ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 3 (March 2026)

Diversity and Distribution of Marine Algae in Barangay Calumpang, General Santos City Coastal Area

Naila M. Giomna
South East Asian Institute of Technology, Inc.
suwaibnailah@gmail.com

Annie Rose P. Garote
South East Asian Institute of Technology, Inc.
annierosegarote88@gmail.com

Mary Lou C. Perang
South East Asian Institute of Technology, Inc.
perangmarylou@gmail.com

Ligaya Joy A. Babelonia
South East Asian Institute of Technology, Inc.
ligayababelonia@gmail.com

Precious Angel C. Gonora
South East Asian Institute of Technology, Inc.
preciousgonora@gmail.com

Andrea K. Dasan
South East Asian Institute of Technology, Inc.
dasanandrea115@gmail.com

Judy Rose B. Sugal
South East Asian Institute of Technology, Inc.
judyrosesugal9@gmail.com

Date Submitted:
February 27, 2026

Date Accepted:
March 12, 2026

Date Published:
March 17, 2026

DOI:
10.5281/zenodo.19057949

ABSTRACT

This study investigated diversity and distribution of marine algae in the coastal ecosystem of Barangay Calumpang, General Santos City. Marine algae play vital ecological roles as oxygen producers, food sources for marine organisms, and contributors to environmental balance. Using an descriptive research design and the line-transect-quadrat method across ten stations along a 500-meter coastline, the study identified eight species among 92 collected samples: Petalonia binghamiae, Ulva lactuca, Caulerpa sertularioides, Ulva intestinalis, Cladophora rupestris, Halophila ovalis, Halodule, and Ulva compressa linnaeus. Ulva lactuca (sea lettuce) was the most abundant and widely distributed species, while Petalonia binghamiae had the lowest abundance due to environmental factors such as limited light and temperature variation. Results showed that sunlight, salinity, and temperature strongly influenced algal presence and growth. Clean water and stable conditions promoted higher diversity, whereas pollution and habitat disturbance reduced algal populations. The study underscores the ecological importance of marine algae as indicators of water quality and emphasizes the need for conservation, waste management, and community awareness to sustain coastal biodiversity.

Keywords: *Coastal ecosystem, Marine algae, Salinity, Abundance, Diversity, Sunlight, Temperature*

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 3 (March 2026)

INTRODUCTION

Marine algae have been living for billions of years in this world, and this organism produced the early oxygen on Earth. It evolved from an ancient cyanobacterium. According to Algae Planet (2024), cyanobacteria released oxygen into the atmosphere as a byproduct of photosynthesis, leading to the accumulation of oxygen in the atmosphere and oceans. Marine algae are the types of algae that are pigmented, such as green, brown, red, and blue-green. Their colors may vary, but it does not indicate whether that specific alga is toxic or beneficial in coastal ecosystems. Thus, algae can be edible and toxic; some edible algae give nutrition and contribute to the food source of humans and marine animals, while others can be nonedible and can cause harm to both humans and marine animals.

The distribution of marine algae is governed by a range of environmental factors, both physical and chemical. Key physical factors include the availability of sunlight, water temperature, wave action, and the nature of the substrate, with algae often exhibiting distinct patterns based on their tolerance to exposure. The chemical environment, including salinity levels and the availability of nutrients like nitrates and phosphates, also plays a critical role in their distribution how they vary. Moreover, nutrient availability can significantly alter species composition and abundance, with excessive nutrients sometimes triggering harmful algae. As with many other marine organisms, climate change and anthropogenic stressors, such as pollution and coastal habitat destruction, are increasingly impacting the distribution and diversity of marine algae communities.

According to Ferdous & Yasuf (2022, p. 5), marine algae are the leading producer in the benthic food chain. Therefore, any change in marine algal communities will disrupt the whole ecosystem. Over years, these discoveries of these green microorganisms contribute to the biotechnological industry. Algae were seen as a biological pump not just to drive, balance, and maintain ecosystems, but it can also be used in different technological fields. The technologies concept applied to microalgal biotechnology was extended to the microalgae application as an effective tool for environmental processes, such as wastewater bioremediation, and also the capacity to mitigate polluting gasses (Ferdous, U., & Yasuf, Z., 2022, p. 5). It proves that the benefits and different applications of the marine algae are so vital that even small alterations of change can affect our ecosystem. However, the current plans, at the time, to establish the consolidation of microalgal biotechnology in the fields of bioenergy and environmental bioremediation were still not sufficiently developed (Depra, M., Lopes, E., et al., 2022, p. 1). This existing study focuses on the beneficial factors and application of marine algae wherein it can provide sustainable goals such as providing excellent nutritional content, high protein, lipids, and carbohydrates that are considered a food with high value-added without emphasizing the harmful factors that can also affect the ecosystem.

To rectify this gap, quantifying the number of the different species of marine algae and its distribution in coastal ecosystems were explored together with the harmful and beneficial factors. Necessarily, to understand that there are also disadvantages to consider and the abundance of marine algae that is useful during application to the said industry and fields in the existing study.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 3 (March 2026)

Objectives

The purpose of this study is indicated as under:

1. To quantify the marine algae, present in the coastal ecosystem.
2. To determine the species abundance of marine algae from a coastal ecosystem.
3. To evaluate the species distribution of marine algae in coastal ecosystem.

METHODOLOGY

Research Design

Using a descriptive survey methodology, this study concentrated on gathering quantitative data (experimental) using field survey. Marine algae at certain coastal location were systematically sampled as part of the survey to ascertain species composition, abundance and dispersion. Additionally, environmental information was gathered to evaluate any possible relationships with the distribution of algae.

Research Locale

Figure 1. Map of the Sampling Area

The study was conducted in the coastal ecosystems of General Santos City, located in the Philippines. Specifically, sampling took place at 1 distinct site: Barangay Calumpang, Purok Saeg. This site is selected to represent the microhabitats where the samples were present and being collected. The geographical coordinates for the sampling station were shown as follows: Saeg (6.0711° N, 125.1537° E). This coastal habitat of the study primarily consisted of mixed rocky, sandy substrates, and is located near a small residential area wherein potential human disturbance may influence water quality or habitats of marine algae. The selection of this site was crucial for the study's objective of how different environmental conditions affect the diversity and distribution of marine algae.

Sampling Technique

For studying marine algae diversity and distribution in coastal ecosystems, the survey made use of the line-transect-quadrat method. This involved establishing perpendicular transect lines from the shore and placing quadrats at regular intervals to identify, count, and estimate the cover of algae species. Additionally, photographic sampling was used to record data on algal distribution and community structure (Sultan, Hamid, & De-Sheng, 2025). To ensure reliable data collection, careful preservation of samples in the lab was crucial, often using methods like formalin. Combining techniques, such as the line-transect quadrat method and photographic sampling, provided a comprehensive understanding of marine algae diversity and distribution. This multi-faceted approach enabled researchers to collect accurate and detailed data, ultimately contributing to a better understanding of coastal ecosystems.

Sampling Materials

The materials, chemicals, and equipment utilized in the experiment are listed below, along with the specific methods and procedures implemented during the experimental process. The materials and equipment included beakers (250 mL and 1000 mL), a dissecting kit, a hot plate, a graduated cylinder (100 mL), glass slides and cover slips, test tubes, a test tube rack, a pH meter, a microscope, pipettes, and a watch glass. The chemicals used in the experiment were formaldehyde, xylene, paraffin wax, immersion oil, and ethanol.

Sample Preparation

Collect marine algae present in the coastal area of General Santos City in (specific place) and enough sample of sea water. Use any container to store the collected samples. The collected fresh samples of algae were rinsed using distilled water and sorted by species. Samples should be preserved by freezing in ice box, while the collected sea water was used to record the water temperature, salinity, and pH to understand the context distribution of algae for later analysis.

Sample Analysis

Tissue samples of marine algae were exposed to fixation using fixative solution to preserve the tissue and cell structures. Dehydration was done after being fixed, exposing the fixative sample in alcohol to remove water from the tissue samples and then clearing it by removing the dehydrating agent from the tissue and replacing it with a substance that would allow for the infiltration of the embedding agent. Using wax infiltration, the tissue sample was infiltrated with molten wax. Now, the tissue sample is embedded with the molten wax to provide support for sectioning. The sectioning part included cutting the tissues into thin slices and proceeding to staining; the thin tissues after are then stained to highlight cellular features.

Microscopy

Microscopic analysis was performed using an electronic microscope to determine the cell structure of different tissue samples. Images were captured from different fields of view under the microscope per sample using a digital camera. The results are subjected to statistical analysis.

RESULTS & DISCUSSION

This section contains a graphical representation of the data gathered, as well as its analysis and interpretation.

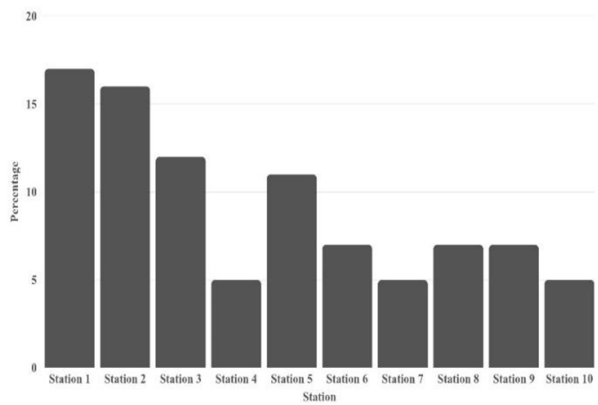

Figure 1.1. Quantification of marine algae by station.

The figure above shows the number of marine algae of all species present in a coastal ecosystem based on the table above.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 3 (March 2026)

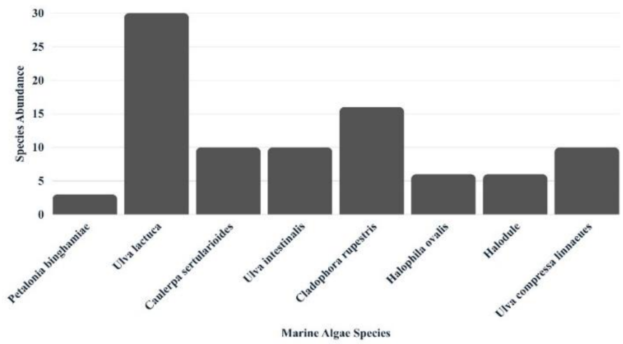

Figure 1.2. Species abundance of marine algae.

The figure above shows the abundance of each species from the coastal ecosystem. The samples contain 8 different species of marine algae and the y-axis represents the percentage of species abundance.

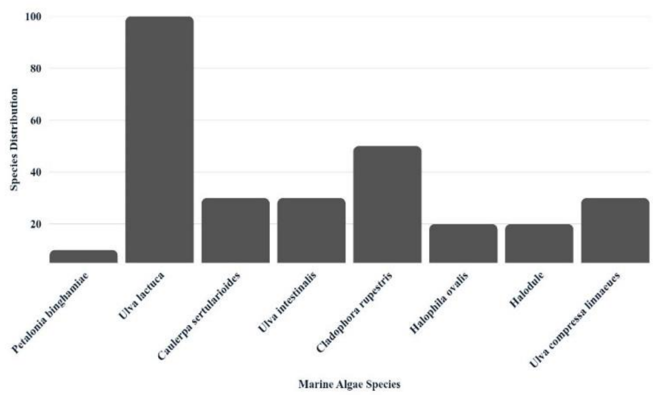

Figure 1.3. Species distribution of marine algae.

The figure shows how the eighth different species are being distributed in a coastal ecosystem. The numerical value in y-axis represents the percentage of the distribution.

DISCUSSION

During the sample collection, it contained 10 stations, and per station, it had a distance of 50 meters, resulting in 500 meters of total area sampled. In addition, each station had 3 samples collected, referring to Table 1, and Figure 1.1 presents the quantification of marine algae present in the coastal ecosystem of General Santos City, specifically in Barangay Calumpang.

Using the density formula, it enabled to quantify the concentration of marine algae in the total area sampled. Based on the Table 1 above, the total number of individuals of all species were

92 by summing up all of the numbers of marine algae. While, the total area sampled were 10 considering the 10 stations for the collection of marine algae. Substituting the data using the formula resulted 9.2.

The result (9.2 individuals per meter squared) was the average count per quadrat of marine algae which was used to determine the population density divided by an area of a single quadrat which is $1m^2$ and getting the same result of 9.2. The same result were used to scale up to the total area. To get the total area of 500 meters, multiplied the distance of each station (50 meters) to the 10 stations. From the density formula's result of 9.2 multiplying to the total area of 500 meters resulting in 4,600. Therefore in 500 meters there were approximately 4,600 marine algae present in the coastal ecosystem of Barangay Calumpang in General Santos City.

The graphical results in Figure 1.1 clearly shows that as a quadrat gets farther away from another station, the biotic factors, such as herbivores and competitors of space and light, including the substrates, contributed to the absence or presence of marine algae. Station 1 was where the most marine algae was collected, with different species, and as the stations go farther to Station 10, the marine algae present became fewer. Considering the station's direct sunlight due to open space. Marine algae are photosynthetic organisms. Algae form organic food molecules from carbon dioxide and water through the process of photosynthesis, in which they capture energy from sunlight (Andersen & Lewin, 2025). They used sunlight as their primary energy source; depending on the light intensity, their growth also varies. Algal growth is affected by different types of shading light because light is a fundamental variable for algae (Singh, 2015). This energy is being utilized to convert carbon dioxide and water to an organic compound like sugar for the cell's growth that leads to population growth of a marine alga. In connection to the light, temperature is also another factor that affects the growth of marine algae wherein when the temperature is low, the growth of an algae slows down as well, and when it is high, the metabolic process of photosynthesis is inhibited, which can lead to damage or death of an algae's cell. Moreover, factors like herbivores such as fish-eating algae cause biomass reduction of marine algae by consuming fast-growing algae to prevent outcompeting other organisms, maintaining the balance in marine ecosystem with such benefit in biodiversity.

Observational studies have found negative correlations between herbivorous fish biomass and macroalgal cover, suggesting that herbivores can exert top-down control on macroalgal abundance, (Edwards, et al., 2014). It gives the other organisms such as coral a space to grow. More importantly, the sea water where marine algae grow contributes to its growth wherein the salinity can trigger its osmotic stress and allowing it to invade freshwater ecosystems. Disrupting other organisms by their space where they grow. When the water salinity increases, it would cause an imbalance in the coastal ecosystem by shrinking available freshwater resources, altering environmental parameters such as metal concentration rise, and the restrained oxygen-and-nutrients distribution creating stressful circumstances that harm the existence of the aquatic flora and fauna, (Dao, et al., 2024).

In Figure 1.2. showing the results in species abundance in coastal ecosystem and it contains 8 samples, namely; Petalonia binghamiae(Haba-nori), Ulva lactuca (sea lettuce), Caulerpa sertularioides (green sea feather), Ulva intestinalis (gutweed), Cladophora rupestris (rock-weed), Halophila ovalis (paddle weed), Halodule (needle seagrass), and Ulva compressa linnaeus (thread

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 3 (March 2026)

weed). The Relative Abundance (RA) formula are used to determine the abundance of a specific species that are being collected in the different station on a coastal ecosystem.

Based on the results, Petalonia binghamiae (Haba-nori) obtained a 3% abundance due to several environmental and biological factors such as unsuitable water temperature, insufficient light, improper substrate, and extreme seawater salinity in Barangay Calumpang. This brown marine alga, also known as “haba-nori” in Japan, has a ribbon-like structure and typically thrives in low-temperature seawater. According to Kurashima et al., the germlings of Petalonia binghamiae grow best at 25°C and show decreased growth at 30°C, indicating that this species requires a distinct temperature range for optimal development. It usually inhabits rocky substrates characterized by fluctuating salinity and demonstrates adaptability to changes in seawater concentration. However, the algae collected from the sampling site were washed away due to low attachment rates, resulting in reduced survival. The shaded surroundings caused by nearby trees also limited light penetration, explaining its low abundance. In contrast, Ulva lactuca (sea lettuce) exhibited a 30% abundance, attributed to high nutrient enrichment in the water, primarily nitrogen and phosphorus, from human-induced sources like agricultural runoff. This species, known for causing “green tides,” thrives in nutrient-rich, rocky, and brackish environments. It is highly adaptable, capable of surviving across various temperatures and salinities, and often accumulates heavy metals, contributing to water pollution when forming large blooms.

Another algae species, Caulerpa sertularioides (green sea feather), showed a 10% abundance in the coastal ecosystem of Barangay Calumpang. This green seaweed, notable for its feather-like appearance and rapid growth, is classified as an invasive species and typically found in warm tropical waters (Mosquera & Salamanca, 2016). The seawater temperature in the study site supported its growth, and the sandy to muddy substrate matched its natural habitat. With a salinity range between 25 and 30 ppt, Caulerpa species thrive in shallow coastal environments but require moderate light intensity since excessive sunlight damages their cells. Consequently, they commonly grow in subtidal areas, explaining their moderate abundance. Similarly, Ulva intestinalis (gutweed) had a 10% abundance and is known for its bright green, tubular structure. It is an opportunistic alga that proliferates in nutrient-rich waters, often caused by sewage or agricultural runoff. Found mainly in brackish water near drainage areas, this species demonstrates remarkable adaptability, forming floating mats that maximize light exposure and ensuring survivability despite light limitations due to surrounding trees (Soufi et al., 2024). Cladophora rupestris (rock weed), another sample with 16% abundance, is a robust green alga with significant biotechnological and pharmaceutical potential. Its adaptability allows it to thrive in nutrient-rich environments, often indicating eutrophic or mesotrophic conditions. It grows on rocks, ropes, and in crevices, providing habitat for various marine organisms (Kutzing, 2025).

Additionally, Halophila ovalis (paddle weed) and Halodule (needle seagrass) both recorded 6% abundance in the sampling area. H. ovalis is a small, leafy marine plant with paddle-shaped leaves, capable of surviving in deep waters with minimal light but limited by total light deprivation. Its low abundance is attributed to its sensitivity to temperature and salinity extremes, which affect its metabolism and growth (Longstaff et al.). Halodule, on the other hand, is a tropical to subtropical seagrass that grows best in warm seawater between 23°C and 32°C and tolerates environmental disturbances and low salinity (Sousa et al., 2025). The final species, Ulva compressa linnaeus (thread weed), exhibited a 10% abundance. It has flattened, hollow, and elongated fronds and requires high light intensity for optimal growth. Reduced sunlight exposure caused by environmental factors and competition from other organisms likely limited its abundance. Overall, approximately 4,600 marine algae were present in the coastal ecosystem. Furthermore, bacteria play a vital role in the life of marine algae, particularly Ulva species, which depend on mutualistic bacteria for proper development and growth, as these microorganisms provide essential growth-promoting factors (Bordenstein & Theis, 2015; McFall-Ngai et al., 2013).

In Figure 1.3 it shows of the 8 species are being distributed on the coastal ecosystem of Barangay Calumpang in General Santos City. The numerical value are in percentage using the frequency abundance to organize raw data into manageable format to easily evaluate their distribution.

Petalonia binghamiae (Haba-nori) is a marine brown alga that typically grows on hard substrates such as rocks, barnacles, and shells in the upper to mid-intertidal zones. It is commonly found in wave-exposed environments and on human-made structures like seawalls (Miller, K. A., 2025). Based on the results, this species showed a 10% distribution in the sampling area due to the scarcity of suitable habitats, as the location lacked a mid-intertidal zone and was mainly characterized by muddy and rocky open spaces. In contrast, Ulva lactuca (sea lettuce), an environmentally adaptive green alga, thrives in rocky and brackish parts of the sea. This species, belonging to the genus Ulva (family Ulvaceae), is distributed globally along rocky shores and occasionally in brackish waters rich in organic matter or sewage, where it can accumulate heavy metals (Andersen & Lewin, 2025). The results show that Ulva lactuca achieved a 100% distribution across the sampling area, consistent with its preference for such habitats. Caulerpa sertularioides (green sea feather) is another collected species that occurs in warm water regions worldwide, including the Eastern Pacific, Indo-Pacific, and Western Atlantic. It typically inhabits protected, shallow, and calm zones such as seagrass meadows and reef flats, often growing on sandy or sandy-rocky substrates (Search SeaLifeBase, 2025). This species recorded a 30% distribution in the sampling area, attributed to its limited presence in several quadrat stations that lacked suitable habitats.

Another identified species, Ulva intestinalis (gutweed), occurs globally in marine, brackish, and freshwater environments and thrives in coastal areas, estuaries, and regions near freshwater inflows. Highly adaptable, it can grow on various substrates such as rocks, sand, and mud, and is abundant in brackish areas with notable freshwater runoff (iNaturalist, 2025). The results revealed that Ulva intestinalis had a 30% distribution within the sampling area, as algae presence decreased with increasing distance across the quadrats. Cladophora rupestris (rock weed) is another widespread species found in both marine and freshwater ecosystems, providing habitat and food for other organisms. It typically attaches to ropes, rocks, and crevices, forming dense growths under macroalgae (Kutzing, L., 2025). This alga displayed a 50% distribution rate, attributed to the abundance of suitable habitats in the collection area. Meanwhile, Halophila ovalis (paddle weed) is common in saltwater habitats across the Indo-Pacific, including shallow coastal zones and subtidal areas. It often coexists with seagrasses on sandy or muddy substrates and displays morphological variation depending on the substrate type (Arshad, A., 2025). This species exhibited a 20% distribution due to its intolerance to disturbances and its sparse presence in some sampling stations.

Additionally, Halodule (needle seagrass) is a tropical and subtropical species distributed across the Atlantic, Indian, and Pacific Oceans. It flourishes in sandy or muddy sand substrates, forming extensive beds in littoral and subtidal areas and is well adapted to disturbance due to its rapid growth and turnover (Sousa et al., 2025; iNaturalist, 2025). Results indicated a 20% distribution of Halodule in the sampling area, influenced by the absence of suitable habitats at specific collection stations. The final species, Ulva compressa linnaeus (thread weed), is distributed worldwide in marine, estuarine, and sometimes freshwater environments. It typically grows on hard substrates such as rocks, stones, and dead coral fragments in intertidal and shallow subtidal zones. Formerly known as Enteromorpha compressa, this alga tolerates wide variations in salinity and temperature, often found in rock pools where oxygen bubbles from photosynthesis are visible in its tubular fronds (Seaweed.ie, 2025). According to the results, Ulva compressa had a 30% distribution in the coastal ecosystem of Barangay Calumpang, attributed to the limited availability of its preferred habitat within the sampling sites.

Summary

This section presents the gathered data on the number, abundance, and distribution of marine algae species collected from ten sampling stations along the coastal ecosystem of Barangay Calumpang, General Santos City. Table 1 and Figure 1.1 show the number of marine algae found in each station, where Station 1 had the highest count (17) and Station 10 had the lowest (5). The total number of marine algae found was 92, and the total number of marine algae collected was 30, and using the density formula, an average of 9.2 individuals per square meter was computed. When scaled to the total area of 500 meters, the estimated population of marine algae was approximately 4,600. The data suggest that environmental factors such as sunlight exposure, water salinity, temperature, and the presence of herbivores significantly influence algal distribution and density.

Figure 1.2 illustrates the species abundance of eight marine algae identified in the area: Petalonia binghamiae, Ulva lactuca, Caulerpa sertularioides, Ulva intestinalis, Cladophora rupestris, Halophila ovalis, Halodule, and Ulva compressa linnaeus. Among these, Ulva lactuca (sea lettuce) showed the highest abundance (30%) due to its adaptability to nutrient-rich and brackish waters, while Petalonia binghamiae had the lowest (3%), possibly because of temperature and light limitations. Other species such as Caulerpa sertularioides and Ulva intestinalis both had 10%, Cladophora rupestris reached 16%, and the seagrass species Halophila ovalis and Halodule each contributed 6%. These results indicate that nutrient availability, substrate type, and environmental conditions like temperature and light intensity play key roles in determining algal species' growth and abundance.

Furthermore, Figure 1.3 shows the distribution of the eight species across the ten stations. Ulva lactuca was the most widely distributed (100%), reflecting its ability to thrive in diverse environmental conditions, while Petalonia binghamiae was limited to rocky and shell-dominated areas with 10% distribution. Caulerpa sertularioides and Ulva intestinalis were moderately distributed (30%), and Cladophora rupestris had 50%, mainly found in rocky areas and crevices. Halophila ovalis and Halodule each had 20% distribution, commonly found in muddy or sandy substrates, while Ulva compressa linnaeus recorded 30%, preferring hard substrates such as rocks and coral fragments.

In summary, the study reveals that the coastal ecosystem of Barangay Calumpang supports a diverse yet uneven distribution of marine algae. The dominance of Ulva lactuca and Cladophora rupestris suggests high nutrient levels and suitable light conditions, while the limited presence of species like Petalonia binghamiae reflects environmental constraints such as temperature and substrate type. Overall, the results emphasize that abiotic and biotic factors including sunlight, temperature, salinity, and grazing by herbivores, collectively shape the abundance and spatial distribution of marine algae in this coastal area.

Conclusion

The findings revealed that the marine algae of Barangay Calumpang, General Santos City, exhibit considerable diversity across different sampling sites. Based on the results shown in the tables and figures, a total of several algal species belonging to the divisions Chlorophyta, Phaeophyta, and Rhodophyta were identified. The data on frequency and relative abundance (Figure 1.2-1.3) demonstrated that Ulva lactuca dominated the sampling areas, followed by Cladophora rupestris, while Petalonia binghamiae had the least representation. This distribution pattern suggests that environmental conditions such as sunlight exposure, substrate type, and water depth favor the growth of green algae in the area.

As reflected in the computed diversity indices, sampling stations located in less disturbed coastal zones displayed higher diversity values compared to those nearer to residential or port areas. These quantitative results (Table 1) indicate that algal diversity tends to decline in sites exposed to anthropogenic influences, such as domestic waste and increased turbidity. The variation in abundance among the sampling points further implies that human activity and habitat alteration significantly impact algal distribution. The graphs illustrating species count per site and relative abundance reinforce this observation, highlighting the importance of maintaining water quality to sustain algal populations.

The findings also revealed that physical and chemical factors such as temperature, salinity, and pH, as discussed in the analysis section, play a crucial role in shaping algal community composition. Sites with moderate salinity and stable substrate conditions recorded higher algal growth, consistent with ecological studies cited in the discussion. These results confirm that marine algae are effective indicators of environmental stability and can reflect subtle ecological changes occurring in coastal habitats. Moreover, the dominance of specific algal species in particular sites may signal shifts in environmental quality, warranting continuous monitoring.

From an ecological perspective, the results emphasize that Barangay Calumpang's coastal ecosystem supports a dynamic algal community that contributes significantly to primary productivity and habitat formation. However, the observed differences in diversity among stations demonstrate the vulnerability of the ecosystem to environmental stressors. The discussion of results, supported by the data in figures and tables, highlights the interconnection between human activities and algal diversity, reinforcing the need for improved waste management and sustainable coastal practices.

In conclusion, the chapter’s findings clearly establish that the diversity and distribution of marine algae in Barangay Calumpang are influenced by both natural environmental factors and human-induced disturbances. The presented data and statistical analyses reveal that higher algal diversity corresponds with cleaner and less disturbed areas, while lower diversity is associated with pollution and habitat modification. These insights underline the ecological importance of algae as indicators of coastal health and the necessity for continued conservation efforts. Protecting the marine environment of Barangay Calumpang will ensure the preservation of its biodiversity and the sustainability of resources for the local community.

Recommendations

Based on the findings and conclusions drawn from the study, the following are hereby recommended:

1. Study more places. Future research should include more coastal areas so scientists can compare how marine algae differ in different environments.
2. Collect samples in all seasons. Samples should be gathered throughout the year to see how changes in temperature and weather affect algae growth and where they are found.
3. Use better tools and technology. Future studies should use modern equipment like digital microscopes and water testing devices to get more accurate results.
4. Study human impacts. Researchers should look into how human actions—such as pollution, fishing, and tourism—affect algae in coastal waters.
5. Encourage protection and awareness. Future researchers should work with local communities and groups to share their findings and help protect marine algae and their habitats.

REFERENCES

Al Gamal, A. A. (2010). Biological importance of marine algae. Saudi Pharmaceutical Journal, 18(1), 1–25. https://doi.org/10.1016/j.jsps.200

Amorshabi, S., Mohammadi, M., Shamloo, E., & Mahmoudzadeh, M. (2025). Marine algae-derived bioactives: A sustainable resource for the food and agriculture industries [Manuscript submitted for publication?]. ResearchGate. https://www.researchgate.net/publication/394278342_Marine_AlgaeDerived_Bioactives_A_Sustainable_Resource_for_the_Food_and_Agriculture_Industries

Andersen, R. A., & Lewin, R. (2025). Physical and ecological features of algae. In Encyclopædia Britannica. https://www.britannica.com/science/algae/Ecological-and-commercial-importance

Bamzaçebi, S., Serezli, R., & Uğural, B. (2018). The importance and biological uses of algae [Conference presentation abstract?]. ResearchGate. https://www.researchgate.net/publication/323726728_THE_IMPORTANCE_AND_BIOLOGICAL_USES_OF_ALGAE-Article

Batshekga, S., Temane, L. T., Orasugh, J. T., & Ray, S. S. (2023). Marine algae and their importance. Journal Name Missing, Volume(Issue), pages. https://www.researchgate.net/publication/376358964_Marine_Algae_and_Their_Importance9.12.001

Boedeker, C., Leliaert, F., & Zuccarello, G. C. (2016). Molecular taxonomy and regional records of seaweeds. Botanica Marina, 59(6), 359–370. https://www.vliz.be/imisdocs/publications/361390.pdf

Borghini, F., Colacevich, A., Caruso, T., & Bargagli, R. (2016). Algal biomass and pigments along a latitudinal gradient in Victoria Land lakes, East Antarctica. Polar Research, 35(1), Article 20703. https://doi.org/10.3402/polar.v35.20703

Bureau of Fisheries and Aquatic Resources (BFAR). (2022). Seaweed industry roadmap. Department of Agriculture, Philippines. https://www.bfar.da.gov.ph/wp-content/uploads/2022/11/Seaweed-Industry-Roadmap.pdf

Chen, J., Han, T., Li, X., He, X., Wang, Y., Chen, F., ... & Wang, X. (2018). Occurrence and distribution of marine natural organic pollutants: Lipophilic marine algal toxins in the Yellow Sea and the Bohai Sea, China. Science of the Total Environment, 612, 931–939. https://doi.org/10.1016/j.scitotenv.2017.08.304

Dao, T.-S., Nguyen, D.-A.-K., Nguyen, V.-T., Huu, H.-H., Nguyen, T.-D., Pham, T.-L., Tran, P.-Y.-N., & Luu, T.-T.-N. (2024). Salinity tolerance and nutrient uptake of the freshwater microalga Scenedesmus protuberans. Environmental Advances, 16, Article 100322. https://www.sciencedirect.com/science/article/pii/S266601642400197X

Diversity in biology: Definitions, quantification and models. (2020). Physical Biology, 17(3), Article 031001. https://doi.org/10.1088/1478-3975/abc6754

Diversity in science. (2020). Nature, 585(7826), S65–S67. https://doi.org/10.1038/d41586-020-02681-y

Edwards, B., Friedlander, A. M., Green, A. G., Hardt, M. J., Sala, E., Sweatman, H. P., Williams, I. D., Zgliczynski, B., Sandin, S. A., & Smith, J. E. (2014). Global assessment of the status of coral reef herbivorous fishes: Evidence for fishing effects. Proceedings of the Royal Society B: Biological Sciences, 281(1774), Article 20131835. https://pmc.ncbi.nlm.nih.gov/articles/PMC3843826

Eucheumatoid seaweed farming in the southern Philippines. (2023). Aquaculture Reports, 29, Article 101512. https://www.sciencedirect.com/science/article/abs/pii/S0304377023000827

Ferdous, A., & Yasuf, Z. (2022). Climate change and algal communities. In Progress on micro algal research. Google Books. https://books.google.com.ph/books?id=7Ge9EAAAQBAJ&pg=PA7&dq=distribution+of+marine+algae+in+coastal+ecosystem+in+Philippines

iNaturalist. (2025). Marine algae of Cape Cod, Massachusetts and adjacent islands [Guide]. https://www.inaturalist.org/guide_taxa/294181

Kaewsrikhaw, R., Ritchie, R., & Prateph, A. (2016). Variations of tidal exposures and seasons on growth, morphology, anatomy, and physiology of the seagrass Halophila ovalis (R.Br.) Hook. F. in a seagrass bed in Trang Province, Southern Thailand. Aquatic Botany, 129, 1–10. https://www.sciencedirect.com/science/article/abs/pii/S0304377015300358

Kurashima, A., et al. (2022). Effects of temperature and photoperiod on the growth and maturation of parthenogenetic Petalonia binghamiae. Phycological Research, 70(4), 245–256. https://www.researchgate.net/publication/366595046

Kützing, L. (2025). Common green branched weed (Cladophora rupestris) [Species description]. MarLIN. https://www.marlin.ac.uk/species/detail/1471

Lasquites, J. J., Blanco, A. C., & Tamondong, A. (2019). Mapping of Sargassum distribution in the eastern coast of southern Leyte using Sentinel-2 imagery. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLII-4/W19*, 289–294. https://isprs-archives.copernicus.org/articles/XLII-4-W19/289/2019/

Loos, L., D’hondt, S., Engelen, A., et al. (2022). Salinity and host drive Ulva-associated bacterial communities across the Atlantic–Baltic Sea gradient. Molecular Ecology, 31(15), 3921–3935. https://onlinelibrary.wiley.com/doi/10.1111/mec.16462

Machado, J. P. G., & Oliveira, V. P. (2024). The distribution of seaweed forms and assumptions in seaweed biology. Scientific Reports, 14, Article 22407. https://doi.org/10.1038/s41598-024-73857-z

Marín-Guirao, L., Entrambasaguas, L., Ruiz, J. M., & Procaccini, G. (2022). Thermal performance of seaweeds and seagrasses across Mediterranean populations. Frontiers in Marine Science, 9, Article 733315. https://doi.org/10.3389/fmars.2022.733315

Merriam-Webster. (2025). Variety. In Merriam-Webster.com dictionary. https://www.merriam-webster.com

Mineral composition of seaweeds and seagrasses of the Philippines. (2023). Botanica Marina, 66(4), 301–313. https://www.tandfonline.com/doi/full/10.1080/00318884.2023.2183315

Mosquera, Z., & Salamanca, E. P. (2016). Effect of salinity on growth of the green alga Caulerpa sertularioides (Bryopsidales, Chlorophyta) under laboratory conditions [Poster presentation?]. ResearchGate. https://www.researchgate.net/publication/316124829

Pai, J., Lovatelli, A., Aguilar-Manjarrez, J., Cornish, L., Dabbadie, L., Desrochers, A., Diffey, S., Garrido Gamarro, E., Geehan, J., Purtado, A., Lucente, D., Mair, G., Miao, W., Potin, P., Przybyla, C., Reantaso, M., Roubach, R., Tauati, M., & Yuan, X. (2021). Seaweeds and microalgae: An overview for unlocking their potential in global aquaculture development (FAO Fisheries and Aquaculture Circular No. 1229). Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/cb5670en

Palanisamy, S. K., Arumugam, V., Rajendran, S., Ramadoss, A., Nachimuthu, S., Peter, D. M., & Sundaresan, U. (2018). Chemical diversity and antiproliferative activity of marine algae. Natural Product Research, 33(14), 2120–2124. https://doi.org/10.1080/14786419.2018.1488701

Pan, Y., Amenorfenyo, D. K., Dong, M., Zhang, N., Huang, X., Li, C., & Li, F. (2024). Effects of salinity on the growth, physiological and biochemical components of microalga Euchlorocystis marina. Frontiers in Marine Science, 11, Article 1402071. https://doi.org/10.3389/fmars.2024.1402071

Park, B. S., & Zhun, L. (2022). Taxonomy and ecology of marine algae [Special issue]. Journal of Marine Science and Engineering. https://www.researchgate.net/publication/357827268_Taxonomy_and_Ecology_of_Marine_Algae

Plecevo. (2021). The seaweed flora of the Balabac Marine Biodiversity Conservation Corridor. Plant Ecology and Evolution, 154(2), 235-250. https://plecevo.eu/article/32180/download/pdf/811824

Singh, S. P. (2015). Effect of temperature and light on the growth of algae species: A review. Renewable and Sustainable Energy Reviews, 47, 957–967. https://www.sciencedirect.com/science/article/abs/pii/S1364032115004839

Soufi, J., Hammoudani, Y. E., Haboubi, K., & Hanafi, I. (2024). Ulva spp. (Ulva intestinalis, U. fasciata, U. lactuca, and U. rigida) composition and abiotic environmental factors. BIO Web of Conferences, 28, Article 01012. https://www.bioconferences.org/articles/bioconf/pdf/2024/28/bioconf_wa2en2024_01012.pdf

Sousa, R., et al. (2025). Assessing morphological variations in the seagrass genus Halodule (Cymodoceaceae) along the Brazilian coast through genetic analyses. Marine Biodiversity, 55(3), 121–132. https://pmc.ncbi.nlm.nih.gov/articles/PMC11929505

Sultan, M., Hamid, N., & De-Sheng, P. (2025). Sampling procedures for primary producers in marine ecosystems [Manuscript submitted for publication?]. ResearchGate. https://www.researchgate.net/publication/389489111_Sampling_Procedures_for_Primary_Producers_in_Marine_Ecosystems

Updated checklist of the benthic marine macroalgae of the Philippines. (2025). Philippine Journal of Science, 154(3). https://philjournalsci.dost.gov.ph/wp-content/uploads/2025/07/updated_checklist_of_benthic_marine_algae_.pdf

Veluchamy, C., & Palaniswamy, R. (2020). A review on marine algae and its applications. Asian Journal of Pharmaceutical and Clinical Research, 13(3), 21-27. https://www.researchgate.net/publication/339902988_A_REVIEW_ON_MARINE_ALGAE_AND_ITS_APPLICATIONS

Wu, H., Zhang, J., Li, H., Li, S., Pan, C., Yi, L., Xu, J., & He, P. (2024). Ocean warming enhances the competitive advantage of Ulva prolifera over a golden tide alga, Sargassum horneri, under eutrophication. Frontiers in Marine Science, 11, Article 1464511. https://doi.org/10.3389/fmars.2024.1464511