Community Structure and Phytoplankton Abundance in Different Estuary in Coast Waters Lekok Pasuruan East Java

E. Y. Herawati¹*, A. Darmawan¹, M. Azkiya¹
¹Faculty of Fisheries and Marine Sciences Brawijaya University
*E-mail: herawati_ey@ub.ac.id

Abstract. The quality of water in estuary is influenced by human activities around it which can affect the sustainability of the life of the organisms in these waters and other living things that use it. The aim is to analyze the abundance of phytoplankton and the quality of the waters of the river estuaries with different land uses for ponds, settlements and mangroves. This study was conducted by using survey method and carried out April - May 2020. The results of the abundance of phytoplankton in the coastal waters of Lekok as a whole are 3543 - 7692 cells / ml which are classified into mesotrophic waters. The phytoplankton with the highest abundance was dominated by Ceratium sp, indicating this species as an indicator of polluted waters. The results of water quality in Lekok coastal waters such as temperature, pH, salinity, DO and TOM are suitable for the life of phytoplankton organisms and in accordance with sea water quality standards. Water quality that exceeds the quality standard for nitrate, orthophosphate and TSS is due to the presence of nutrients or organic matter from human activities in different land uses that enter the waters and river estuaries.

1. Introduction
The coastal area is a transitional area between terrestrial and marine ecosystems. This place receive a load of organic material input from the land, especially domestic waste and industrial waste that is carried by rivers that empties into the coast [1]. The waters of Lekok in Pasuruan Regency receive input from the Rejoso river and several small tributaries where in the previous section there are residential areas, industrial and agricultural activities that have the potential to dump their waste into the river which will eventually reach the sea. Conditions like this can affect water quality which can affect the fertility of the waters and the growth of organisms in it. Changes in water quality are closely related to water potential in terms of phytoplankton abundance. Phytoplankton is a biological parameter that can be used as an indicator to evaluate the quality and fertility level of a waters [2].

Phytoplankton are microscopic organisms that are autotrophic or capable of producing organic material from inorganic materials through photosynthesis with the help of light. Nutrient content can affect the abundance of phytoplankton because phytoplankton growth is also strongly influenced by the presence of nutrients. Waters that contain high nitrate and orthophosphate nutrients can be said that these waters have high fertility and productivity as well. The presence of nitrates and orthophosphates that are too high can trigger a process of eutrophication and a phytoplankton population explosion (blooming) [3]. The dense population in this coastal area with various activities can increase domestic waste in the water, which can add nutrients for organisms in the waters including phytoplankton. Therefore, the aim of the research is to determine the abundance of phytoplankton and the condition of the water quality of the river mouths with different land uses around the estuary (settlement, pond and mangroves).
2. Material and Methods

2.1 Research Material
The material in this study is the abundance of phytoplankton and water quality. Water quality parameters measured are temperature, brightness, TSS, pH, DO, salinity, current velocity, TOM, nitrate, orthophosphate, silica, identification of phytoplankton, calculating the relative flexibility, dominance and diversity index.

2.2 Research Methods
The method used in this research is descriptive research with survey methods, carried out in April - May 2020. Sampling was conducted in the coastal waters of Lekok, Pasuruan, East Java. Samples were taken 2 times with intervals of 2 weeks. The sampling technique was purposive sampling method. Sampling was carried out at 3 different stations, namely station 1, namely the river estuary close to residential areas, station 2, namely the river estuary close to the pond and station 3, namely the river estuary close to the mangrove area. The map of the sampling location can be seen in Figure 1.

Figure 1. Location Map of Sampling Stations in Lekok Coastal Waters

Information:
Station I: Located in a residential area
Station II: Located in the pond area
Station III: Located in a conservation area Mangroves

2.3 Analysis of Physical and Chemical Descriptions
The physico-chemical analysis of the water measured in-situ is compared with the applicable seawater quality standards [4], especially for the benefit of marine life.
3. Results and Discussion

3.1. Phytoplankton Community

Observations of phytoplankton communities found 6 divisions including Chrysophyta, Dinoflagellata, Chlorophyta, Cyanophyta, Ciliophora, Cyanobacteria. The Chrysophyta division found 2 classes, namely Bacillariophyceae consisting of 14 genera including Chaetoceros sp., Skeletonema sp., Melosira sp., Navicula sp., Nitzchia sp., Campylodiscus sp., Rhizosolenia sp., Surirella sp., Pleurosigma sp., Amphora sp., Thalassionema sp., Asterionella sp., Hemiaspis sp., Gyrosigma sp., And the Coscinodiscophyceae class consisting of the genus Coscinodiscus sp. Dinoflagellate division found Dinophyceae class consisting of 4 genera including Protoperidinium sp., Ceratium sp., Dinophysis sp., Peridinium sp. The Chlorophyta division was found from the Chlorophyceae class consisting of 2 genera including Chlamydomonas sp., Gonatozygon sp. The Cyanophyta Division was found from the Cyanophyceae class consisting of 1 genus, namely Oscillatoria sp. The Ciliophora division was found from the Oligotricha class consisting of 1 genus, namely Tintinnopsis sp. The Cyanobacteria division was found from the class Hormogoneae consisting of 1 genus, namely Anabaena sp.

The most common phytoplankton communities are the Chrysophyta and Dinoflagellate divisions. Chrysophyta are phytoplankton known as diatoms. The diatom genus is one that can be used as a biological indicator for uncontaminated waters [5]. The types of Chrysophyta diatoms that are often found in the waters off the coast of Indonesia include Chaetoceros sp., Rhizosolenia sp., Thalassionema sp., and Bacteriastrum sp., while in coastal areas or river estuaries there are usually Skeletonema sp. and sometimes Coscinodiscus sp. Meanwhile, Dinoflagellates are phytoplankton which are very common in water after diatoms [6].

3.2 Phytoplankton Abundance

The results of the calculation of the overall phytoplankton abundance are 3543 - 7692 cells / ml. The highest abundance value was at the estuary station of the first sampling settlement, this was due to the high levels of nutrients, namely orthophosphate, namely 0.05 mg / l, this value was very high when compared to other stations. According to [7], water nutrient content is interrelated with the abundance of phytoplankton where the higher the nutrient content in a water, the higher the abundance of phytoplankton.

| Station                                | Sampling 1 | Sampling 2 |
|-----------------------------------------|------------|------------|
| The estuary of the river a settlement area | 7692       | 3577       |
| The estuary of the pond area            | 3703       | 3543       |
| River estuary in mangrove area          | 5057       | 3924       |

Based on the value of the abundance of phytoplankton, the coastal waters of Lekok are classified into mesotrophic waters. This is in accordance with the statement of [8], that waters based on the abundance of phytoplankton are divided into 3, namely oligotrophic waters which are waters with low fertility levels with an abundance of phytoplankton ranging from 0 - 2000 cells / ml. Mesotrophic waters are waters with moderate fertility levels with an abundance of phytoplankton ranging from 2000 - 15,000 cells / ml, while eutrophic waters are waters with high fertility rates with an abundance of phytoplankton ranging from > 15,000 cells / ml.
3.3 Relative Abundance of Phytoplankton
The relative abundance of phytoplankton in the coastal waters of Lekok at each station is slightly different because of the environmental conditions around the station due to the entry of organic and inorganic materials which have an influence on the relative abundance of phytoplankton and surrounding organisms. The analysis diagram of the relative abundance of phytoplankton in the coastal waters of Lekok at each station can be seen in the following figure:

**Figure 2.** Pytoplankton Relative Abundance Station 1

**Figure 3.** Pytoplankton Relative Abundance Station 2

**Figure 4.** Pytoplankton Relative Abundance Station 3
Relative abundance at the estuary station for the highest residential area of the Dinoflagellate division is 63%, station 2 is the mouth of the river in the pond area and station 3 is the estuary of the highest mangrove area in the Chrysophyta division at 63% and 55%. The most common genus found in coastal Lekok waters is the Chrysophyta division. According to [9], the phytoplankton genus Chrysophyta division is the dominant phytoplankton found in Indonesian marine waters, especially in coastal waters and has properties that are easy to adapt to the environment and resistant to extreme conditions.

3.4 Diversity Index
Diversity index shows the variations in the types of phytoplankton in the waters. The results of the phytoplankton diversity index can be seen in Table 2.

| Table 2. Diversity Index | Station | Sampling 1 | Sampling 2 |
|--------------------------|---------|------------|------------|
|                          | The estuary of the river a settlement area | 1,970     | 1,315      |
|                          | The estuary of the pond area | 2,011     | 1,658      |
|                          | River estuary in mangrove area | 2,131     | 2,096      |

Table 2 shows that the phytoplankton diversity index is 1.315 - 2.131. Based on this range, the Lekok coastal waters show a moderate diversity index with moderate individual distribution and moderate community stability. This is in accordance with the statement of [10], the diversity index value range of 0-1 indicates that the area has high ecological pressure and a low species diversity index with uneven distribution of individuals and low community stability. The range 1-3 shows a moderate diversity index with moderate individual distribution and moderate community stability, a diversity value > 3 indicates the state of an area that is experiencing low ecological pressure and a high species diversity index with high individual distribution and high community stability.

3.5. Dominance Index
Dominance index used to see the presence or absence of certain species that dominate other species in a water. The results of the phytoplankton dominance index can be seen in Table 3.

| Table 3. Dominance Index | Station | Sampling 1 | Sampling 2 |
|--------------------------|---------|------------|------------|
|                          | The estuary of the river a settlement area | 0,160     | 0,379      |
|                          | The estuary of the pond area | 0,181     | 0,277      |
|                          | River estuary in mangrove area | 0,158     | 0,149      |

Table 3 shows the results of the dominance index, namely 0.149 - 0.379. This shows that in the coastal waters of Lekok there are no certain types that dominate and the community structure is stable. This is in accordance with [11] statement, the Dominance index describes the total number of phytoplankton contained in each research station. Dominance index ranges from 0 - 1. The value of the dominance index < 0.5 means that the community structure is stable. Dominance index value > 0.5 means that the community structure is in an unstable state due to ecological pressure.
3.6 Relationship between Physical and Chemical Parameters with Phytoplankton

The influence of water quality parameters is very important for the survival of phytoplankton because it functions as a medium of life. The value of water quality in the coastal waters of Lekok is in the range of sea water quality standards (Kep.Men.LH / No.51 / 2004) which can be seen in Table 5.

Table 4. Results of Analysis of Water Quality Parameters in Lekok Coastal Waters

| Parameter       | Sampling 1 | Sampling 2 | Sampling 3 | Quality standards |
|-----------------|------------|------------|------------|-------------------|
|                 | St 1       | St 2       | St 3       | St 1       | St 2       | St 3       | St 1       | St 2       | St 3       |
| Temperature (℃) | 32,29      | 32,54      | 31,72      | 30,89      | 30,52      | 29,24      | 28 -32     |
| Brightness (cm) | 68         | 60         | 63         | 72         | 70         | 57         | >3 m       |
| Flow Velocity (m / s) | 0,031 | 0,041      | 0,043      | 0,051      | 0,033      | 0,026      |            |
| pH              | 7,3        | 7,4        | 7,6        | 7,6        | 7,5        | 7,8        | 7 – 8,5    |
| Salinitas (ppt) | 29,79      | 30,79      | 32,09      | 33,78      | 33,49      | 33,69      | 33 -34     |
| TSS (mg/l)      | 162        | 139        | 139        | 217        | 198        | 221        | 20 –80     |
| DO (mg/l)       | 6,20       | 6,11       | 6,14       | 6,17       | 6,14       | 5,72       | >5         |
| TOM (mg/l)      | 15,59      | 14,32      | 29,01      | 27,28      | 20,90      | 37,63      | ≤ 30       |
| Nitrat (mg/l)   | 0,07       | 0,06       | 0,08       | 0,05       | 0,07       | 0,09       | 0,008      |
| Ortofosfat (mg/l) | 0,05   | 0,05       | 0,06       | 0,03       | 0,02       | 0,04       | 0,015      |
| Silika (mg/l)   | 6,155      | 7,303      | 6,871      | 4,258      | 5,943      | 6,871      |            |

Remarks:
St 1 = station 1 estuary of residential area
St 2 = station 2 the estuary of the pond area
St 3 = station 3 the estuary of the mangrove area

The results of water quality in the coastal waters of Lekok such as temperature, pH, salinity, DO and TOM with values that meet the water quality standards are also one of the factors that support the high abundance of phytoplankton. Parameters that exceed seawater quality standards are nitrate, orthophosphate and TSS. This is due to the high nutrient content or organic matter of fishing activities that enter the waters and river estuaries, which generally carry nutrients from the land. In addition, it is also influenced by the current when it reaches the tide, so that the mass of river water carrying organic wastes from agricultural, residential and fishery activities when it reaches the sea will be carried away by the current.

The results of measuring water quality parameters including physical, chemical and biological parameters in the estuary area on the coast of Lekok show that the sampling stations have different ranges of values. This is caused by the water input factor from the river mouth. Water input from river estuaries will carry certain nutrients that will be utilized by aquatic organisms such as phytoplankton. Phytoplankton plays an important role in changing the quality of coastal waters in Lekok.

The results of observations and measurements of phytoplankton from different river estuaries indicate an abundance of certain phytoplankton genera, due to the activity of the surrounding residents, causing changes in nutrient content at each river estuary station. At the estuary station in residential areas, the surrounding residents dispose of household waste in the river flow, which can cause changes in the nutrient content of a water. The enrichment of certain types of nutrients can result in an explosion in the abundance of certain phytoplankton genera such as Ceratium sp. which is phytoplankton as an indicator of polluted waters. The river estuary station in the fishery pond area produces waste containing certain nutrients, after harvest the water is discharged into the river, so the phytoplankton genus is dominated by Melosira sp. and Skeletonema sp which is higher than other types. which can make the waters toxic and dangerous to other organisms such as...
fish. While the river estuary station that passes through the mangrove area, genus Ceratium sp. is an indicator of polluted waters.

4. Conclusions and Suggestions

4.1 Conclusion

Based on the results of the study, it is concluded that the coastal waters of Lekok, Lekok District, Pasuruan Regency, East Java are as follows:

1. The results of observations and calculations of the abundance of phytoplankton in the coastal waters of Lekok as a whole are 3543 - 7692 cells / ml which are classified as mesotrophic waters. The most abundant phytoplankton genus from the Chrysophyta division, with the highest abundance of the genus Dinoflagellata genus Ceratium sp. which indicates that these species are indicators of polluted waters.

2. The results of water quality in the coastal waters of Lekok such as temperature, pH, salinity, DO and TOM are suitable for the life of phytoplankton organisms and in accordance with sea water quality standards. Water quality that exceeds the quality standard for nitrate, orthophosphate and TSS is due to the presence of nutrients or organic matter from human activities in different land uses that enter the waters and river estuaries.

4.2 Suggestions

Suggestions that can be given regarding these results are necessary

1. Provide insight and counseling to residents of the coastal areas of Lekok not to dispose of household waste in the river and participate in maintaining the cleanliness of their environment so that the environment and coastal waters of Lekok are no longer polluted.

2. Provide advice on handling to pond owners in order to treat pond discharge water that is discharged into the river to maintain water quality in the area of the pond estuary

Reference

[1] Wulandari, D. (2009). Keterikatan Antara Kelimpahan Fitoplankton Dengan Parameter Fisika Kimia Di Estuari Sungai Brantas (Porong), Jawa Timur. IPB Repository. Bogor.

[2] Iswanto, C. Y., Hutabarat, S., & Purnomo, P. W. (2015). Analisis Kesuburan Perairan Berdasarkan Keanekaragaman Plankton, Nitrat dan Fosfat di Sungai Jali dan Sungai Lereng Desa Keburuh, Purworejo. Management of Aquatic Resources Journal, 4(3), 84-90.

[3] Tungka, A. W., Haeruddin dan C. Ain. 2016. Konsentrasi nitrat dan ortofosfat di muara sungai Banir Kanal Barat dan kaitannya dengan kelimpahan fitoplankton harmful alga blooms (HABs). Jurnal Sain Tek Perikanan. 12(1): 40-46.

[4] Kementerian Lingkungan Hidup (KLH). 2004. Keputusan Menteri KLH No.51/2004 Tentang Baku Mutu Air Laut untuk Biota Laut. KLH, Jakarta.

[5] Umiatun, S., Carmudi dan Christiani. 2017. Hubungan antara kandungan silika dengan kelimpahan diatom bentik di sepanjang sungai pelus kabupaten banyumas. Scripta Biologica. 4(1): 61-67.

[6] Juadi., I. Dewiyanti dan Nurfadillah. 2018. Komposisi Jenis dan Kelimpahan Fitooplankton di Perairan Ujong Pie Kecamatan Muara Tiga Kabupaten Pidie. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Uinsyah. 3 (1): 112-120.

[7] Ayuningsih, M. S., I. B. Hendrarto dan P. W. Purnomo. 2014. Distribusi kelimpahan fitoplankton dan klorofil-a di teluk sekembu kabupaten jepara : hubungannya dengan kandungan nitrat dan fosfat di perairan. Diponegoro Journal Of Maquaries. 3(2) :138-147

[8] Suryanto, A. M. 2011. Kelimpahan dan komposisi fitoplankton di waduk selorejo kecamatan ngantang kabupaten malang. Jurnal Kelautan. 4 (2) :135-140.
[9] Paikia, K dan J. D. Kalor. 2017. Distribusi nitrat dan fosfat terhadap kelimpahan fitoplankton di perairan pesisir yapen timur. *Journal of Fisheries and Marine Science*. 1 (2): 66-71.

[10] Liwutang, Y. E., F. B. Manginsela Dan Jan.Fws. Tamanampo. 2013. Kepadatan dan keanekaragaman fitoplankton di Perairan Sekitar Kawasan Reklamasi Pantai Manado. *Jurnal Ilmiah Platax*. 1(3): 109-117.

[11] Wahyuni, I. S dan D. Rosanti. 2016. Keanekaragaman fitoplankton di kolam retensi kambang iwak kota palembang. *Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam*. 13(2): 48-57.