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The Population Structure of Endemic Halmahera Walking Shark (*Hemiscyllium halmahera,* Allen 2013) in Kao Bay Sea, North Maluku, Indonesia

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ABSTRACT

The Halmahera Walking Shark (*Hemiscyllium halmahera*) is an endemic fish in the Halmahera Sea. This species is distributed and found in the Kao Bay sea. The International Union for Conservation of Nature (IUCN) data shows that the Halmahera Walking Shark is in the Near Threatened status. Protection is carried out to protect the population, therefore scientific data and information are needed. This study focuses on the biological structure of the Halmahera Walking Shark population in Kao Bay sea. Data collection was carried out exploratively in coral reef, seagrass, mangrove ecosystems and by-catch. Samples were taken for morphometric data, weight and sex. Morphometric data were analyzed to obtain cohorts, separation index, class intervals, length-weight relationships and condition factors of walking shark. The result were found to be 33 individuals (13 male and 20 female). Morphological characteristics based on morphometric variables found no significant differences. Analysis of the cohort of the Halmahera Walking Shark (*H.halmahera*) found 3 groups namely the juvenile, mature and old age phases. The separation index shows that individuals come from different populations based on length. Growth pattern of the Halmahera Walking Shark (*H.halmahera*) is negative allometric. The histogram of the frequency distribution between classes found small to large size structures with different relative frequency percentages. The condition factor found that the body proportions of the Halmahera Walking Shark (*H.halmahera*) were in the plump category. All of this information is important to provide scientific data specifications to population.

Keywords: *Endemism, Halmahera, Morphology, Island, Semi enclosed*

ABSTRAK

Hiu Berjalan Halmahera (*Hemiscyllium halmahera*) adalah ikan endemik di laut Halmahera. Spesies ini tersebar dan ditemukan di perairan Teluk Kao. Data International Union for Conservation of Nature (IUCN) menunjukan bahwa Hiu Berjalan Halmahera (*H. halmahera*) berstatus hampir terancam (*near threatened).* Perlindungan dilakukan untuk menjaga populasi, namun diperlukan data dan informasi ilmiah. Penelitian ini focus pada struktur biologi populasi Hiu Berjalan Halmahera di Teluk Kao. Pengambilan data dilakukan secara eksploratif pada terumbu karang, lamun, mangrove dan tangkap samping (by-catch). Sampel diambil data morfometrik, berat dan kelamin. Data morfometrik dianalisis untuk untuk mendapatkan kelompok umur (cohort), indeks separasi, interval kelas, hubungan panjang berat dan factor kondisi. Hasil penelitian ditemukan ditemukan 33 individu dengan dua jenis kelamin (13 jantan dan 20 betina). Karakteristik morfologi berdasarkan variable morfometrik ditemukan tidak terdapat perbedaan signifikan. Analisis kelompok umur (cohort) Hiu Berjalan Halmahera (*H.halmahera*) ditemukan 3 kelompok yakni fase juvenile, dewasa (pra produksi) dan umur tua. Indeks separasi menunjukan bahwa individu berasal dari populasi berbeda berdasarkan ukuran panjang. Pola pertumbuhan Hiu Berjalan Halmahera (*H.halmahera*) allometrik negative. Histogram distribusi

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frekuensi selang kelas ditemukan struktur ukuran kecil hingga besar dengan persentasi frekuensi relative berbeda. Faktor kondisi ditemukan bahwa proporsi tubuh Hiu Berjalan Halmahera (*H.halmahera*) kategori montok. Keseluruhan informasi ini penting untuk memberikan spesifikasi data ilmiah berkaitan populasi.

Kata kunci: Endemisme, Halmahera, Morfologi, Pulau, Semi tertutup

1. Introduction

Numerous studies have been conducted

The process of assimilation and circulation in Kao Bay sea, an area with a small bay shape, is highly dependent on the motion of the sea tides. On the island of Halmahera, Kao Bay is situated between the districts of East Halmahera and North Halmahera. The village makes use of Kao Bay sea as a location for the exploitation of fisheries resources. The Halmahera Sea, where the The Indonesian Throughflow (ITF; Indonesian: Arus Lintas Indonesia) enters, is connected to the Kao Bay sea. In the Kao Bay sea, fishermen use handlines and nets to catch fish. The waters of this area are slightly influenced by waves due to the land being protected on the right and left sides. The influence of tides dominates the Kao Bay sea, because this area is semi-enclosed. the sea have a propensity for having species with unusual traits, especially poor species mobility. Morphological and genetic changes are possible through a long isolation process due to geology and oceanography. Due to the bay's morphology, The Kao Bay area has its own characteristics because it is a body of water that juts out into the mainland with a diameter of 15 km2 (Husen, 2016). In general, geomorphology can form species that are different from other locations..

The Halmahera Walking Shark (*Hemiscyllium halmahera*) is a fish resource found in the Kao Bay sea. The Halmahera Walking Shark (*H. halmahera*) is an endemic species in Halmahera sea. This species was found by Allen et al. (2013) and published as an endemic species. In general, in the Halmahera Islands this species is called gurango bodo, gurango hoga, gurango bintik, gurango tokek, gurango buta, gurango loreng, gurango nyare, and gurango haga (Jutan et al. 2018; Akbar et al.2019). The movement of this species uses pectoral fins on the substrate, like walking (Allen & Erdman, 2008; Allen et al. 2013;2016; Jutan et al. 2017;2018; Akbar et al. 2019; Madduppa et al. 2020; Mu'min et al. 2021). Status Hiu Berjalan Halmahera (*H. halmahera*) di IUCN (International Union for Conservation of Nature) yakni hampir terancam (*Near Threatened*). The Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 30 of 2023 about Full Protection of Walking Sharks (*Hemiscyllium* spp.) in Indonesian Seas is how the government carries out protection. The Walking Shark population is being protected and preserved by the determination of its classification. Research related to the biological structure of the Halmahera walking shark population needs to be carried out for the benefit of information regarding the condition of the population. A constant stream of scientific data can serve as the foundation for a Halmahera Walking Shark (*H. halmahera*) protection strategy.

Previous studies have been carried out such as morphometric, genetic and tonic immobility studies on the Halmahera Walking Shark (*H. halmahera*) at several locations in North Maluku as reported (Allen et al. 2013; Allen et al. 2016; Jutan et al. 2017; 2018; Akbar et al. 2019; Mukharror et al. 2019; Madduppa et al. 2020; Mu'min et al. 2021; Wahab et al. 2022). Jutan et al. (2018) published information on the health of the Halmahera walking shark population in Kao Bay. Time series data must be obtained even though previous study has been done in this area. In order to offer precise information about the biological population structure of the Halmahera Walking Shark (*H. halmahera*), it is crucial to report on ongoing developments and provide updates.

2. Material and Methods

In the of Kao Bay sea (127^{o}34'50"-128^{o}8'30"E and 0^{o}50'00"-2^{o}22'10"N), the research was carried out between October 2021 and March 2023 in Figure 1. Rapid sampling and exploratory data gathering at Kao Bay, North Halmahera Regency. Basic diving gear is used to gather samples at a depth of 1-2 meters, while scuba diving is used at a depth of 3-15 meters. Additionally, samples were collected through handline fishing and bycatch utilizing nets in coral reef slopes and flat areas. PT (total length), PS (standard length), TK (head height), PK (head length), LK (head width), LT (body circumference), SP (pectoral fin), SA (anal fin), SD (dorsal fin), and EBB (back tail) measurements were taken for each

individual found in Figure 2 (Allen et al. 2013; Akbar et al. 2019; Madduppa et al. 2020).

The Halmahera Walking Shark (*H. halmahera*) morphometric variable was thoroughly measured to obtain data on various body sizes in Figure 2 (Akbar et al. 2019; Madduppa et al. 2020). All morphometric measurement data were collected, then tabulated into *Microsoft Excel*.

Age group data processing (Cohort) was analyzed with long frequency with ELEFAN (Electronic Legth Frequency Analysis) software (FISAT II, FAO ICLARM Stock Assessment Tool) (Utami et al. 2018). Analysis of long frequency distribution using the Bhattacharya method (1967) with Microsoft Excel using Sturges' rule (Sturges, 1926) in Lempoy et al. (2020).

Analysis of the length-weight relationship using the linear regression equation was performed using Microsoft Excel. The relationship between length and weight can be analyzed using the Linear Allometric Model (LAM) equation (Effendi, 1979; Sparre & Venema, 1999) :

$$W = aL^b \text{ atau } \ln W = \ln a + b \ln L$$

Where W is the fish's weight in grams, L is its length in centimeters, an is the intercept of the linear regression, and b is the regression coefficient. The pattern of fish growth can be

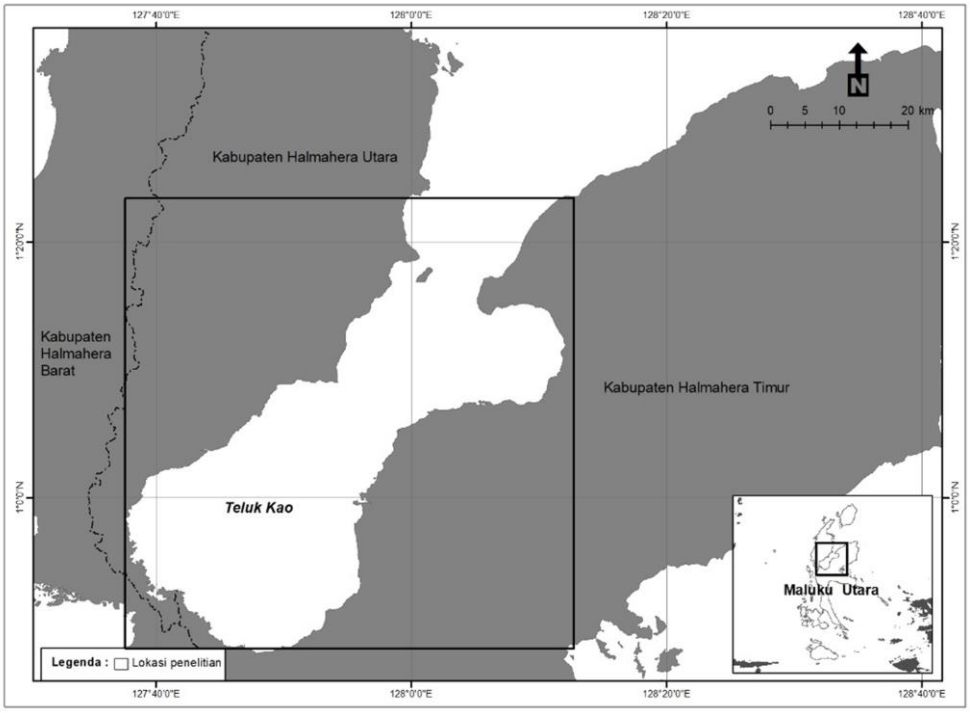

Figure 1. Site collection Halmahera Walking Shark (*H. halmahera*) in Kao Bay sea

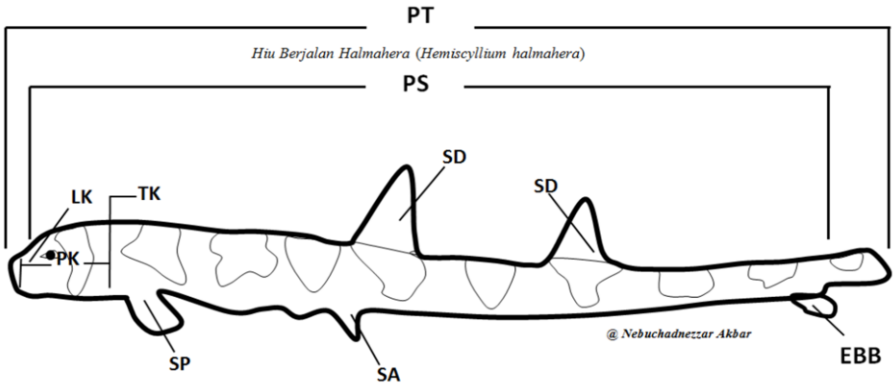

Figure 2. Halmahera walking shark (*H. halmahera*) morphometrics measurements

inferred from the calculation's findings by using the b value. The growth pattern is isometric if the value of b is 3, meaning that weight gain is similar to the fish's development in length, and allometric if the value of b is less than 3. The sample's weight and length are used to calculate the condition factor (Ibrahim et al. 2017). Based on (Effendi, 1997), the factor criteria for the fish's condition are established.

3. Results and Discussion

In Kao Bay, a total of 33 Halmahera Walking Sharks (*H. halmahera)* were discovered (Table 1). The samples are distributed throughout four substations, including Kao Bay. South (8 individuals), Kao Bay North (17 individuals), Kao Bay East (4 individuals), and Kao Bay West (4 individuals). The sex ratio for the males (13 individuals) and females (20 individuals) (Table 1). Because it still finds a pair of sex (Male and female), the Halmahera Walking Shark (*H. halmahera*) has a normal sex ratio. The existence of two sexual partners indicates that the population's reproductive process is normally condition. The results of the discovery of a sex pair are supported by previous research conducted (Akbar et al. 2019; Maduppa et al.2020). The frequency of individual presence is low, because the species is solitary, so the probability of being in a space is low. Even though the movement patterns are sinusoidal (rotating in the surrounding area) (Raoult et al. 2018), the appearance of the Halmahera walking shark is difficult to predict, because the movements are always moving (not fixed). Mumin et al (2021) said that the distribution of the Halmahera Walking Shark (*H. halmahera*) has a random distribution pattern and the distance between individuals cannot be predicted. The movement of this species is different for each individual, although 1-2 individuals can be found in coastal ecosystems. The Halmahera walking shark appears to be an opportunistic predator, using both smell and electrical reception to capture prey (Heupel & Bannet, 1998). Morphometric characteristics in Kao Bay found total body length ranging from 22-76 cm (49 cm ±38.2), standard body length 55-72 cm (38.5 cm ± 47.4), fish head height 2.3-6.2 cm (4.25 cm ± 2.8), head length 6-16 cm (11 cm ± 7.1), head width 4.8-8 cm (6.4 cm ± 2.3), pectoral fin length 3.1-8 cm (5.5 cm ± 3.5) , anal fin length 3.2-6.3 cm (4.7 cm ± 2.2), dorsal fin length 3.6-7.2 cm (5.4 cm ± 2.5), rear tail length 35-14 cm (mean 18 cm ± 16) and body weight 200-550 gr (375 gr ± 247) (Table 2). In general, the morphological characteristics

Table 1. Total individuals of Halmahera Walking Sharks (*H.halmahera*) in Kao Bay sea

Location	Sex		Amount
	Male	Famale	
Kao Bay. South	3	5	8
Kao Bay. North	6	11	17
Kao Bay. East	2	2	4
Kao Bay. West	2	2	4
Totals	13	20	33

Table 2. Morphometric Characteristics of Halmahera Walking Sharks in Kao Bay sea

Characteristics	Maximum	Minimum	Averages	Standard Deviation (SD)
PT	76	22	49	38.2
PS	72	55	38.5	47.4
TK	6.2	2.3	4.25	2.8
PK	16	6	11	7.1
LK	8	4.8	6.4	2.3
SP	8	3.1	5.5	3.5
SA	6.3	3.2	4.7	2.2
SD	7.2	3.6	5.4	2.5
EBB	35	14	18	16
LT	31	7	19	17
B	550	200	375	247.5

Information : PT-EBB = cm, dan Heavy (B) = gr

of the Halmahera walking shark species did not have significant differences. The Hemiscyllium family has morphological, physiological and kinematic similarities, a distinguishing feature (landmark) between species is the phenotype (Madduppa et al. 2020; Porter et al. 2022). The similarities found in the populations indicate that the group came from a common ancestor (ancestral) and close genetics (Akbar et al. 2018). Morphological similarities indicate that individuals come from the same ancestry or ancestor. Genus hemiscyllium have similarities between individuals, because they have the same ancestral origin (Dudgeon *et al*.2020).

Three age groups were discovered using a cohort analysis based on the total length of the Halmahera walking shark population in Kao Bay (Figure 3). There are three histogram peaks on the age group (cohort) curve. There were three generations of Halmahera walking sharks (*H.halmahera*) in the Kao Bay sea, as indicated by the age group (cohort) discovered.

The histogram model found provides information that the Halmahera Walking Shark (*H.halmahera*) in Kao Bay sea is a native species bioecologically. The histogram model explains that the life cycle of the Halmahera Walking Shark (*H.halmahera*) consists of juvenile, mature and old age phases. The cohort data explains that the sustainability of the Halmahera Walking Shark population is normal, due to normal biological processes (reproduction dan population growth). Age grouping also provides information regarding the sustainability of the Halmahera Walking Shark (*H.halmahera*) population. The histogram of the cohort found that the second age group was more dominant than the first and third age groups. The data explained that the adult age group (second histogram peak) was found to be dominant (abundant). The mode shift to the right on the histogram indicates that the population is experiencing long growth. The population groups that are formed, probably came from the same ancestor (ancestral), this is due to limited migration and narrow ecological niches. The process of inbreeding is likely to occur between sub-populations of the Halmahera Walking Shark (*H.halmahera*) in Kao Bay sea. The reproductive cycle, growth and development of the Halmahera Walking Shark (*H.halmahera*) were carried out simultaneously in Kao Bay sea, so that generations were formed based on length measurement. Fish of the same length come from the same birth (Fong et al. 2002; Dewanti et al. 2019; Xu et al. 2022).

At the population level, the Halmahera walking shark age group in Kao Bay sea exhibits variations in the distribution of individuals. The first age group's population had a mean value and standard deviation of 32 ± 4.8 (9 individuals), while the second age group's population had a mean value and standard deviation of 89.3 ± 10.44 (22 individuals). The third cohort had a mean value

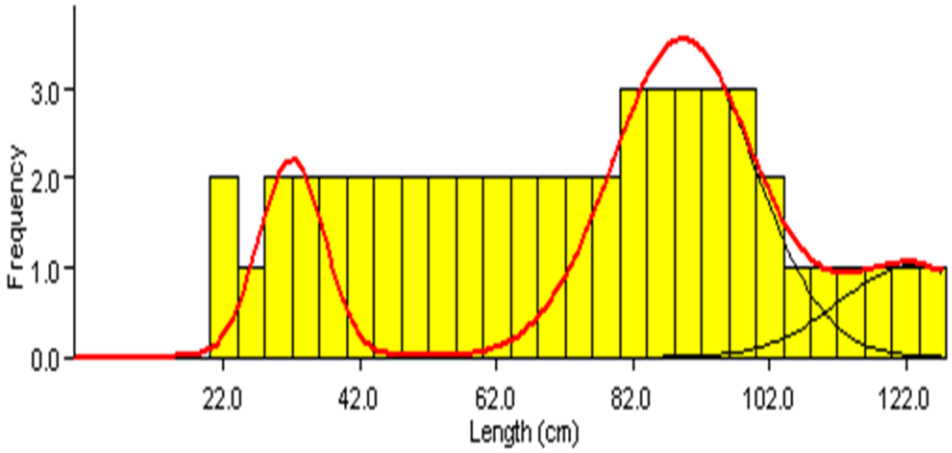

Figure 3. Histogram of cohort of Halmahera walking sharks in Kao Bay sea

Table 3. Average of Halmahera Walking Sharks (*H.halmahera*) cohort in Kao Bay sea

Groups	Mean ± standard deviation	Population	Index separation
1	32 ± 4.8	9	n.a.
2	89.3 ± 10.44	22	7.52
3	123.97 ± 10.68	2	3.19

and standard deviation of 123.97 ± 10.68 with 2 individuals in the population (Table 3). Based on the separation index value, it can be said that the age group of the Halmahera walking sharks in Kao Bay sea comes from different populations. A separation index value <2 explains that adjacent populations come from the same population and a value >2 indicates that the length measure of a group comes from a different population (Djumanto et al. 2014). The separation index describes the level of separation or breakdown of two adjacent age groups (Sparre & Venema, 1999).

The Halmahera walking shark (*H.halmahera*) in Kao Bay sea is a native species according to the histogram model that was discovered (Figure 3). Juvenile, mature, and old age phases make up the Halmahera shark's life cycle, according to the histogram model. According to the cohort data, the Halmahera shark population's survival is typical, as it results from typical biological processes (reproduction and growth). The second age group was more prevalent than the first and third age groups, according to the cohort's histogram (Figure 3). The information demonstrated that the adult age group, which appeared as the second histogram peak, was dominant (abundant). The histogram's mode shift to the right shows that the population is expanding slowly. The population is expanding in size, therefore the growth mode shifts to the right, then it shifts to the left to reflect population recruitment (Saranga et al. 2018; Jutan et al. 2018). Native fish populations, such as the Halmahera walking sharks (*H.halmahera*) in Kao Bay sea, require attention and policy for population sustainability and preservation in order to avoid extinction (Umar & Sulaiman, 2013; Hasan et al., 2022). The three modes of length identified by the asymptotic length calculation are 22 cm, 45 cm, and 55 cm (Figure 3). Cohort diversity can be created in the same fish species in a region or in separate waters as a result of size, number, dispersion, and length of stay, according to Retraubun et al. (2021). Based on an examination of the length distribution, the age group of the fish was determined (Annisa et al. 2021).

A total of 33 individual Halmahera walking sharks (*H.halmahera*) were calculated to determine the length-weight relationship in Kao Bay. The results of the analysis found the value of the growth coefficient (b) = 0.88676, the coefficient of determination (R^2) = 0.914 and the correlation coefficient (r) = 0.9951 (Figure 4). The coefficient of determination (R^2) for 33 individuals received a high score of 91%, indicating a close relationship between the independent variable (fish length) and the dependent variable (fish weight). Correlation (r) obtained a value of 0.99, this explains that the correlation between length and weight variables is strong. The results of the analysis of the growth coefficient (b) < 3 indicate that the population growth pattern of the Halmahera Walking Shark (*H.halmahera*) is negative allometric. Negative allometric growth illustrates that the increase in length is faster than the increase in weight.

The allometric growth pattern is probably due to the influence of the marine environment. Based on research in Kao Bay sea, heavy metals have been found. The influence of oceanographic dynamics is relatively small in Kao Bay and the influence of heavy metal inputs of mercury (Hg), cadmium (Cd), copper (Cu), lead (Pb) and arsenic (As) is likely to have an impact on growth patterns. The results of Lessy's research (2015) show that levels of heavy metals mercury (Hg), cadmium (Cd), copper (Cu), lead (Pb) and arsenic (As) have been found in Kao Bay, although they have not passed the quality standard values. The heavy metals Pb and Zn have been concentrated in sediments in Kao Bay (Lessy, 2015). Heavy metals are likely to have an impact on the availability and quality of food, so that the growth in length becomes faster than weight. Mobility to search for food may be higher, indicating an impact on weight gain.

The growth pattern of the Halmahera Walking Shark (*H.halmahera*) population is different from previous reports, namely Jutan et al. (2017) in Kao Bay, North Halmahera who found an isometric growth pattern.The research findings in Kao Bay are distinct from those at the same site published by Jutan et al. (2017). According to our research, 33 Halmahera Walking Sharks (*H.halmahera*) (13 males and 20 females) were discovered throughout the sampling period in 2021–2023, however this wasn't done frequently. Except for time and season, sampling was done at random. Of course, a difference in time and sample methodology will yield different analytic results about the quantity and size of the morphometrics discovered. The sample period, the number, size, and population of fish observed are all factors that have an impact on the importance of the data in the analysis's findings (Fuadi et al. 2016; Kurnia et al. 2019; Rachmawan et al. 2021).

The diversity index is more likely to be influenced by the wealth index. The sampling time, frequency and intensity of sampling can

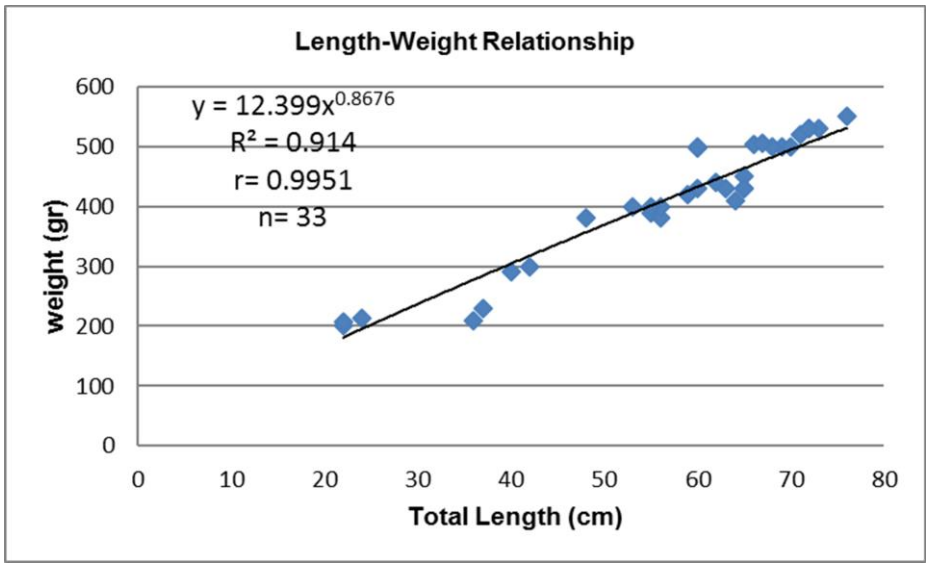

Figure 4. Length-weight relationship in the Halmahera Walking Shark population in Kao Bay sea

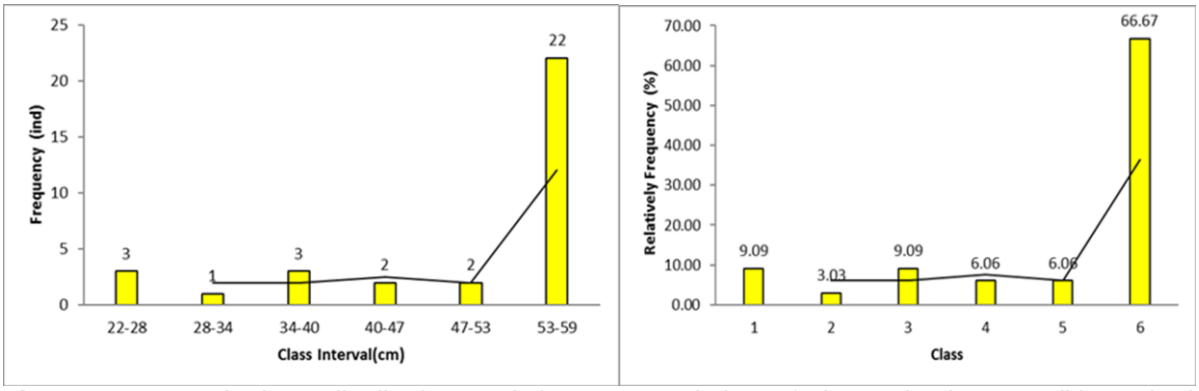

Figure 5. Interval class distribution and frequency relative of the Halmahera Walking Shark population in Kao Bay sea

produce different estimates of fish species composition and community structure (Zhao et al. 2017). The importance of full sampling of all size and age classes whenever possible, provides important information (Bolser et al. 2018). Effect of fishing effort and sample size on the precision of survival probability estimates (Kordjazi et al. 2016). Differences in the number and size of the samples discovered as well as the sampling (period and season) are likely to have been brought on by this dissimilarity. For one year (2016–2017), Jutan et al. (2017) undertook periodic sampling; this undoubtedly had an impact on the quantity and size of samples discovered. Long-term sampling can also clearly capture the by-products associated with the seasons (west monsoon and east monsoon), helping to explain the monsoon's representativeness and altering the size and quantity of samples. Jutan et al. (2017) reported that sampling operations (2016–2017) discovered a total of 264 Halmahera walking sharks (*H.halmahera*), of which 142 were males and 122 were females. Minimum and maximum lengths for the entire size distribution are 20 cm and 76.50 cm, respectively.

The class interval distribution of 33 individual Halmahera walking sharks (*H.halmahera*) in Kao Bay was found to be 22-59 cm in size (Figure 5). The highest occurrence of individuals (22 individuals) was in the size class interval of 53-59 cm (Figure 5). Among other size classes there is a similarity in individual distribution and shows a low number (Figure 5). In the class interval of 28-34 cm, 1 individual frequency was found (Figure 5). The histogram of the frequency distribution between the Halmahera walking shark classes in Kao Bay shows a small to large size structure, thus describing a normal distribution. The pattern of class intervals and individual frequencies found indicates that the life cycle mechanism is

normal. The processes of recruitment, reproduction and defense against predatory aggression are adaptations and strategies carried out by the Halmahera Walking Shark (*H.halmahera*) in Kao Bay sea.

According to Jutan et al. (2018), there are two peaks in the year for Halmahera Walking Shark (*H.halmahera*) recruitment in Kao Bay: a minor peak in March and a significant surge from July to September. The abundance of individuals in the 53-59 cm class interval suggests that mature sizes predominate in the Kao Bay sea for the Halamhera walking shark (*H.halmahera*). The findings of Jutan et al. (2018), who discovered Halmahera walking sharks (*H.halmahera*) found dominance in adult size (57-67 cm), corroborate the conclusions of this study. characterizing recruitment, growth patterns, environmental conditions, and fishing operations while also increasing and decreasing fish length (Sharfina et al. 2014; Tarigan et al. 2017). The Halmahera walking shark population in Kao Bay has juveniles, as evidenced by the smallest individual size of 22–28 cm. The report by Jutan et al. (2017) at Kao Bay, where they discovered a species in the juvenile group, namely 22.5 cm, supports the findings of this study. Juveniles' presence suggests that Kao Bay sea are used as a habitat for mating, hatching, growth, protection, and food acquisition. The closeness of the research findings explains why Kao Bay is a sustainable habitat for the Halmahera Walking Shark (*H.halmahera*) population, which has a set life cycle.

The influence of oceanographic dynamics is relatively small in Kao Bay and the influence of heavy metal inputs of mercury (Hg), cadmium (Cd), copper (Cu), lead (Pb) and arsenic (As) is likely to have an impact on growth patterns. The results of Lessy's research (2015) show that levels of heavy metals mercury (Hg), cadmium (Cd), copper (Cu), lead (Pb) and arsenic (As) have been found in Kao Bay, although they have not passed the quality standard values. Heavy metals Pb and Zn have been concentrated in sediments in Kao Bay (Lessy, 2015). Diet, habitat conditions, and season may also contribute to negative allometric growth. The Halmahera Walking Shark, on the other hand, demonstrates that this species is a local species on the island of Kao Bay. Morphological alterations may be brought on by habitat loss brought on by exploitation or by the presence of heavy metal fluids. The ecological equilibrium has also been disturbed by the past manmade actions that caused coral ecosystems to die. Coral reef distribution is shrinking both spatially and quantitatively, which disturbs the rhythms of life.

Relative frequency analysis in Kao Bay found that class 6 obtained 66.67%, class 1 and 3 namely 9.09%, class 4 and 5 namely 6.06%, and class 2 had a low value of 3.03% (Figure 5). The highest relative frequency and class values in group 6 correlate with the number of individuals between classes (Figure 5). In general it can be said that the relative frequency values describe the probability of individual attendance in each class. Class 6 description is the Halmahera walking shark species on Morotai Island with a length range of 53-59cm. Class 1 and 3 groups are species with different sizes, namely 22-28 cm (class 1) and 34-40 cm (class 3). Species of different sizes but with the same number were also found in groups of class 4 and 5 which had a length range of 40-47 (class 4) and 47-53 cm (class 5). Class 2 is the lowest class interval with a length range of 28-34 cm (Figure 5). The

Table 4. Condition factors Halmahera walking sharks (*H.halmahera*) in Kao Bay sea

No	Location	Samples	Condition factor (FK)	
			Ranges	Evarages
1	Kao Bay. South	8	0.7752-1.0670	1.006
2	Kao Bay. North	17	0.9216 - 1.0903	1.015
3	Kao Bay. East	4	0.8433 - 1.0817	1.001
4	Kao Bay. West	4	0.7821 - 1.1586	1.002
1	Teluk Kao	33	0.756-1.155	1.003

Table 5. The sex specific condition factors for Halmahera Walking Sharks (*H.halmahera*) in Kao Bay sea

No	Sex	Samples	Condition factor (FK)	
			Ranges	Evarages
1	Male	13	0.9272 - 1.1557	1.0399
2	Famale	20	0.7561 - 1.1039	0.9804

relative frequency value describes the percentage of individuals present in a population. This value also provides information about the probability of an individual's presence in the waters based on length.

Based on the results of condition factor analysis on 33 individual Halmahera walking sharks (*H.halmahera*) in Kao Bay sea, it shows that morphologically they have plump criteria (Table 4). Overall the data shows that the Halmahera walking shark population in Kao Bay is still in a stable condition (Table 4). The condition factor (FK) value of Halmahera walking sharks (*H.halmahera*) in the Kao Bay sea has a range of 0.756-1.155 with an average value of 1.003 (Table 4). Condition factor based on sub location, then at Kao Bay station. South has a value range of 0.8561-1.0973 with an average value of 1.0012, South Morotai Station obtains a value range of 0.7752-1.0670 with an average value of 1.006, Kao Bay. North is obtained between 0.9216 - 1.0903 with an average of 1.015, Kao Bay. East found a value range of 0.8433 - 1.0817 with an average of 1.001 and Kao Bay. West got a value of 0.7821 - 1.1586 with an average of 1.002 (Table 4)

The highest condition factor is at Kao Bay station. North and lower are found at the Kao Bay station. South (Table 4). The results of the analysis illustrate that the Halmahera Walking Shark (*H.halmahera*) has a plump body (Fusiform). Condition factors Condition factors with a value of 1-3 explain that the body of the fish is plump (Effendi, 2002). The condition factor is an important biological parameter, which can indicate the suitability of a particular water quality for fish growth and the average size index of species. The condition factor describes the interaction between biotic and abiotic factors on physiological conditions and values indicating fish fatness (Faradonbeh et al. 2015; Ramses et al. 2020). Condition factor analysis describes the plumpness of fish based on length-weight. Normal condition factors provide information regarding fish health and the balance between predators and prey in a waters (Gundo et al. 2014; Muchlisin et al. 2017). For endemic species to serve as the foundation for conservation policies, physical certainty must be attained. This is due to the fact that fish plumpness is a sign of physical well. The state of the swollen body provides details on the environment, which supports the Halmahera walking shark's existence.

Condition factors for Halmahera walking sharks (*H.halmahera*) based on sex in Kao Bay were found to be different (Table 5). The results of factor analysis on the condition of the Halmahera walking shark in Kao Bay in the male sex were obtained between 0.9272 - 1.1557 with an average value of 1.0399 (Table 5). Female genitalia found condition factors ranging from 0.7561 - 1.1039 with an average of 0.9804 (Table 5). According to the value range (Table 5), the male sex is valued higher than the female. Depending on the length, weight, and number of humans present, the condition factor's value varies. In general, internal elements including gonad maturity, reproduction, spawning, and mating as well as natural food have an impact on a female's health (Effendie, 2002; Motta et al. 2005; Motta et al. 2014). The female condition component is more volatile since the female genitalia is typically more impacted by many circumstances than the male genitalia. Predators' effect and the degree of environmental selectivity may have a greater impact on female sex, which leads to a more dynamic female condition factor. The success of identifying food sources and morphometric assessments may have contributed to male plumpness, despite the condition factor values being just slightly different between the sexes. The study's findings are consistent with those of Jutan et al. (2017), who discovered the body of a large Halmahera walking shark in Koa Bay. The swollen body demonstrates that walking sharks are growing in a healthy manner (Jutan et al. 2017). According to Effendi (2002), both internal (sex, age, illness, and genetic) and environmental (food and water temperature) factors might affect fish growth. According to in-situ measurements, Kao Bay sea have a surface temperature of 29 ^{O}C. According to Millions et al. (2017), the water temperature in Kao Bay typically stays between 25 and 26 ^{O}C at sea level and 29 ^{O}C at a depth of 15 to 20 meters. High tolerance is exhibited by Halmahera walking sharks (*H.halmahera*) in hypoxic waters with a temperature of 30 ^{O}C.

4. Conclusion

The basic conclusion is that paired sexes accurately capture population continuity. The fact that the subpopulations' morphometric differences are so small suggests that they have a common ancestor. These endemic species are local species, and the age group (*cohort*) is separated into three age groups: the juvenile, adult, and old age phases. A healthy population and typical surroundings were described by the body's condition, which was discovered to be plump. The general condition of the Halmahera Walking Shark (*H.halmahera*)

in Kao Bay sea has been described.For future research, it is necessary to collect data and observe the condition of the Halmahera Walking Shark (*H.halmahera*) population based on different seasons, namely the east monsoon, the first post-arid, the second transition and the western monsoon.

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