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Population Structure of the Halmahera Walking Shark (*Hemiscylium halmahera*) Endemic Species in Morotai Island Sea, North Maluku, Indonesia

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ABSTRACT

Halmahera walking sharks (*Hemiscylium halmahera*)are listed in the IUCN's Near Threatened Category due to the fishing activity catch criterion (International Union for Conservation of Nature). This study focused on the cohort distribution of length intervals and conditions. Samples of 30 individuals were collected at a depth of 1 to 10 meters, where scuba diving uses minimal diving equipment in the areas of seagrass, mangrove and coral reef (South Morotai, North Morotai, South West Morotai, and East Morotai). For the Halmahera walking shark population, three age groups were detected, with various lengths: 22-81, 42-103 and 62-125cm. Separation indices of >2 were recorded for the three groups. Given that tiny to large sizes are present, the distribution spans the 21.5-82.3cm class, which explains why the length frequency was regularly distributed. The range of the Halmahera walking shark's condition factor on Morotai Island is 0.8169-1.4264. (mean 1.0064). The male sex condition factor ranged between 0.8470 and 1.1227 (mean 1.0032), and the female genitalia fluctuated between 0.8402 and 1.4331 (average= 1. 1.0086). Therefore, the ecological state of the Halmahera walking shark population fishery in the seas off Morotai Island was successfully revealed via this investigation. Information and data are adequate to be utilized in launching species conservation policies.

INTRODUCTION

Geographically, the Halmahera archipelago includes the Morotai Island. This area is a hotspot for great biodiversity **(Allen, 2000; Huffard *et al.*, 2012)**. The coral triangle include the Halmahera region, which has a wide variety of zooxanthella corals **(Veron *et al.*, 2009)**. Geographically, Morotai Island benefits from oceanography, coral reef habitats, seagrass, mangroves and a variety of fish species. 1624 reef fish are present, 30.3-71.06% of the coral is covered, and the southern portion of Morotai Island has a distribution of mangroves and seagrass **(Koroy *et al.*, 2019; Purba *et al.*, 2019; Wahab *et al.*, 2020)**.The existence of fish species, particularly the Halmahera walking shark, is supported by the presence of coastal ecosystems.

The Halmahera walking shark's distribution was recorded in the study of **Wahab *et al.* (2022)** in Morotai Island's shore. One of Halmahera's marine endemic species is the walking shark **(Akbar *et al.*, 2019)**. In the Ternate and Bacan areas of the Halmahera sea, this species was discovered and recorded in the work of **Allen *et al.* (2013)**. Gurango Tokek, gurango bodo, gurango buta, gurango loreng, gurango nyare and gurango haga are some native names for the Halmahera walking sharks **(Jutan *et al.*, 2018; Akbar *et al.*, 2019)**. This species of nocturnal animal inhabits shallow waters near coral reefs, seagrass beds and mangrove environments with sandy substrates **(Allen & Dudgeon 2010; Allen *et al.*, 2016; Jutan *et al.*, 2017; Madduppa *et al.*, 2020; Mumin *et al.*, 2021)**. A type of reef fish in the Hemiscyllidea family is the walking shark, often known as the bamboo shark **(Allen *et al.*, 2013)**. The Hemiscyllidea family prefers coral reef habitats since they provide food, spawning grounds and rearing protection for their animals **(Compagna, 2001, Allen & Ermann, 2008; Allen *et al.*, 2013; Heinrich *et al.*, 2014, 2015; Widiarto *et al.*, 2020)**. This species walks like an animal by using its two pectoral fins to propel itself through the water column.This procedure is used to locate food and facilitate local migration **(Madduppa *et al.*, 2020)**.The marine biota consumed by the Halmahera walking sharks include annelids, polycaetes, crabs, larvae and fish bones **(Janson *et al.*, 2012; Allen *et al.*, 2013; Jutan *et al.*, 2019)**.

There are nine species of walking sharks in the genus Hemiscyllium, of which two are listed in the IUCN (*International Union for Conservation of Nature*) Red List as Near Threatened and five as Vulnerable **(VanderWright *et al.*, 2021)**. According to IUCN (*International Union for Conservation of Nature*) data, the walking shark population in Halmahera is near threatened (near threatened), which indicates the existence of a lot of human activity or environmental deterioration, causing the population to decrease. According to a preliminary study **(Jutan *et al.*, 2016)** conducted in Kao Bay, the causes contributing to the population loss were habitats vulnerable to anthropogenic activity-induced habitat degradation and mining processes that led to the introduction of mercury waste streams. According to **Jutan *et al.* (2018)**, there are signs that the Halmahera walking shark population in this area has been overfished. High levels of anthropogenic activity can lead to the decline or extinction of species or populations. An increase in the amount of anthropogenic CO_2 emitted into the environment is a result of global industrialisation, fast deforestation and the burning of fossil fuels for the sake of primary energy. Since animals develop hypoxia and anoxia as a result of the increase in CO_2, their embryonic growth is in danger **(Johnson *et al.*, 2016)**. Large bulk and slow movement increase the likelihood of being eaten by sharks **(Saraswati, 2016)**. According to local information, octopuses and mangrove crabs (*Scylla serrate*) also devour Halmahera walking sharks. Mangrove crabs are caught using traditional fishing methods including fishing traps bubu and walking shark meat as bait. Sharks are simpler for humans to catch because of their huge bulk and slow pace. Based on size structure and reproduction, fishing activities have a greater impact on the dynamics of fish populations **(Satria & Kurnia, 2017)**.

Numerous places in the North Maluku waters have been subject to Halmahera walking shark investigations **(Allen *et al.*, 2013, Jutan *et al.*, 2016, 2018, Akbar *et al.*, 2019, Mukharror *et al.*, 2019, Madduppa *et al.*, 2020, Mu'min *et al.*, 2021, Wahab *et al.*, 2022)**. There are data gaps since prior study did not cover certain features of the Morotai Island population. On Morotai Island, there is no information available regarding the population makeup of the Halmahera walking shark. The lack of information availability demonstrates the need for population structure study. Fish population structure must serve as the foundation for all conservation management and policy decisions **(Chiang *et al.*, 2008; Pertiwi *et al.*, 2017)**. For assuming and estimating population based on number, biology, population dynamics and reproduction for management indicators, population structure knowledge is crucial **(Heupel & Bannet, 2007; Jamal *et al.*, 2011; Hasibuan *et al.*, 2018)**. Data on population structure is used to support policy for sustainable resource management, fisheries development and stock information **(Suwarso and Zamroni, 2014; Toatubun *et al.*, 2015; Chodrijah *et al.*, 2020)**. The Halmahera walking shark's population structure in terms of age group (cohort), long frequency distribution and condition parameters in the waters of Morotai Island was the main target of the study.

MATERIALS AND METHODS

1. Study Area

Samples were collected between July 2021 and February 2022. Morotai Island was selected as the location of the study site (128^{o}15'00"-128^{o}48'00"E and 00"E-2^{o}00'00"-2^{o}40'00"N). South Morotai (128^{o}27'63"E and 2^{o}06'48"N), North Morotai (128^{o}65'20"E and 2^{o}34'14"N), South West Morotai (128^{o}21'16"E and 2^{o}25'27"N) and East Morotai (128^{o}56'43"E and 2^{o}08'82"N) were the sampling locations (Fig. 1). The research station served as a metaphor for the entirety of Morotai Island.

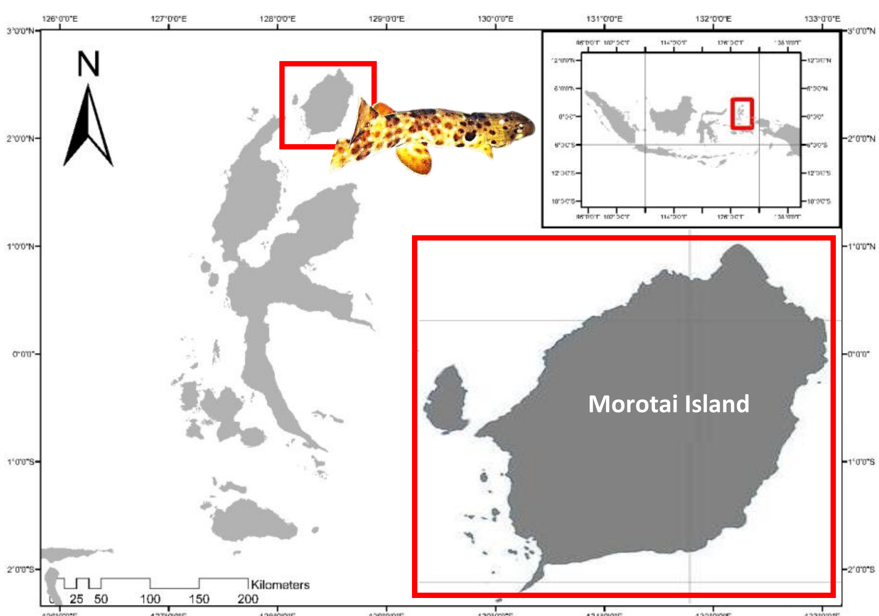

Fig. 1. *Hemiscyllium halmahera* study area in Morotai Island Sea

Halmahera Island is geographically bordered by the Pacific Ocean, the Halmahera Sea, the Maluku Sea and the mainland of Halmahera Island. Morotai Island is situated north of Halmahera Island (part of Halmahera Archipelago). This island has an interesting geographical position for bordering the Pacific Ocean. Mangroves, seagrass and coral reefs are the three coastal ecosystems on this island. The amount of Pacific Ocean water, the Indonesian Cross Current (Arlindo), the Eddy Current and the coastline current of Papua New Guinea all have an impact on the Morotai seas (New Guinea Coastal Current-NGCC). 117 kilometers separate Morotai Island from Halmahera Island's main land. With a distance of 1.303 kilometers, West Papua borders Morotai Island's eastern side. Although there are many different fish species in the waters of the Morotai Island, no reports of the walking shark halmahera have been made. Since this species population is endemic, it is crucial that we provide information about its presence and current state for urgent population management and species conservation management.

2. Sampling

Sample collection was carried out during the day and at night. We conducted sampling during the day because of the sleeping and passive behavior of these animals. Collection was carried out at night because it is nocturnal and is found in the intertidal region while moving and feeding. 30 individuals was the total sample number and were separated into groups of the South Morotai (8 individuals), North Morotai (9 individuals), South West Morotai (8 individuals) and East Morotai (5 individuals) (Fig. 1). Sampling was achived with basic diving equipment at 1-2 meter intervals and scuba diving at 3-15 meter depths. Divers caught samples (hand collection), brought them to the surface and put them in a sample box (fish box) filled with seawater. On land, fish samples were weighed before being released once more. Seagrass and mangrove environments, as well as coral reef ecosystems were the subjects of sample collection (Fig. 2). Bycatch samples were also collected utilizing fishing handlines and gill nets. Samples discovered in the water column were then manually collected (hand collection) and placed in a seawater-filled container. Samples were weighed, measured for length and photographed before returning to the ocean.

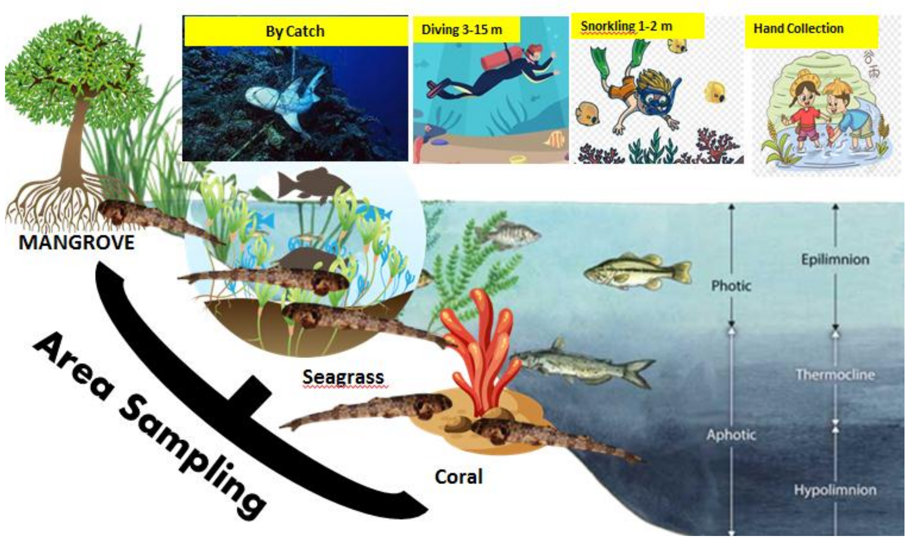

Fig. 2. The sampling area of *Halmahera walking shark* (*H. halmahera*)

3. Data analysis

The measurements of the Halmahera walking sharks were all determined, and the data were then entered into *Microsoft Excel*.

4. Cohorts

Cohorts are teams that share a similar age range and are descended from the same stock **(Yonvitner, 2012)**. **The Bhattacharya approach (1967)**, with its core idea of dividing data plots by identifying the highest and lowest points on the size of the fish discovered was used to estimate age groups. Utilizing the ELEFAN (Electronic Legth Frequency Analysis) program (FISAT II, FAO ICLARM Stock Assessment Tool), the age group data processing was evaluated with long frequency **(Utami *et al.*, 2018; Muhsoni, 2019)**.

5. Length frequency distribution

Using the total fish length acquired, the length frequency distribution was calculated **(Utami *et al.*, 2018)**. The steps of the **Bhattacharya method's (1967)** examination of the distribution of length frequencies include grouping the necessary number of length classes, figuring out the interval's (class and breadth), and then figuring out how often each long class interval occurs **(Utami *et al.*, 2018)**. Long frequency distribution data can be obtained using Microsoft Excel and the Sturges rule **(Sturges, 1926 as cited in Lempoy *et al.*, 2020)**.

6. Condition factor (Kf)

To determine the plumpness of fish in a water area, factor analysis of fish circumstances was conducted. The sample's length and weight were used to calculate the condition factor value **(Ibrahim *et al.*, 2017)**. Based on the study of **Effendie (1997)**, the criteria for fish condition factors are presented in Table (1). If the growth is isometric, the formula is then determined based on the findings of the length-weight study **(Effendie, 2002)** as follows:

$$K = \frac{10^5 W}{L^3}$$

Allometric growth pattern and condition factor calculation are determined using the following formula:

$$K = \frac{W}{aL^b}$$

Where, K = Condition factor; W = Fish weight (gr), and L = Total length (cm)

Tabel 1. Criteria and the range of values for fish condition factor

No	Criterion	Value range
1	Plump (*Fusiform*)	1-3
2	Flat (*Compressed*)	2-4

RESULTS

1. Cohort

Based on the examination of the length distribution, an age grouping (*cohort*) was created. Three age groups of the Halmahera walking shark population were discovered on Morotai Island, indicating that this region is their primary habitat. Three histogram peaks were recorded with respect to age groups and divided based on length data (Fig. 3). The findings of this investigation demonstrate that the Halmahera walking shark was discovered on the Morotai Island in three distinct age cohorts or from three births. Three length modes with values ranging from 22-81, 42-103 and 62-125cm were used to separate the age groups (Fig. 2). With respect to age groups, the first had a mean and standard deviation of 52.4 ± 7.1 for a population of 9 individuals; the second had a mean and standard deviation of 73.63 ± 9.12 for a population of 13 individuals, and the third had a mean and standard deviation of 105.27 ± 14.74 for a population of 8 individuals.

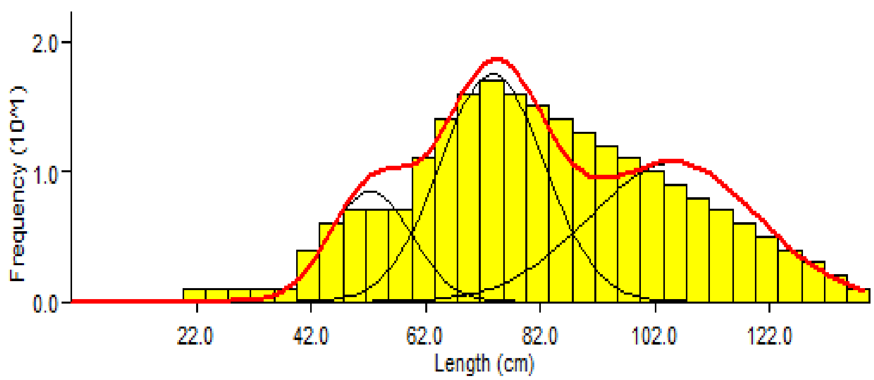

Table 2. On Morotai Island, the Halmahera walking sharks cohort, averages, population and separation index

Cohort	Average ± standard deviation	Population	Separation index
1	52.4 ± 7.1	9	n.a.
2	73.63 ± 9.12	13	2.62
3	105.27 ± 14.74	8	2.65

In order to distinguish groups of fish sizes and calculate a separation index, the Bhattacharya approach was applied. In all three groups, the separation index was determined > 2 (2.62-2.65) (Table 2). In order to move on to the next step of analysis, the separation value suggested that the separation of the Halmahera walking shark size group on Morotai Island is appropriate.

2. Length frequency distribution

On Morotai Island, the analysis of 30 halmahera walking sharks found a dispersion between classes of 21.5-82.3 cm (Fig. 4). Size range (51.9- 62cm) recorded the maximum frequency of 14 population in the class interval (Fig. 4). A frequency of 6 population was discovered in the class interval of 41.8- 51.9cm (Fig. 4). In the class ranges of 31.6-41.8 cm, 62-72.1 cm and 72.1-82.3 cm, the mean frequency of 3 individuals was observed (Fig. 4). It was discovered that there was a frequency of 1 individual for class intervals between 21.5 and 31.6 cm (Fig. 3).

Grade 4 had a relative frequency value of 46.67%; grade 3 was 20%; grades 2.5 and 6 were 10%, and grade 1 had a relative frequency value of 3.33% (Fig.5). There is a correlation between the highest relative frequency in group 4 and the population size (Figs. 4, 5). Based on the class interval in class 4 group, the relative frequency demonstrates that there is a strong likelihood that each individual will attend. A halmahera walking shark species found on the Morotai Island, with a length range of 51.9- 62cm is in class 4 group. Species in class groups 2, 5 and 6 had length values ranging from 31.6- 82.3cm; whereas, class group 1 species possessed a low length range of 21.5- 31.6cm, and class group 3 species owned a length range of 41.8-51.9cm (Figs. 4 and 5).

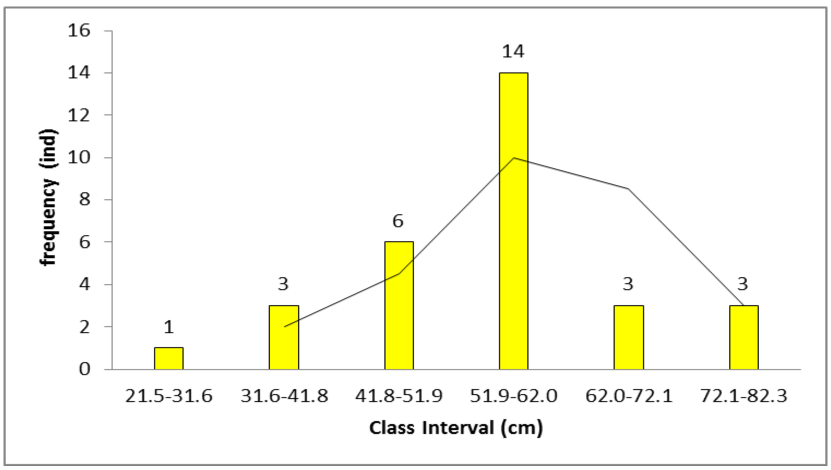

Fig. 4. Halmahera walking shark class interval distribution on Morotai Island

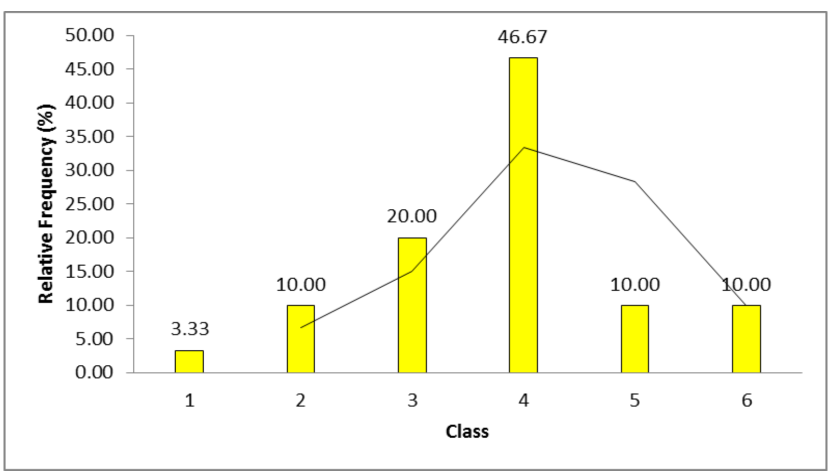

Fig. 5. The Morotai Island relative frequency class of the Halmahera walking shark

3. Condition factor (Kf)

The condition factors analysis was performed for 30 halmahera walking sharks (Table 3). Each location's distribution of halmahera walking sharks individual was detected during the investigation to learn more about the condition factors (Table 3). Based on the findings, the condition factor of the fish under investigatin off the Morotai Island ranged from 0.8169 to 1.4264. (mean 1.0064) (Table 3).

In addition, based on the distribution at each station, the condition factor showed different values (Table 3). The condition factor ranged from 0.8561 to 1.0973 at North Morotai Station, from 0.9318 to 1.0806 at South Morotai Station, from 0.8363 to 1.3918 at South West Morotai Station and from 0.8831 to 1.1496 at East Morotai Station, with a mean value of 1.0040 (Table 3). The South Morotai station recorded the highest condition factor, with values ranging from 0.9318 to 1.0806 and an average of 1.0044. At North Morotai station, low condition factor values were registered, ranging from 0.8561 to 1.0973, with an average value of 1.0012 (Table 3).

Table 3. The condition factor of halmahera walking shark off the Morotai Island

No	Location	No. of samples	Condition factor (FK)	
			Range	Average
1	North Morotai	9	0.8561-1.0973	1.0012
2	South Morotai	8	0.9318 - 1.0806	1.0044
3	South West Morotai	8	0.8363 - 1.3918	1.0116
4	East Morotai	5	0.8831 - 1.1496	1.0040
1	Morotai Island	30	0.8169-1.4264	1.0064

By sex, various halmahera walking shark condition parameters were determined (Table 4). Male genital condition factor values varied from 0.8470 to 1.1227, with a mean value of 1.0032 (Table 4). The condition variables for the female sex ranged from 0.8402 to 1.4331, with a mean of 1.0086 (Table 4).

Table 4. Condition factors of *H. halmahera* by sex on Morotai Island

No	Sex	No of samples	Condition factor (FK)	
			Ranges	Ranges
1	Male	16	0.8470-1.1227	1.0032
2	Female	14	0.8402-1.4331	1.0086

DISCUSSION

The existence of people in this age range suggests that the water area is a suitable habitat for fish populations to thrive **(Yonvitner, 2012)**. Different generations are coexisting in the environment, as evidenced by the number of cohorts discovered. When compared to the first and third age groups, the second age group has a larger population. The second group contained a sizable number of individuals, suggesting that the Halmahera walking shark population in the waters around Morotai Island was predominately adult-sized, in the reproductive stage, or had mature gonads. A shift to the right in the age group of the fish population on Morotai Island suggests that the Halmahera walking shark stock has grown in size **(Fig.3)**. An increase in fish stocks is indicated by a rightward shift in the age group (**Annisa *et al.*, 2021)**. The frequency value indicates that the minimum number shifts before the height increases. The change in frequency values in the age group histograms explains why there is a chance that long data could appear based on various sizes. It was discovered that the composite distribution had a range of mean, population, and comparison index values **(Table 2)**. Overall, the distribution of Halmahera walking shark at various population levels is shown by the three age groups.

The age structure of the fish stock is altered as a result of this movement. Different age structures in populations are hypothesized to be caused by mortality and recruitment (adding new age groups to fish stocks) **(Setiyowati, 2016 ; Asiah *et al.*, 2018; Sweking *et al.*, 2020; Zulfahmi *et al*., 2021)**. Despite the fact that indirect exploration was discovered as a result of a mistaken catch, this situation demonstrates that the Halmahera shark population is in a stable condition (*by catch*). The age group's shift to the right indicates that fish resource stocks have grown and that fish recruitment has increased **(Satria and Kurnia, 2017; Utami *et al.*, 2018; Annisa *et al.*, 2021)**. The high survival rate is explained by the increase in age group, and it also shows that there are many Halmahera walking sharks on Morotai Island. Aquatic environmental factors promote the vast population, resulting in the development of subpopulations. The spread of subpopulations in high numbers makes population resources accessible in a variety of waters. The sustainability and sustainability of the population are, of course, guaranteed by the abundance of resources. To lower the incidence of mortality from anthropogenic causes, attention must be paid to the extent of exploitation and indirect use (such as by catch). Even so, natural mortality is a condition that cannot be avoided. Natural mortality is typically caused by anthropogenic factors like unintentional fishing, consumption, and aquarium upkeep as well as biological factors like predation, disease, and environmental factors.

Age group statistics demonstrate that each sampling has a long mode shift, which suggests that the population contains different age groups. A regular population expansion of individuals is explained by the increase in the length mode of individual fish **(Utami *et al.*, 2018)**. The Halmahera walking shark, which lives in the waters off Morotai Island, can be identified by the difference in age groups based on length. The classification of age groups showed that there was a young age (Larvae) which was 22 cm which was the first group, the developing phase group (Juvenile) was 42 cm and the productive fish phase group (Adult) was 62 cm. According to **Djumanto *et al.* (2014)**, the population with two lengths indicates that there are two fish generations (young and old) that live and develop simultaneously. Due to the regular phases of reproduction, development, and growth, the proportion of generations discovered suggests that fish resources are in a stable condition. According to length-based age classification, the Halmahera walking shark group spawned at various times. Age classification based on length also clarifies if fish were collected during or before spawning **(Nursinar and Panigoro, 2015)**.

The separation index of the three groups, according to an analysis of age groups, was greater than two (>2). The extent of separation or breakdown between two adjacent age groups is indicated by the separation index **(Spare and Venema, 1999)**. If the separation index value < 2, it means that the length of a group originated from a distinct population, and if it is > 2, it came from a different population (Djumanto *et al.,* 2014).

The value of the separation index <2 cannot be separated by age groups, because it results in overlapping of the two age groups analyzed **(Sparre and Venema, 1999)**. According to the separation index's value, the age group of Halmahera walking sharks on Morotai Island likely originates from a different population. Additionally, it may be argued that there are sub-populations dispersed around the coastline areas of Morotai Island. It is assumed that there are population groupings that are distributed in other island locations (north, south, west, and east). Oceanography is one example of an environmental complexity that can either promote or hinder the dispersal of subpopulations.

Given that the length distribution is observed in small to large sizes, the data indicates that the Halmahera Walking Shark's length frequency has a normal distribution between classes. The population regeneration is described as operating regularly within this normal class span. Stock creation, recruitment, growth, and mortality occur in a natural manner. Also identified during the normal biological period were the factors influencing population survival. The habitat environment, predators, and individual genetic propensities all play a significant role in determining how stable the stock population is. The range of total length values can be utilized to gather data on the state of the population. Information on length frequency is a crucial element for determining fish growth.

It is believed that the size range of 21.5–41.8 cm represents a new individual (recruitment) and juvenile species. The Halmahera Walking Shark, measuring 22.5 cm, was a juvenile category species and a new recruit at the study site, according to **Jutan *et al*. (2017)** .'s investigation. According to observations made in the aquarium, the young H. ocellatum measured 150 mm (15 cm) in size (Allen *et al.*, 2016). The huge Halmahera Walking Shark has enormous group sizes, which suggests that this species can survive in the seas around Morotai Island. Growth patterns, food and population stocks can be impacted by the availability of food, water circulation, and stable ecological conditions.

The lengths of the Halmahera walking shark species ranged from 16.9 to 79 cm in Kao Bay **(Jutan *et al.*, 2017; 2018)**, 40 to 63 cm in the sea waters of Maitara Island, Tidore, Mare, Weda Bay (Loleo), and Lelei **(Akbar *et al.*, 2019)**, 40 cm in the sea waters of Tidore **(Mukharror *et al.*, 2020)**, 45 to **(Wahab *et al.*, 2022)**. By consuming benthic creatures that are rich in protein and nutrition, the Halmahera walking shark is a top predator in biotic coral reef environments (**Jutan *et al.*, 2019**). Due to internal and external influences, fish species located in the same aquatic environment have diverse growth trends, which are explained by the different length ranges **(Rananda *et al.*, 2020 : Annisa *et al.*, 2021)**. Internal factors like illness and biological genetics are followed by environmental and predator exterior elements like oceanographic and dietary conditions **(Hasibuan *et al.*, 2018; Polanunu *et al.*, 2020)**. The amount of people discovered determines whether a frequency is high or low. In order to clarify the number of individuals detected, the relative length frequency value displays the percentage of individual occurrences in the class group. Tall people are more likely to be found with class distribution in each size, which suggests that the population is steady.

Conditional variables The reason the fish's body is chubby is explained by condition variables with values of 1-3 **(Effendie, 2002)**. The findings show that the Halmahera Walking Shark has a plump body (*Fusiform*). The fish's plumpness indicated that the Halmahera Walking Shark in the Morotai sea received food support and lived in a typical environment. The study conducted by **Jutan *et al.* (2019)** Small fish scales

(96.6%), Annelida (2.1%), fish larvae (0.3%), Mysis (0.2%), Eucalanus sp (0.2%), Pseudeuphausia (0.2%), Hyperia sp, Acrocalanus sp, Copilia sp, and fishbone (0.1%) were all detected in the stomach contents of the Halmahera Walking Shark. It has been discovered that walking sharks consume fish and marine invertebrate larvae and bones **(Compagno, 2001; Allen *et al.*, 2016)**. Grouper larvae can support body weight because of their high protein content, which ranges from 47.37 to 49.29 **(Setiawati *et al.*, 2020)**. In nature, fish require protein and fat as sources of energy, to survive, and to grow **(Marzuqi and Anjusary, 2013)**. Laor (Annelida) is a target fish for consumption since it has a high nutritional content of 10% to 15%. **(Liline, 2017)**. Since crustaceans have an 81.46% protein content, according to **Ghazali *et al.* (2017)** study, they are frequently fed to marine and domestic animals as food **(Yuwono, 2005).**

Nutrition from food and the environment contributes to fish plumpness **(Santos *et al.*, 2022)**. The difference in the condition factor's value at the study site was most likely brought on by variations in body mass index, height and weight, and food. The Halmahera Walking Shark migrates alone, which has an impact on distribution and population density. It was not possible to determine how frequently the Halmahera Walking Shark group was spotted in the vast water column. Although there is a distance between men and females when migrating, it is likely that this species will be discovered in pairs in the high water column. Body size and length are influenced by a region's ability to adapt to its surroundings. Diet is influenced by the accessibility of food and obstructions in the food-seeking process. Fish condition is influenced by food weight, size, age, and environment, according to **Gani *et al.* (2020)**. The Halmahera Walking Sharks' ability to acquire food, spawn, and maintain their survival is supported by the habitat's condition, which was determined to be pretty good. This condition factor value was obtained at the study station. According to studies on the coral reef ecosystem cover in Morotai sea, it is ecologically suitable to serve as a habitat for the Halmahera Walking Shark **(Purba *et al.*, 2019; Hadi *et al.*, 2018; Koroy and Paraisu, 2020; Wahab *et al.*, 2021)**. The abundance of food enhances the connection between fish and their surroundings **(Bidawi *et al.*, 2017)**.

The Halmahera walking shark's membership in the fat category can be explained by the importance of male and female sex variables. The density of fish meat is still normal despite the plump that fish growth is included in the negative allometric. These results may differ because fish may have used a certain period of time to store body plump due to an excess of food. The length of the person's weight and the quantity of samples discovered have an impact on the value of the various condition criteria. Overall, there were no appreciable changes in the condition factor values, indicating that the fish's body size was normal.

Important biological criteria known as condition variables can be used to determine if a body of water is suitable for fish growth and the species' average size index. Based on the length-weight ratio, condition factor analysis describes the bulkiness of the fish. The fish's plumpness reveals individual growth patterns, hence characterizing the body's shape. Growth patterns are influenced by the environment rather than just one species **(Muchlisin *et al*., 2017)**. The condition factor is related to weight, size, sex, gonad maturity, and fish physiology both before and after reproduction **(Effendi, 2002)**. Fish can be identified by their plumpness based on condition factor analysis, which is reflected by individual length-weight **(Shasia *et al.*, 2021)**. The physical capacity of the fish can define the ability to survive and reproduce by providing information on the physical condition of the fish. Conditions help with biology comprehension and are crucial fo**r species management in natural stock protection programs** (Faradonbeh *et al.*, 2015). Based on biological and environmental aspects, condition factors provide information on fish conditions **(Syuhada *et al.*, 2020)**.

CONCLUSION

The Halmahera Walking Shark (*H.halmahera*) population structure was discovered to be three generations old, demonstrating the population's viability. According to the distribution of long intervals, there are class differences based on certain length measures. The population is described as having a plump body size by the condition factor (Fusiform). In Morotai Island's maritime waters, the biological state of the Halmahera Walking Shark population (*H. halmahera*) was discovered in typical circumstances.

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