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Pattern of appearance of Whale Sharks (Rhincodon typus) Botubarani Gorontalo Based on Satellite Marker Monitoring

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Abstract: This research aims to determine the spatio-temporal distribution of Whale Sharks in Tomini Bay using satellite markers on Botubarani Beach, Bone Bolango Regency, Gorontalo Province. The subjects of this research were two individual whale sharks that had satellite tags attached to them as well as whale sharks that appeared at the time the research was conducted. The method used in this research is (1) photo ID to differentiate between individual types of whale sharks, (2) using satellite-based technology, by installing 2 (two) satellite tagging units of the Finmount Tag type on ID 53 whale sharks with body length measurements. 4.16 meters and the ID 55 measures 4.77 meters. The research was conducted from April 2023 to August 2023. The migration patterns of individual whale sharks attached with satellite tags show that they have a tendency to keep returning to the Botubarani coast of Gorontalo with different spatial and temporal distribution patterns. In terms of the number of appearances of the two individuals after installing fine markers for Whale Shark ID 53 in the period of 1 (one) year, it was recorded that 58 times were recorded in the waters of Botubarani, Gorontalo and its surroundings. Meanwhile, Whale Shark ID 55 in the same period was only recorded 21 times in the waters of Botubarani Gorontalo beach. Most of the Whale Shark aggregation locations in Tomini Bay identified through satellite tagging data on these two individuals have not yet entered the conservation area. The results of this satellite tagging method can be a basis for future reference for establishing conservation areas, especially in Tomini Bay for protection, preservation and sustainable use. limited and responsible for the existence of whale sharks.

Keywords: Whale Shark, Photo ID, Tagging satellite

INTRODUCTION

The location where whale sharks appear in the Gorontalo sea area is in the waters of Botubarani Village, Kabila Bone District, Bone Bolango Regency, which is included in the Tomini Bay area. Based on information from local fishermen, the appearance of whale sharks in Botubarani waters and its surroundings has actually been a long time coming, but the exact time is not known. This can be proven by the mention of this fish with the local name Munggiangohulalo. This fish usually only appears at certain times. They sometimes appear every day but sometimes they don't appear and then disappear from Botubarani waters.

According to local fishermen, these fish are actually just a nuisance to fishermen because they usually swim near boats and prey on target fish such as nike fish. Olii, et al. (2017); Sharei, et al.

(2019), nike fish are small fish that appear in the waters of Gorontalo Bay at the end of the month to the beginning of the month in the Hijri calendar year. It is also reported that this fish will usually move to Nike fishing locations during the fishing season. Thus, it is possible that the presence of Whale Sharks in Botubarani waters and its surroundings is related to food as stated by Jonahson and Harding, (2007); Rahman, et al. (2017). The results of recent research on the sustainability of nike fish in the waters of Tomini Bay show that of the 5 dimensions analyzed there are 4 dimensions that are unsustainable (Sahami, et al. 2024). This will certainly also be a threat to the sustainability of Whale Sharks in Botubarani.

The existence of whale sharks in the waters of Botubarani, Gorontalo, has become known to the public since 2016, but scientific studies have been carried out in recent years. With the power of social media, Botubarani has now become a well-known whale shark tourist attraction abroad. This of course must receive serious attention for good management so that it is sustainable. Several researches related to this fish in Botubarani have been carried out, including by Rahman, et al. (2017) who conducted an initial study of the emergence of whale sharks in Tomini Bay which was linked to physical and biological factors in the waters. Then Rombe, et al. (2022) who conducted a study on the condition of the whale shark population and measured several water quality parameters. Meanwhile, information about the distribution pattern of Whale Sharks that appear in Botubarani waters is not yet available.

Whale sharks can influence community structure and function through top-down density effects and risk-based effects on the distribution and abundance of their prey (Heithaus, et al. 2008). Thus it is important to predict migration and aggregation patterns as well as anthropogenic impacts (Hammerschlag, et al. 2010).

So far there has been no scientific information about the movements of whale sharks. Information about the emergence of whale sharks is very important considering that Gorontalo is one of the regions in Indonesia which is a priority for marine biodiversity conservation, especially whale sharks. A more in-depth study is needed regarding the emergence and behavior of Whale Sharks over a long and continuous period of time at the location where they appear to obtain accurate data and information. Rahman, et al. (2017) stated that the appearance of whale sharks in the waters of Tomini Bay cannot currently be predicted accurately.

Documenting the movement and behavior of marine animals is a big challenge because of their high mobility and the influence of diverse water conditions (Martin, et al., 2009). With current advances in technology, tracking using satellite tags allows scientists to know the movement and roaming patterns of animals with satellite tags attached (Bailey, et al. 2010),

The aim of this research is to determine the occurrence pattern of the Gorontalo Botubarani Whale Shark using satellite tags.

RESEARCH METHODOLOGY

To find out the pattern of appearance of the Gorontalo Botubarani Whale Shark using the satellite tagging method on Whale Sharks, then collecting data from satellite signal receivers via the wildlife computer portal on Whale Sharks ID 53 and ID 55 which have satellite tags installed.

1. Tools and materials

The tools and materials used in this research are as follows:

1. Net size 20 x 50 meters; 2. Fishing boat; 3.Basic diving equipment (mask, snorkel, fins); 4. Scuba Equipment (Tube, Regulator, BCD); 5. Satellite marking tool typeFinmount Tag ; 6. Underwater camera; 7. Shrimp feed.

2. Method

1. *Satellite Bookmarks*

The satellite marker used in this research is the SPLASH10-346A type made by Wildlife Computers. This tag measures 198 mm x 84 mm x 23 mm and is specifically designed for mounting on the dorsal fin of whale sharks with large battery packs. This marker has the ability to work up to 450 days if it does not experience physical damage. Whale Shark movement data was obtained from monitoring using the WildLife Computer Portal.

To find out the condition parameters of temperature, depth, time of Whale Shark at the surface, time of Whale Shark at depth and the migration coordinates of Whale Sharks are obtained from data sent by satellite tags and downloaded directly via the wildlife computers portal.

2. Photo ID

In this research, Photo-ID is used to identify each different individual Whale Shark, in order to obtain accurate results. Photo-ID can distinguish one individual from another through the pattern of white dots found all over the body which is unique for each individual and is likened to a human fingerprint which does not change throughout the year (Azourmanian, et al. 2005; Speed, et al. 2007; Brooks, et al. 2010).

The main photo-ID used is the left side from the last gill to the tip of the pectoral fin. Apart from that, Photo-ID from the right side, gender and estimated length. This is very important to observe when equipping the identification key. Photo-ID taking is carried out for every individual seen during monitoring.

The advantage of using Photo-ID compared to using conventional tagging methods is that Photo-ID is not invasive, thereby reducing the negative impact of placing tags which can usually affect movement or changes in behavior. Each individual was identified using the Paint.Net program and the Interactive Individual Identification System (I3S2.0). From the results of this individual identification we determined the age group of the Whale Shark.

4. Observation of the Spatio-Temporal Distribution of Whale Sharks

The difference between one individual and another is only in the pattern of white spots on their body. Therefore, to analyze the emergence of whale sharks, which are monospecies, they are not calculated using a specific formula. Information regarding the appearance of Whale Sharks at Botubarani Beach can only be seen from the total number of individuals found and the number of new individuals.

The distribution of Whale Sharks studied is in the form of spatial (related to space) and temporal (time of appearance trend) distributions using satellite marker data. Spatio distribution is carried out by observing along the Botubarani coastal area or based on location.

RESEARCH RESULTS AND DISCUSSION

1. Spatio-temporal distribution of Whale Sharks in Tomini Bay

The results of observations of the spatial temporal distribution patterns of 2 (two) individual Whale Sharks with ID GT 53 and ID GT 55 which had satellite tagging installed showed different patterns. After embedding the satellite tagging device, the two individuals gave their first signal to

the satellite which was successfully read by the wildlife computer application software at different time intervals. The research results provided interesting results because the two individuals returned to Botubarani waters after migrating in the Tomini Bay area.

1.1. Whale Shark Horizontal Migration Patterns

The results of the analysis of horizontal spatial distribution patterns of the two observed individuals are presented in Figure 9.

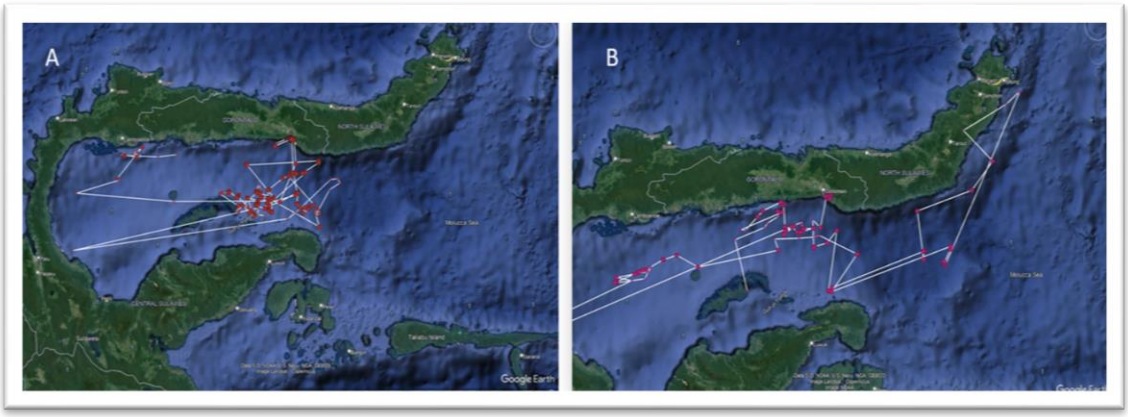

Figure 9. Spatial distribution pattern of Whale Sharks in the waters of Tomini Bay. A). Individual with ID 53; B). Individual with ID 55.

A. Horizontal Migration ID 53

Individual ID 53 sent his first signal with his coordinate position in the waters of Pohuwato Regency in the East Wonggarasi District on December 30 2022 after 7 days since the satellite tagging device was embedded in his body on December 23 2022.

Furthermore, on January 23 to February 5 2023, Individual ID 53 was detected in the waters of Central Sulawesi, precisely in the waters of Parigi Moutong. From 13 February to 9 March 2023, its position was detected in the waters of the Togean Islands, Central Sulawesi, and on 11 March 2023, the Whale Shark ID 53 returned to the waters of Botubarani Beach, Bone Bolango Regency, Gorontalo Province (Figure 9A).

The horizontal migration pattern of whale shark ID 53 started from December 23 2022, starting at Botubarani beach, then migrating out around Tomini Bay and returning to Botubarani beach, recorded for 79 days with a distance of 703.49 km.

B. Horizontal Migration ID 55

Observation results show that the individual with ID 55 who was embedded with satellite tagging on December 24 2022 shows a fixed coordinate position around Botubarani beach in accordance with the first signal received via satellite tagging data on the same day. This is different from individual ID 53 where the first signal was received 7 days after being tagged.

The migration movement pattern of the ID 55 Whale Shark was seen from 24 December 2022 to 7 January 2023, still in the waters of Botubarani Beach, but on 4 May 2023 it gave a signal that its position coordinates were already in the middle of the sea at Tomini Bay and on 16 May 2023 it was already in The waters of the Banggai Islands, Central Sulawsi Province. Furthermore, on May 19 2023, the position will be in Bolaang Uki Waters, South Bolaang Mongondow Regency, North Sulawesi Province. On May 20 2023, the ID 55 whale shark followed along the coast of East Bolaang Mongondow from Nuangan District to Kotabunan and on May 22 2023 at 13.04 it was in the waters of Kombi District, Minahasa Regency, on the same day at exactly 13.40 WIT the ID

whale shark 55 is already in Lembeh Waters, North Sulawesi Province. These coordinates are the whale shark ID 55's migration that is furthest to the north of Tomini Bay from Botubarani Beach, Gorontalo.

This individual whale shark with ID 55 after leaving Lembeh waters, North Sulawesi Province again followed the same route to re-enter the waters of Banggai Islands and on July 17 2023. Then it continued its movement towards Central Sulawesi, namely around Parigi Moutong waters on July 31 2023 until 15 August 2023. On 26 August 2023 ID 55 has started to enter the waters of the southern coast of Gorontalo Province, until on 18 October 2023 this Whale Shark returns to Botubarani beach, Kabila Bone sub-district, Bone Bolango Regency, Gorontalo Province (Figure 9B) .

Based on observations, ID 55 remained for 9 days but left Botubarani waters, namely on October 27 2023 and on October 30 it was detected in the waters of the Togean Islands, Central Sulawesi. The latest data is December 19 2023. The whale shark has returned to Botubarani beach.

The horizontal movement of whale sharks during migration is their attempt to find food (Handoko, 2017). The movement of whale sharks is also influenced by many factors, one of which is the availability of food at a whale shark aggregation location, as stated by Sleeman, et al. (2010) research on the movement of seven whale sharks that were tagged and released from the Ningallo Reef area into the Indian Ocean. From these observations, it was concluded that the movements of whale sharks follow the movement of plankton as food for these animals carried by surface currents in the Indian Ocean.

According to Rosalina et al. (2021) that the wandering nature of whale sharks while filter feeding has caused whale sharks to move in and out of Botubarani waters. When there are no tourists or management providing shrimp waste or small fish, the Whale Sharks will move to other places to look for more food. The phenomenon that can be seen is during the nike fish season. Maruanaya, et al. (2022) reported that the number of individuals appearing in Kwatisore waters is closely related to the catch of anchovies by Bagan fishermen.

1.2. Whale Shark Vertical Migration Patterns

The results showed that the two individuals observed had different vertical distribution patterns.

A. Vertical Migration ID 53

The results of observations of the vertical migration of Whale Shark ID 53 show that its movement was detected predominantly at the surface of waters with a depth of 0 to 30 meters and the maximum depth recorded was 480 meters (Figure 10). The presence of Whale Shark ID 53 at maximum depth with a frequency of 2 times, namely on February 5 2023 and March 20 2023. The coordinate position is halfway between Botubarani beach and Kurinai beach. From the vertical movement graph, it was also found that Whale Sharks are often at a depth of 375 meters with a frequency of 10 times at that depth. According to satellite data, the coordinates are around Kurinai Beach, Botubarani Village, Kabila Bone District, Bone Bolango Regency, Gorontalo Province.

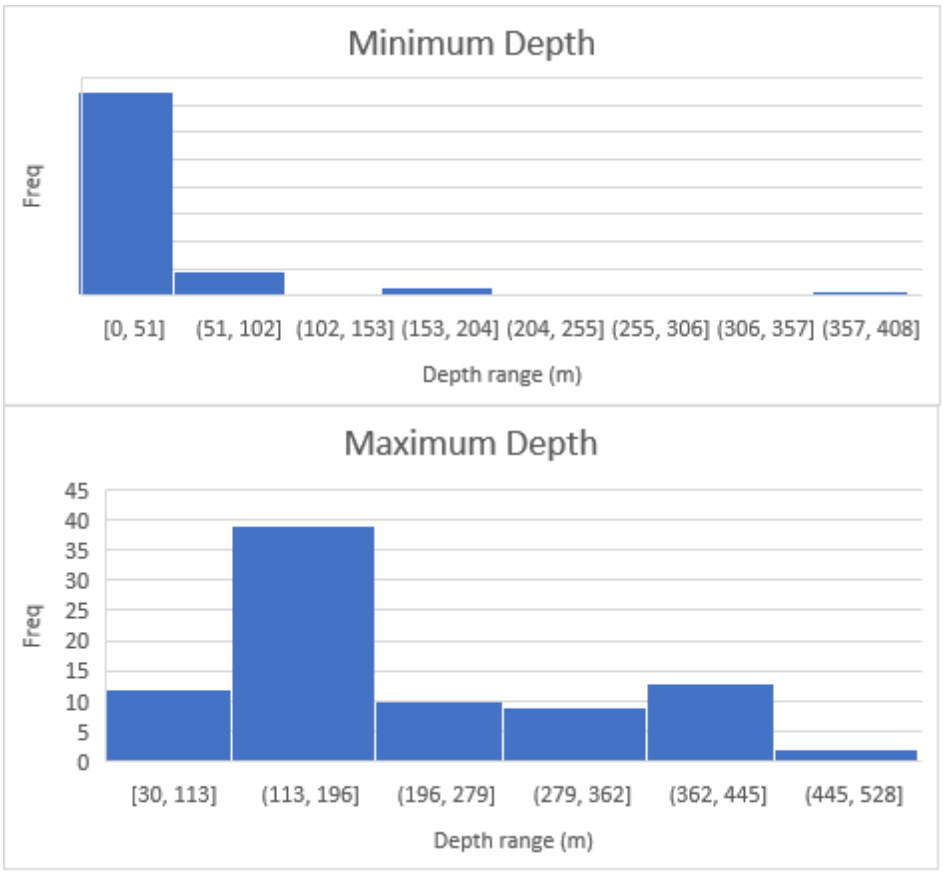

Figure 10. Graph of Vertical Distribution Pattern of Whale Shark ID 53 Based on Minimum and Maximum Depth

DataThis graph of the vertical movement of ID 53 whale sharks shows that their activity is mostly on the surface, which is thought to be due to their search for food on the surface of the waters. A more detailed comparison of the vertical migration of individual ID 53 is presented in Figure 11.

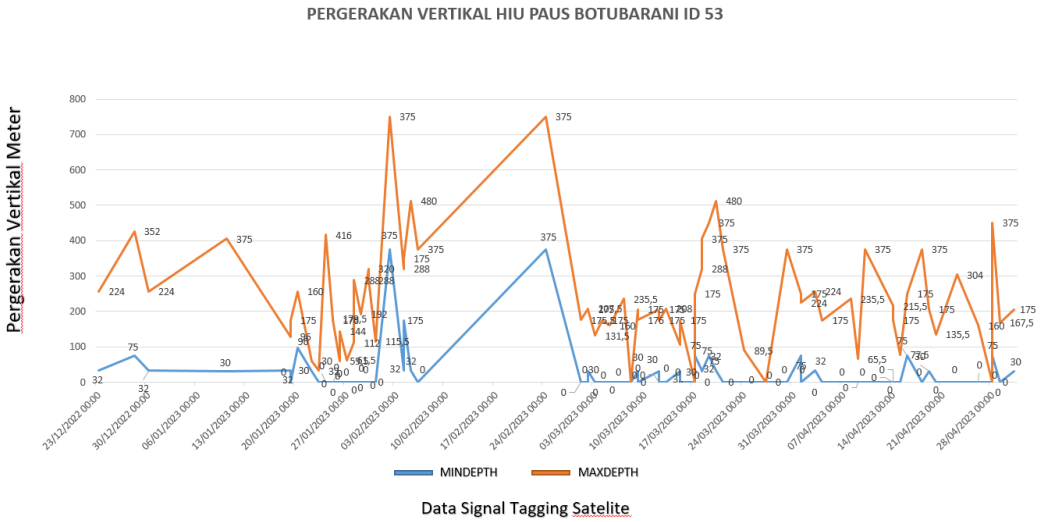

Figure 11. Vertical Movement Graph of Whale Shark ID 53 in Botubarani

Picture11 shows that the vertical migration of individual ID 53 tends to have the same pattern between minimum depth and maximum depth. This may be due to the migration activity being carried out on the same day where it stopped for a moment before continuing its spatial migration activity.

B. Vertical Migration ID 55

The vertical movement of the Gorontalo Botubarani Whale Shark ID 55 is almost the same as individual ID 53, where it is more dominant on the surface of the water, namely 0 to 30 meters, which is thought to be due to searching for food. The deepest depth recorded based on satellite tagging results is 528 meters, but the whale shark ID 55 is often also at a depth of 175 meters, which is recorded 10 times in its vertical movement phase during the 5 months since it was embedded with the satellite tagging tool. A more detailed comparison between vertical migration at minimum and maximum depths of individual ID 55 is presented in Figure 12.

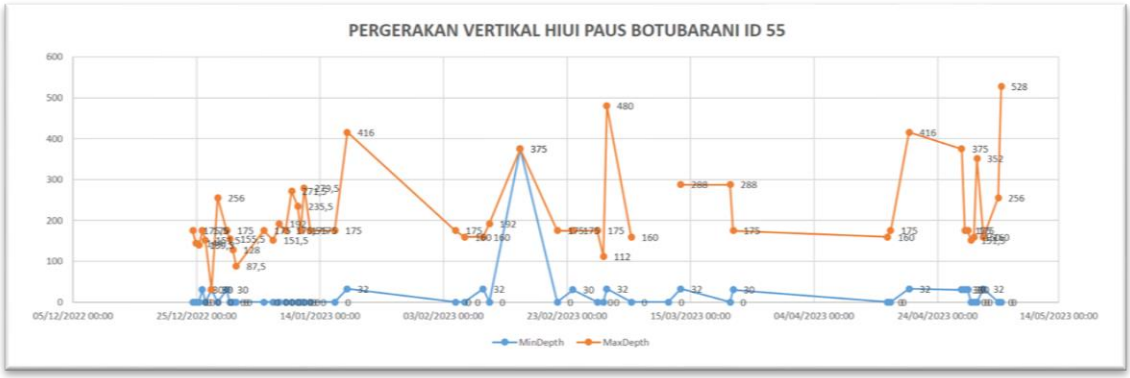

Figure 12. Vertical Movement Graph of Whale Shark ID 55 in Botubarani

Figure 12 shows that the vertical migration pattern of individual ID 55 is different from ID 53. This may be due to the different migration movement times where ID 55 was in Botubarani longer before carrying out horizontal migration.Rahman, et al. (2017) stated that Whale Sharks have a pelagic habitat, which means that Whale Sharks prefer to spend time on the surface of the waters, but are often found in open waters to coastal waters, sometimes even entering lagoon areas.

Migration to the surface is often carried out in order to find food in the form of plankton and small fish as well as crustaceans and squid. According to Rosalina, et al. (2021) that Whale Sharks in Botubarani waters tend to spend their time in shallow waters at a depth of less than 50 meters or close to the surface because these fish are plankton-eating fish and are filter feeder animals. The behavior of diving into deep water is thought to be due to following the movement of the food. Maruanaya, et al. (2022) reported that whale sharks are more likely to be on the surface of the waters during the day than at night and the behavior of whale sharks appearing on the surface of the waters is an effort to meet their daily food needs.

2. Temperature data based on satellite marker data

2.1. Whale Shark ID 53

The results of recording temperature data using data from the ID 53 satellite tagging are presented in Figure 13

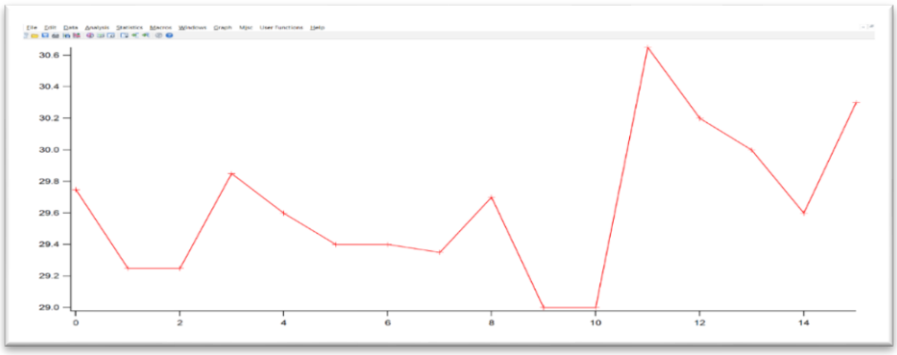

Figure 13. Graphic of Water Temperature Pattern at Whale Shark Aggregation Location ID 53

The graph in Figure 13 shows that the individual Whale Shark ID 53 has an activity niche at a temperature of 29oC to 30oC which is the ideal temperature for the whale shark's habitat environment. The lowest temperature fluctuations based on data are 27.50 C to 310 C, the highest. The temperature detected is the temperature of the environment according to the movement where the whale shark is, both vertical movement and horizontal movement of the whale shark.

2.1. Whale Shark ID 53

The results of recording temperature data using data from the ID 55 satellite tagging are presented in Figure 13

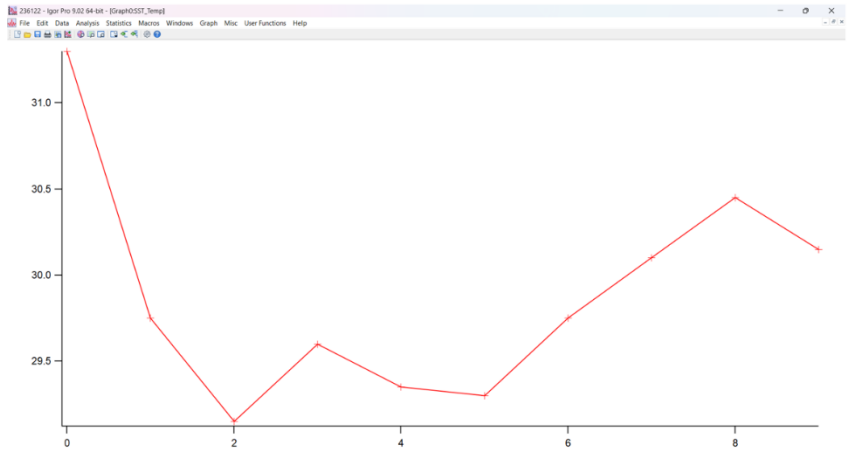

Figure 14. Graphic of Water Temperature Pattern at ID 55 Whale Shark Aggregation Location

The results of observations of water temperature conditions for the ID 55 aggregation (Figure 14) recorded that the highest was 32.7oC and the lowest was 27.9oC. Rahman, et al. (2017) reported the results of direct surface temperature measurements at the research location, ranging from 30.3-31.6oC. Rombe, et al. (2022) reported that the results of measuring the average value of water quality parameters for Botubarani water temperature during research were 29°C.

This temperature difference affects the vertical movement of whale sharks when at the surface, the temperature will rise according to surface water conditions, and vice versa if at depth or at night conditions this will of course affect this temperature data. The same condition occurred in research conducted byRohner, et al. 2018 in Mozambique waters.Temperature data shows that whale sharks embedded with satellite tagging are between 18.5-29.7°C, with an average of 23.9°C.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Whale sharks are solitary animals (like to be alone) and are rarely seen in groups. This type of shark is a slow swimmer, with a speed of no more than 5 km/hour. This fish swims by moving its entire body from side to side (not just relying on its tail, like some other types of shark) (Colman in Graham, 2003). Based on the research results, it can be concluded as follows:

1. Based on the results of satellite marker data, whale sharks that appear in Botubarani waters have a tendency to keep returning to Botubarani Beach with different spatial and temporal distribution patterns.
2. Based on visual data collection, the number of whale sharks appearing on the Botubarani beach in Gorontalo increases the number of new individuals every year. However, the frequency of whale sharks appearing at one time on the same day at the same time every year is starting to decrease.

Suggestion

1. Most of the Whale Shark aggregation locations in Tomini Bay identified through satellite tagging data on these two individuals have not yet entered conservation areas, so that in the future the protection of whale sharks will still be less than optimal, this is related to the status of Whale Sharks which are fully protected through KEPMEN KP Number 18 of 2013.
2. It is necessary to create a Standard Operating Procedure (SOP) for installing satellite tagging on whale shark bodies along with the required tools and materials as one of the results of this research so that it can be used by other researchers.
3. In the future, it is necessary to carry out further research and add satellite tagging tools to the Botubarani Gorontalo Whale Shark.
4. The results of this satellite tagging method can be a basis for future reference for establishing a conservation area, especially in Tomini Bay for the protection, preservation and limited and responsible use of the existence of whale sharks.

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