, RGD – contributed in the conception and design of the work, and in writing of the manuscript.*

Responsible Editor: Niño Jess Mar F. Mecha, MSc