Behavioral and Biophysical Studies of Dugong (Dugong dugon) Habitat in Waters Mali Beach, Kabola District, Indonesia.

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Abstract. Dugongs are generally shy animals, so observing their existence is very limited to hundreds of meters. In contrast to the behavior of Dugong who lives in the coastal waters of Mali, Kabola Regency, Indonesia. Its uniqueness can interact with humans at a very close distance and can even be on the back. It is, therefore, necessary to explore other behavioral patterns and habits and biophysical habitats of Dugongs as information to maintain their survival. This research aims to find out the behavior and biophysics of dugong habitat in the coastal waters of Mali, Kabola Subdistrict, Indonesia. The study uses direct observation methods in the form of observing the characteristics and biophysical conditions of dugong habitats including (1) determining dugong activity areas using GPS coordinates; (2) observe habitat characteristics and biophysical conditions by observing biotic and abiotic conditions, and (3) measuring physicochemical parameters, namely temperature, salinity, and pH. Next, to observe the daily behavior of dugongs when interacting with their habitat environment in the form of time: breathing, going around the boat, swimming at the bottom, swimming on the surface, swimming in the water column, resting at the bottom, eating and exposing the back. In the observations, dugongs swimming around the ship immediately responded and then approached and rubbed his body to the leg then through the pectoral fins that tried to hug to get a leg on the model being tested. Then turn under the boat and remove the penis. In general, the biophysical conditions of sandy and dense habitats are overgrown with seagrass.

1. Introduction

Dugong dugon is a marine herbivore mammal in its taxonomy has kingdom Animalia, phylum Chordata, mammal class, order Sirenia, family Dugongidae, and genus Dugong. Dugong itself is included in the vulnerable category by the IUCN (International Union for the Conservation of Nature and Natural Resources) and Appendix I by CITES (Convention on International Trade in Endangered Species), where the existence of this organism in the world population is below 500 heads, [1],[2],[3].

The Government of Indonesia has issued Government Regulation No. 7 of 1999 concerning the Preservation of Plant and Animal Species (PP 7/1999) as a conservation management regulation. In appendix no. 20 of the Government Regulation, Dugong dugon is listed as a protected animal [4].

The condition requires an effort to protect dugongs from becoming extinct quickly. Efforts are made to protect a species or ecosystem called conservation [5], [6], [7], [8]. Dugong conservation can be done with three approaches, namely ecological, socio-cultural and economic approaches, and the
right mechanism is to conserve habitats [2], [9]. Mali’s beach waters are one of the locations that become dugong habitats in the Alor Regency. This area is located in Kabola Village, Kabola District, Alor Regency, East Nusa Tenggara. This aquatic area has ecological criteria for the survival of dugong life, among others, has a seagrass expanse with the naked eye has a high density where seagrass is a natural feed for dugong, in addition to the feed factor the state of the substrate of this area is a sandy area and a little shards of coral, even in the interior is still seen a very good coral reef, where this state is a strong indication of ecological niches (a suitable place for dugongs to forage, rest, or reproduce).

Dugong naturally in social interaction is a shy biota so usually if crossed with humans in a distance of <100m and rarely appear [3], [10], [11]. But not with dugongs living in Malian waters, this dugong approaches humans at a very close distance so that it can be used. A bad human behavior (visitor) is to swim and dive with the dugong, this is intensely done by every visitor in every visit to this area to see a dugong. In a day there are fifteen-twenty boats loading visitors (humans) to the location enjoying the uniqueness of dugong and always participating in diving, the inevitable thing is trampling their habitat that has an impact on damage such as seagrass being scattered, and then the association of coral reefs that are habitat of small fish around also destroyed, this can reduce the diversity and quality of life of the Dugong.

Tourism current activity in Mali beach area poses a serious threat to the survival of dugong. According to the data collected by World Wide Found (WWF) Lesser Sunda, that many foreign and local people already know that in the coastal waters of Mali there are unique Dugongs playing with humans (touchable) and even diving together, and this action is already underway. Given that the dugong is a rare organism and is protected because it is experiencing a decline in population due to ecological pressures on its habitat. In line with that, Dugongs living in coastal waters of Mali tend to be familiar with humans, which can affect the existence of habitats due to excessive interactions, so information related to the characteristics of life and habitat status of dugongs in Mali’s coastal waters is needed at this time. For this reason, it is deemed necessary to conduct research related to Habitat Characteristics and Daily Behavior of Dugongs in Mali Waters, Kabola District, Alor Regency. The purpose of this study was to observe the habitat characteristics and daily behavior of Dugong in the waters of the Mali Coast, Kabola Alor Regency.

2. Material and Methods

2.1. Location and Time of Research
This research was conducted from April to May 2021, in the waters of the Mali Coast, Kabola District, Alor Regency, East Nusa Tenggara Province.

![Figure 1. Research Area, Mali Coastal Waters, Kabola District, Alor Regency, East Nusa Tenggara Province, Indonesia.](image)

2.2. Research Tools and Materials
Tools and Materials used in this study are a medium that helps in the collection of data that can be seen in the table below.
Table 1. Research Tools and Materials

| Tools and Materials       | information                                                                 |
|---------------------------|-----------------------------------------------------------------------------|
| Ship                      | To search for the whereabouts Mali Coastal Waters, Kabola District, Alor Regency, East Nusa Tenggara Province, Indonesia. |
| GPS                       | To determine the coordinates of the dugong encounter                         |
| Camera digital            | Documentation                                                               |
| Handicap                  | Dugong behavior documentation                                               |
| Hand refractometer        | Measuring salinity                                                          |
| Thermometer alcohol       | Measuring temperature                                                       |
| pH meter                  | Measuring pH                                                                |
| Books and Pens            | Record all data obtained during observation                                 |
| Jam                       | To mark the time of dugong appearance                                       |
| Stopwatch                 | To calculate the breathing time and length of dugong diving                 |
| Questionnaire Sheets      | For interviews with fishermen and coastal communities                       |

2.3. Data Retrieval Method

The method of data retrieval used in this study is the direct observation/survey method, according to [3], [5], [11], [12]. The Survey Method is an investigation conducted to obtain facts from the symptoms and seek factual information.

Surveys conducted in the form of observations on characteristics and biophysical conditions of Dugong habitat, as directed [13], among others: (1) determine dugong activity areas using GPS coordinate points; (2) observe habitat characteristics and biophysical conditions through observation of biotic and abiotic conditions, and (3) measurement of physical-chemical parameters i.e. temperature, salinity, and pH.

Furthermore, for observation of the dugong’s daily behavior in the form of time: breathing, circling the boat, swimming at the bottom, swimming on the surface, swimming in the water column, resting at the bottom, eating and removing the back [3], [14], [15].

Then specifically observing dugong behavior when interacting with the habitat environment, the survey design used is a method of exploration using motorboats with a pattern around the dugong activity area and data collection starts around 07.00 – 17.00 WIB and is done every day. In this study Dugong observations using a survey with one group of observers (single platform) [15], [16], [17]. This observation was made with three people observing the appearance of the Dugong on one deck. The first observer position is at the bow of the ship, the second observer is in the middle of the ship, and the third observer is near the stern of the ship.

![Observer position on the Single Platform method](image)

Figure 2. Observer position on the Single Platform method (1. First observer spot, 2. Second observer place, 3. Third observer place)
2.4. Data Analysis
Information obtained in the field when conducting research is recorded later described and compiled through references or libraries related to the ideal habitat for the survival of Dugong that should be.

3. Results and Discussion

3.1. General Circumstances of The Research Site
The coastal area of Mali Beach, Kabola Village, Kabola Subdistrict, Alor Regency is an area overgrown with seagrass that is dense enough to meet dugong habitat criteria. This dense seagrass association area continues to be maintained through advocacy conducted by worldwide found (WWF) Lesser Sunda, to the local community through Dugong and seagrass conservation program (DCSP) to maintain the existence of seagrass, as the main source of feed Dugong. Some training, monitoring, incentives are given to support the activities of the Supervisory Community Group (Pokmaswas) and belongs to the village, business Entity to increase the role of supervision.

3.2. Dugong Activity Area
The Dugong activity area is always around the place where the dugong finds food or nutrients, so when conducting observations dugong is always at this location and does not appear to move or exit this location. Station point determination is recorded using GPS (Global Positioning System).
1. Station 1 is located S 8007'58.48" E 124-37'15.17"
2. Station 2 is located S 8007'13" E 124 37'10"
3. Station 3 is located S 8007'38" E 124⁰36'18"
4. Station 4 is located S 8008'04" E 124 36'07"

3.3. Characteristics of Seagrass at Research Site
The ideal criteria for Dugong habitat are seagrass fields because seagrass is the main feed dugong, this state is the actual condition in the coastal waters of Mali, which is already a very important ecosystem in coastal areas and coastal waters.

Some important roles of seagrass areas the main feed of important biota in addition to dugongs such as green turtles, in addition to being a nursery area of various other types of marine biota, even in the aspect of the robustness of sediment movement of waves is as a binder of sediment and chemically as carbon storage through carbon cycle in nature and the place of occurrence of other nutrient cycles, [7], [17], [18].
Seagrass fields located at the research site have a type of mixed vegetation, namely seagrass that generally consists of at least 3 species. Characteristics of seagrass in the Indo-Pacific tropics and subtropics that have a high diversity of species and mixed vegetation types [8], [19], [20]. At each station found seagrass species that include pioneer types, such as *Halophila ovalis*, *Halodule uninervis*, and *Cymodocea rotundata*. These types of seagrass have relatively small sizes, rapid growth rates, and shorter lifetimes.

Its natural habitat, dugong consumes delicate, less lush seagrass species, such as seagrasses of the genus *Halodule* and *Halophila*. It is thought that dugongs through feed on all seagrass species, however, they prefer seagrass species with high nitrogen levels, low fiber, and high calories. Species that have high nitrogen levels and low fiber are generally fast-growing pioneer species, which grow in intertidal and subtidal zones such as *Halodule sp.* and *Halophila sp.* The area overgrown by these species is generally a lagoon or covered bay that has a depth of fewer than five meters. Dugongs have been observed eating seagrass in the area during the day and night [6], [7], [21].

![Figure 4. Types of seagrass *Halophila ovalis* (a) and *Halodule uninervis* (b) are the types of seagrass which are the preferred nutrients by Dugong](image)

3.4. Identification of Feeding Trails

Feeding trails are found in stations 1 and 2, the condition of the feeding trail is a new feeding trail, it is seen in the observation that several times dugongs dive deeper and are seen eating. Dugongs can make a feeding trial at mealtimes ± five meters. There are two ways of dugong eating, (1). *Cropping*, Dugong only takes part of the leaves and leaf fronds. (2). *Grazing*, that is Dugong crawls with the support of both pectoral fins and plucks the entire seagrass grow to its roots, this activity will leave traces or elongated paths on the seabed or better known as feeding trail. [2], [8], [20].

![Figure 5. There are traces of Dugong feeding](image)
3.5. Dugong Behavior Observation

Response Dugong is swimming quickly around the motorboat because it has an instinct for interest in sound. According to [22], [23], [24], shows that mermaids are sensitive to ships approaching from a distance of 150m at a speed of three to five knots. Furthermore, it is known that the dugong has a sensitive nature to the surrounding sounds and observes the sound and can remember the sounds it usually hears. Then, when moving the observation location, the observation was carried out slowly, because the Dugong continued to follow at the stern of the motorboat.

Observations on the behavior on the surface of the water there is dugong activity to breathe oxygen. Dugong’s interval dive then re-emerges and performs the same cycle for three to ten minutes. Dugongs are marine mammals that breathe using lungs and tend to be unable to utilize dissolved oxygen in the water.

The Dugong underwater using an underwater camera found the dugong removing his penis, swimming around the boat, and snarling his body into the hull. Dugongs in Malian waters have male genitalia and will remove them if something stimulates them. It is suspected that this dugong has entered a biologically mature age for mating but it is known that the dugong in Mali waters is only one without a female dugong. Dugongs in Malian waters have a body ± 3 meters with the age of teenagers before adulthood. It is at this age that it is usually looking for females to marry. However, based on observations from WWF in 2017 and 2018, there was no presence of female dugongs in Mali Waters, Kabola village.

Observations on visitors who carry out activities around the ship. This observation was made using someone who lowered his leg on the side of the ship. The dugong that swims around the ship immediately responds and approaches and swiping to the leg then tries to hug to get the man's foot (Figure 5).

This kind of dugong behavior is not the usual behavior of other wild dugongs. This behavior is classified as aggressive, because it will be dangerous in humans who will do snorkeling and diving activities in Mali waters, Kabola Village.

![Figure 6. Dugong interaction with humans](image)

3.6. Environmental Conditions at The Research Site

The physical-chemical parameters in water play a very important role in the survival of all organism in it, not least the seagrass species.

| Location | station | temperature (°C) | salinity (‰/00) | pH |
|----------|---------|-----------------|-----------------|-----|
| Mali     | St 1    | 29.5            | 30              | 7.92|
|          | St 2    | 29              | 32              | 7.95|
|          | St 3    | 27.5            | 29.6            | 8   |
|          | St 4    | 30              | 30              | 7.99|

Table 2. Water Quality at Research Site
3.6.1. Temperature

Temperature is one of the very important factors in regulating the metabolic process and distribution of organisms. Metabolic processes will be able to take place or work optimally in a relatively narrow temperature range, namely at vulnerable 0°C to 40°C, but there are also organisms capable of tolerant temperatures above 40°C and below 0°C, such as green-blue algae capable of living at 85°C in hot springs. According to [7], marine organisms can adapt to life and multiply at a temperature range narrower than the 0–40°C range.

Water temperatures at all four stations are still within normal limits at 27.5°C to 30°C. When viewed from the measurement results, the temperature at the four stations is still included in the optimum conditions in seagrass growth. The optimum temperature required by seagrass to grow is around 28°C–30°C. For seagrass, the temperature can affect physiological processes such as photosynthesis, respiration rate, growth, and reproduction. If outside the optimal range, physiological processes can decrease sharply (Dahuri, 2003 in Jurajj et al., 2017). Syafutra et al., (2018), added that temperatures from 25-35°C, are the optimum temperature for photosynthesis in seagrass.

3.6.2. Salinity.

Salinity distribution in a country is strongly influenced by many factors, including evaporation, rainfall, water circulation patterns, and freshwater content entering the ocean waters. Seawater entering sea waters can come from rainfall or surface flows and river flows.

From the results of field measurements obtained salinity range results at the station 32-29.6 ppt, this value includes normal in seagrass area [25], explains that most types of seagrass can tolerate a wide salinity range and seagrass can live in the salinity range of 10–40 ppt. For example, Thallasia is found to live at salinity between 3.5-60 ppt though short tolerance time, while halodule species can live at salinity above 72 ppt, however, this type of seagrass has the optimum growth condition of 35 ppt [26]. While in the thalassemia group the optimum salinity for its growth is in the range of 24-35 ppt, [27].

3.6.3. Degree Of Acidity (pH)

PH values are very important to know in water, as the pH will be the controller of the type and speed of reaction of some materials in the water. The pH value is an expression of the concentration of hydrogen ions (H⁺) in water. pH variations can occur due to chemical and biological processes that can produce both acidic and alkaline compounds. In addition, the pH value can also be caused by the insertion of acidic waste or alkalis from the mainland.

The pH values obtained from the four stations range from 7.92-8. This condition is still relatively normal, according to the Decision of the Minister of Environment No. 51 the year 2004 the pH threshold value in seawater is worth 7-8.5. It is also said by [28], that seagrass can grow well when the pH of normal seawater is around 7.8 and 8.5 because at that time the bicarbonate ions needed for photosynthesis by seagrass are in an abundant state.

3.6.4. Substrate

In general, seagrass can live on various types of sediment or substrates, ranging from mud to basic sediment consisting of 40% fine sludge deposits [28], [29], seagrass needs a soft base, this is because it is easily penetrated by its roots and rhizomes in supporting the seagrass body. The observation of substrates at the research site has a type of sandy sediment with a small fraction of fine ka rang on mali beach.

The particle size distribution of sediment greatly affects the exchange of pore water with a column of water on top of it. The distribution of particle size that tends towards dust and clay will cause the exchange of pore water with water columns to become low so that the concentration of nutrients and phytotoxins such as sulfide in the sediment will increase [6]. The opposite condition will be experienced by seagrass if it occupies a type of rough sand sediment, [30].

4. Conclusion

Based on the results of the study, it can be concluded that there are various behaviors conducted by dugong in Mali Waters, Kabola Village such as breathing, circling the boat, swimming on the surface,
swimming at the bottom, swimming in the water column, eating, resting at the bottom, playing the steering wheel, moving his body to the ship, moving his body to the wheel, removing the penis, moving his penis to the ship, and trying to play with humans. Characteristic habitat is a seagrass field with a combination of sand substrates.

Dugong feeding trails are found only at station 2 of Mali Beach, with habitat conditions heavily overgrown with seagrass species *Halophila ovalis*, *Halodule unnerves*, and *Cymodocea rotundata*.

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