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LEVEL OF WATER FERTILITY BASED ON PHYTOPLANKTON ABUNDANCE IN THE WATERS OF TOBATI VILLAGE, SOUTH JAYAPURA DISTRICT, JAYAPURA CITY

Tingkat Kesuburan Perairan Berdasarkan Kelimpahan Fitoplankton di Perairan Kampung Tobati Distrik Jayapura Selatan, Kota Jayapura

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ABSTRACT

Water fertility is the ability of a body of water to support and sustain the survival and growth of organisms such as phytoplankton and other marine plants. Phytoplankton are used as biological indicators to determine water quality, either by analyzing species diversity or by using certain indicator species.This research aims to assess the fertility level of the waters based on phytoplankton abundance in the waters of Tobati Village. The study was conducted from June to August 2025. Plankton samples were collected randomly at 4 stations with 3 replications. Water quality parameters were measured in situ, while nitrate and phosphate analyses were carried out at the Regional Health Laboratory of Papua. Identification and enumeration of phytoplankton were conducted at the Aquatic Resources Management Laboratory. Data analysis included total phytoplankton abundance, diversity index, evenness index, and water fertility criteria. The results showed 12 phytoplankton species including of the classes Bacillariophyceae and Dinophyceae. The highest total phytoplankton abundance in the waters of Tobati Village was found at station II with 8,855 cells/L, while the lowest was recorded at station I with 7,007 cells/L. The diversity index values at stations I and II were categorized as moderate, while at stations III and IV they were classified as low. The evenness index ranged from 0.14 to 0.42, indicating that phytoplankton species distribution across the four stations was uneven. Based on the findings, the average phytoplankton abundance across the four stations was 7,543 cells/L. The waters of Tobati Village are categorized as mesotrophic (moderately fertile). Thus, the fertility level of Tobati Village waters, South Jayapura District, Jayapura City, based on phytoplankton abundance, falls under the moderately fertile (mesotrophic) category, with no indication of pollution.

Keywords: Phytoplankton, Fertility, Abundance, Waters, Tobati

ABSTRAK

Kesuburan perairan adalah kemampuan suatu perairan dalam menunjang dan menjaga kelangsungan hidup serta pertumbuhan organisme seperti fitoplankton dan tumbuhan laut lainnya. Fitoplankton dimanfaatkan sebagai indikator biologis untuk menentukan kualitas perairan, baik dengan menganalisis keragaman spesies maupun dengan menggunakan spesies indikator tertentu. Penelitian bertujuan menilai kesuburan perairan melalui jumlah fitoplankton yang terdapat di Perairan Kampung Tobati. Penelitian dilakukan pada Bulan Juni - Agustus 2025. Sampel plankton dikumpulkan secara acak di 4 stasiun dengan 3 kali ulangan. Pengambilan data indikator kualitas air diterapkan melalui metode *in situ*. Adapun analisis sampel air Nitrat dan Fosfat di Balai Laboratorium Kesehatan Daerah Papua. Penentuan jenis dan pencacahan fitoplankton dilakukan pada laboratorium Manajemen Sumber Daya Perairan. Analisis data meliputi kelimpahan total fitoplankton, indeks keanekaragaman, indeks keseragaman dan kriteria kesuburan perairan. Hasil penelitian ditemukan 12 spesies fitoplankton mencakup kelas Bacillariophyceae dan Dinophyceae. Totalitas kelimpahan fitoplankton di Perairan Kampung Tobati tertinggi ditemukan pada stasiun II yakni sebesar 8855 Sel/L dan kelimpahan paling rendah terdapat pada stasiun I yakni sebesar 7007 sel/L. Nilai indeks keanekaragaman pada stasiun I dan II tergolong sedang, pada stasiun II dan IV tergolong rendah. Nilai homogenitas berada dalam rentang 0,14 – 0,42 menandakan bahwa spesies fitoplankton pada keempat stasiun kurang merata. Hasil penelitian menunjukkan bahwa rata-rata kelimpahan fitoplankton pada keempat stasiun adalah 7543 Sel/L. Perairan Kampung Tobati tergolong sedang (mesotrofik). Tingkat kesuburan Perairan Kampung Tobati, Distrik Jayapura Selatan Kota Jayapura berdasarkan kelimpahan fitoplankton tergolong sedang sehingga masuk dalam kriteria perairan yang masih subur (mesotrofik) serta belum adanya indikasi pencemaran.

Kata Kunci: Fitoplankton, Kesuburan, Kelimpahan, Perairan, Tobati

INTRODUCTION

Water fertility refers to the ability of an aquatic environment to support and sustain the life and growth of organisms such as phytoplankton and other marine plants (Yuliana *et al*., 2012). The fertility condition of marine waters is closely related to the abundance of nutrients within the environment. The plentiful availability of nutrients triggers an increase in the concentration of essential elements (upwelling). This phenomenon stimulates phytoplankton productivity, which plays a crucial role in marine ecosystems (Tambaru, 2008).

Through photosynthetic activity, chlorophyll-containing phytoplankton are vital in the formation of organic matter and the provision of oxygen in the aquatic environment, as well as in determining the level of primary productivity within marine ecosystems. The net productivity from photosynthesis carried out by plankton is transferred to other organisms within the ecosystem. The energy derived from photosynthesis, stored in phytoplankton, is passed on to heterotrophic organisms through the process of energy transfer in the food chain (Dimenta *et al*., 2018). The presence of abundant nutrients such as nitrate and phosphate in aquatic ecosystems provides ecological benefits to phytoplankton abundance, which in turn affects the presence of zooplankton, fish, and other marine biota. Phytoplankton can serve as biological indicators for assessing water quality, either by analyzing species diversity or through the use of specific indicator species (Tasak, 2018). In addition to serving as indicators of water fertility, phytoplankton also provide information about the degree of pollution occurring in the aquatic environment.

Tobati Village waters are located within Youtefa Bay, adjacent to Enggros Village, the Red Bridge, and the Ring Road. This area lies within the South Jayapura District and is dominated by residential settlements consisting primarily of stilt houses. The waters of Tobati

Village host essential biological communities, including coral reefs, seagrasses, and mangrove forests. Surrounding Tobati Village is a natural tourism park that serves as a recreational destination for the people of Papua. Various human activities in Tobati Village waters are suspected to contribute to increasing nutrient concentrations, consequently affecting the water's fertility level. However, ecological studies regarding the fertility level of waters surrounding Youtefa Bay remain limited. Therefore, data concerning reference values for phytoplankton abundance and diversity are still insufficient. This necessitates research on water fertility levels based on phytoplankton abundance in the waters of Tobati Village.

METHODS

Place and Time of Research

This study was conducted in the waters of Tobati Village in July 2025. The research location was selected based on the availability of nutrient supplies from the land. The research consisted of two stages: field observation and laboratory analysis.

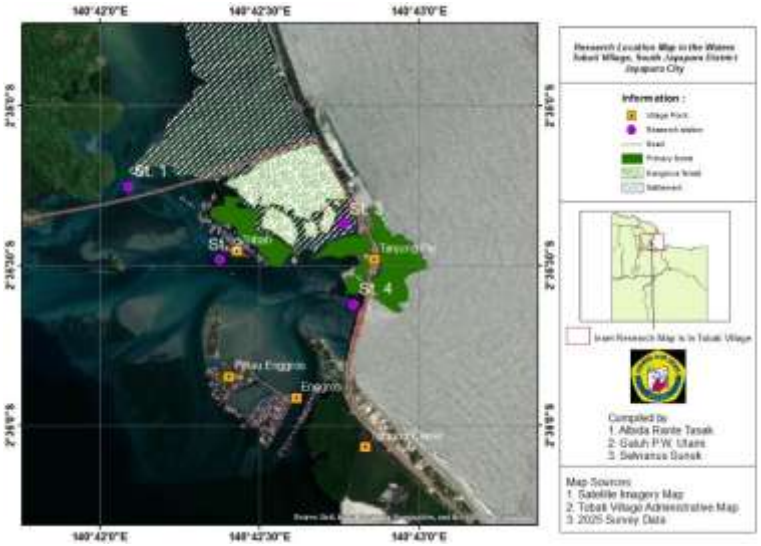

Figure 1. Research Location Map

Determining Sampling Locations

Sampling was conducted at four stations. The locations of the stations were determined based on phytoplankton sampling, considering the homogenous nature of the waters in Tobati Village. Plankton samples were taken randomly at the four stations, three times.

Phytoplankton Sampling and Identification

The phytoplankton sampling process at a depth of 5-10 meters using a Nansen bottle tool, then the phytoplankton sample in the Nansen bottle was poured into a 5 liter bucket and then filtered using a plankton net. Each sample was repeated 3 times to increase data accuracy. Phytoplankton samples that had been preserved with Lugol in a 100ml sample bottle were then further identified at the Aquatic Resources Management Laboratory, Ottow Geissler University, Papua. Identification of phytoplankton samples was carried out in the laboratory using a Sedgewick Rafter Cell (SRC) which was then observed using a microscope to determine the type and enumeration of the number of phytoplankton. The identification results were then matched with several Phytoplankton Identification Books.

Water Quality Parameter Collection

Water quality variable data was obtained by measuring temperature, pH, salinity, clarity, and dissolved oxygen (DO) using in situ methods. Meanwhile, water samples for nitrate and phosphate were taken using Nansen bottles, which were then analyzed at the Papua Regional Health Laboratory.

Data Analysis

Interpretation of phytoplankton data in the form of ecological index analysis, namely the abundance, diversity, uniformity and fertility levels of the waters.

1. **Phytoplankton Abundance**

To determine the abundance of phytoplankton, the equation used according to APHA (2012) uses the following formula:

$$N = n\,x\,\frac{a}{A}x\frac{V}{Vc}x\frac{1}{V}$$

information:
N = Abundance of Phytoplankton species
n = The number of phytoplankton cells observed
a = cover glass area (mm^2)
v = volume of water in the prepared glass (ml)
A = Unit of one field of view (mm^2)
Vc = Volume of water under the cover glass (ml)
V = Volume of filtered water (L)

2. **Diversity index**

The calculation of diversity was analyzed based on the formula (Dewiyanti *et al*., 2015), using the equation:

$$H' = -\Sigma\frac{\mathrm{ni}}{\mathrm{N}}LN\frac{ni}{N}$$

information:
H' = Diversity index
ni = Number of individuals in type-i
N = Total of all individuals

3. **Uniformity Index**

Based on the formula proposed by Odum (1993), species uniformity is calculated using the following formula:

$$E = \frac{H'}{Hmax}$$

information:
E = Species uniformity index
H' = Diversity index
Hmax = Maximum species diversity value (ln S)
S = Number of types

According to Krebs in (Afif, A. *et al*., 2014) The uniformity index has a value range of 0 to 1 with the following classification:

0- 0,4 = Low species uniformity
0,4 - 0,6 = Moderate type uniformity
0,6- 1,0 = High type uniformity

4. Water Fertility Level

One indicator that can be implemented to determine the level of water fertility is the abundance of phytoplankton (Suryanto & Herwati, 2009).

Table. Water Fertility Level Based on Phytoplankton Abundance

Water Fertility	Phytoplankton Abundance (Cells/L)
Oligotrophic Waters (low)	0–2000
Mesotrophic Waters (moderate)	2000–15000
Eutrophic Waters (high)	>15000

RESULTS

1. Abundance of Species and Ecological Index Values of Tobati Village Waters

Based on the identification results conducted in the waters of Tobati Village, 12 phytoplankton species from the Bacillariophyceae and Dinophyceae classes were found. The types and numbers of phytoplankton are presented in Table 2.

Table 2. Types and Total Abundance of Phytoplankton

Genus	Station			
	I	II	III	IV
Ceratium furca	491	471	259	331
Chaetoceros decipiens	353	589	475	620
Chaetoceros laciniosus	530	1835	989	723
Chaetoceros neglectus	353	0	561	723
Chaetoceros peruvianus	589	707	0	0
Pseudo-Nitzschia cuspidata	922	660	712	930
Rhizosolenia hebetata	648	1790	1511	930
Rhizosolenia setigera	353	895	0	1240
Nitzschia longissima	648	0	756	661
Protoperidinium claudicans	353	0	479	723
Thalassiosira gravida	0	1060	540	0
Thalassiosira punctigera	1767	848	756	372
Jumlah	7007	8855	7056	7253

Based on the identification results in the waters of Tobati Village, the ecological index is shown in Table 3.

Table 3. Phytoplankton Ecological Index in the Waters of Tobati Village.

Environmental Indicators	Station I	II	III	IV
Diversity (H')	1.04 (moderate)	1.05 (moderate)	0.70 (low)	0.34 (low)
Evenness (E)	0.42	0.42	0.28	0.14
Fertility Level	Mesotrophic (moderate)	Mesotrophic (moderate)	Mesotrophic (moderate)	Mesotrophic (moderate)

2. Water Quality Parameters

Water quality parameters collected from each research station can be observed in table 4.

Table 4. Water Quality Parameters

Parameter	Station I	II	III	IV
Temperature (°C)	32	31	30	30
pH	6.8	7	6.8	7.4
Salinity (ppt)	33	33	36	33
Transparency (cm)	56	62	48	48
Dissolved Oxygen (mg/L)	5.2	6.4	5.2	5.2
Nitrate (mg/L)	3.2	2.8	2.3	1.8
Phosphate (mg/L)	0.43	0.34	0.34	0.51

DISCUSSION

1. Abundance of Species and Ecological Index Values of Tobati Village Waters

Phytoplankton in the waters of Kampung Tobati were found to be highest in the species *Chaetoceros laciniosus* from the class Bacillariophyceae (Diatom), which played a dominant role due to its ability to adapt and survive in various aquatic environmental conditions. This statement is supported by Amelia *et al.* (2012), who stated that when nutrient concentrations increase, Bacillariophyta can reproduce up to three times within 24 hours. In contrast, the lowest abundance was found in the species *Ceratium furca* from the class Dinophyceae. Meanwhile, the class Dinophyceae is known to have a slower reproductive rate, being able to perform cell division only once every 24 hours (Praseno & Sugestiningsih, 2000).

The highest total abundance of phytoplankton in the waters of Kampung Tobati was found at Station II, amounting to 8,855 cells/L, while the lowest was recorded at Station I, amounting to 7,007 cells/L. The high abundance at Station II is related to its position within a residential area, which directly receives domestic wastewater. This waste contains organic and inorganic materials that support phytoplankton growth (Ulpa, 2025). Meanwhile, Station I had the lowest value, although not significantly different. The low phytoplankton abundance at this station may be due to its location farther from residential areas, receiving organic material inputs only from mangrove litter surrounding the station.

The values of the diversity index (H'), evenness index (E), and the trophic level were used to describe the stability level of the aquatic community. The diversity index in the waters of Kampung Tobati ranged from 0.34 to 1.34, while the evenness index ranged from 0.14 to 0.42. Based on phytoplankton abundance, the trophic level at all four stations was categorized as mesotrophic (moderate).

At Stations I and II, the evenness index values were within the moderate category, while at Stations III and IV, they were within the low category. The low phytoplankton diversity may be attributed to the sampling period coinciding with the rainy season, which increased freshwater input and consequently reduced salinity levels, affecting the presence of phytoplankton species (Table 4). Odum (1993) stated that diversity index values ranging from 0 to 1 indicate environmental conditions experiencing significant ecological stress. According to Nuraya *et al.,* (2022), instability in salinity levels is a factor that can reduce the diversity level of aquatic organisms.

The evenness index values ranging from 0.14 to 0.42 indicate that phytoplankton species across the four stations were unevenly distributed. This condition is caused by the dominance of certain phytoplankton species with high abundance in the water column. According to Pirzan *et al.* (2017), when the evenness value approaches zero, it indicates a low distribution of individuals among species within a community. Conversely, when the evenness value approaches one, it reflects a community condition where individuals are relatively evenly distributed among species.

Referring to the results of the average phytoplankton abundance across the four stations, which was 7,543 cells/L, the waters of Kampung Tobati are classified as mesotrophic, or moderately fertile. This condition is still considered good as it does not yet show signs of pollution. Nutrients accumulated in the waters—derived from domestic activities, marine traffic, and mangrove litter—can still be naturally utilized by phytoplankton in the surface layer and by decomposer bacteria in the benthic zone (Makmur, 2012).

2. Water Quality Parameters

The measurement results of water quality parameters in the waters of Kampung Tobati varied across stations. The temperature in the waters of Kampung Tobati ranged from 30–32°C, which is considered optimal for phytoplankton growth (Rahman *et al.*, 2016). The pH value ranged between 6.8–7.4, indicating suitable conditions for phytoplankton development. According to Kristanto (2002), the normal pH range for water is between 6 and 8. The salinity values were classified as favorable for phytoplankton growth. Romimohtarto and Juwana (2004) stated that phytoplankton can generally tolerate salinity levels between 28–34 ppt. The transparency values in the waters of Kampung Tobati ranged from 48–62 cm, which are considered optimal for phytoplankton sustainability. Referring to Asmawi (1985), optimal water transparency for aquatic organism survival is >45 cm.

Dissolved oxygen (DO) functions as a fundamental factor supporting metabolic processes and physiological activities of aquatic organisms. The DO levels in the waters of Kampung Tobati ranged from 5.2–6.4 mg/L. This value is categorized as good since it remains above the permissible threshold (>5 mg/L). DO concentration is determined by phytoplankton photosynthetic activity and is also influenced by environmental factors during sampling (Zainuri *et al.*, 2023).

The nitrate concentration in the waters of Kampung Tobati ranged from 1.2–3.8 mg/L. This indicates that the water condition is good, as phytoplankton can still grow optimally. According to Nugroho (2006), nitrate concentrations ranging from 0.3–12 mg/L support optimal phytoplankton growth. Phosphate concentrations in the waters of Kampung Tobati ranged from 0.34–0.51 mg/L. The water quality in this area is still considered good, as the phosphate concentration does not exceed the optimum limit for phytoplankton growth. Persada *et al.* (2018) explained that phosphate concentrations within the range of 0.27–5.51 mg/L can support maximum phytoplankton productivity.

CONCLUSION

The fertility level of the waters of Tobati Village, South Jayapura District, Jayapura City, based on phytoplankton abundance is classified as moderate, thus entering the criteria for fertile waters (mesotrophic) and there are no indications of pollution. The results of the diversity index calculation indicate that the level of community stability at all observation stations is classified as low to moderate. The imbalance in the uniformity index values between stations is due to the high abundance of dominant phytoplankton species. The water quality of Tobati Village waters can be considered to meet the criteria of good because the physical and chemical indicators of the water measured are included in the range of quality standards, therefore still supporting optimal phytoplankton growth.

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