JURNAL SEGARA
http://ejournal-balitbang.kkp.go.id/index.php/segara

ISSN : 1907-0659
e-ISSN : 2461-1166
Acreditation Number : 158/E/KPT/2021

ABUNDANCE AND DIVERSITY OF PHYTOPLANKTON AND ZOOPLANKTON IN WATERS OF YOUTEFA BAY TOURISM AREA

Annita Sari[1)], Ambo Tuwo[2)], Chair Rani[2)], Amran Saru[2)], & Yudi Prayitno[1)]

[1)]Aquaculture Departement, Faculty of Fisheries and Marine Science, Yapis Papua University, Jayapura, Papua, Indonesia.
[2)]Marine Science and Fisheries Departement, Faculty Of Marine Science and Fisheries, Hasanuddin University, Makasar, South Sulawesi, Indonesia.

Received: 12 November 2022; Revised: 4 Januari 2022; Accepted: 4 Januari 2022

ABSTRACT

The waters in Youtefa Bay have degradation due to the transition from mangrove areas to industrial sites, housing, bridge construction and household waste disposal. Water degradation has indirectly affected the growth of plankton. Plankton consists of phytoplankton which is the primary producer of the food chain so that it is utilized by zooplankton as the first consumer. The aim of this study was to determine the abundance and diversity of phytoplankton and zooplankton. This research was conducted during June-August 2019, the method used purposive sampling. Samples were obtained from 6 observation stations. The results showed there is 28 species of phytoplankton (∑160,000 ind/L) and 15 species of Zooplankton (∑ 84,200 ind/L). The diversity index of Phytoplankton is ranging from 1-2.21; Dominance (D) 0.17-0.4 and similarity (E) 0.59-1, while for zooplankton diversity (H') ranges from 0.97-1.39; Domination (D) 0.07-0.42 and similarity (E) 0.59-1. The Diversity Index shows that the waters of Youtefa Bay have moderate diversity. The similarity between genera is relatively same. The Dominance index value during the observation was seen <0.5 or close to 0, this means that in the community that there was no genus that was extremely dominating the other genera.

Key words: Abundance, Diversity, Phytoplankton, Zooplankton, Youtefa Bay.

Corresponding author:
Jl. Pasir Putih I Ancol Timur, Jakarta Utara 14430. Email: annitasarie@gmail.com

INTRODUCTION

Youtefa Bay is one of the coastal areas located in Jayapura City. The area of Youtefa Bay Tourism Park is around 1,675 Ha which includes several traditional villages, namely Tobati, Enggros and Nafri Villages (Tebaiy, 2004; Kubelabobir *et al*., 2015). Youtefa Bay Tourism Park has considerable tourism potential for example for coastal tourism and mangrove tourism, but in developing the Youtefa Bay Tourism Park, a sustainable and sustainable management concept is needed that involves all stakeholders, the government, business actors, NGOs, communities, educational institutions/colleges and supported by traditional institutions and regulations and the application of law (Paulangan, 2014).

The community utilizes Youtefa Bay Tourism Park as a catching fisheries and fish cultivation area, fishing, and tourism transportation routes, traditional fishing ports, docks and RT (anthropogenic) waste storage activities which indirectly affect the carrying capacity of the Youtefa Bay. The high activity around the Youtefa Bay has an impact on the rate of sedimentation, turbidity of river and seawater, increasing household and industrial waste. This causes a decrease in aesthetic value and tourism, disturbed mangrove forest conditions, decreasing the number of catches and fishing distances further (Janviter, 2012), to know the condition of the waters in the area then a biological indicator is needed. One of the microorganisms that can be used as bioindicators is plankton, that consists of phytoplankton (plant plankton) and zooplankton (animal plankton). Phytoplankton, which is the primary producer of the food chain, is therefore used by zooplankton as the first consumer (Nybakken, 1992; Romimohtarto, 2009). Degradable aquatic ecosystems greatly affect phytoplankton because it can cause low abundance and diversity of phytoplankton. This situation can affect the level of water fertility, because one level of water fertility is determined by the level of abundance of phytoplankton, so that plankton can also be used as a type indicator to determine the condition of waters in good or polluted conditions (Kubelabobir *et al*.,2015).

Youtefa Bay has a very important ecological function and high economic value because its utilization involves many parties with different needs and changes in the environmental conditions of Youtefa bay are influenced by activities that occur around the bay. Water degradation has indirectly affected the growth of plankton. Based on the potential, continuity, and sustainability of the Youtefa Bay Tourism Park area, it is necessary to conduct a study of the existing conditions of waters regarding the abundance and diversity of phytoplankton and zooplankton.

.

METHODOLOGY

Study Area

This research was conducted in the Youtefa Bay Tourism Park area from April to August 2019. The observation station was in Tobati Village; Enggros Village; Nafri 1 Village (Mangrove condition is relatively natural and located in the Youtefa bay basin section far from the settlement); Nafri 2 Village (Mangrove Ecosystem is close to a settlement and part of the land

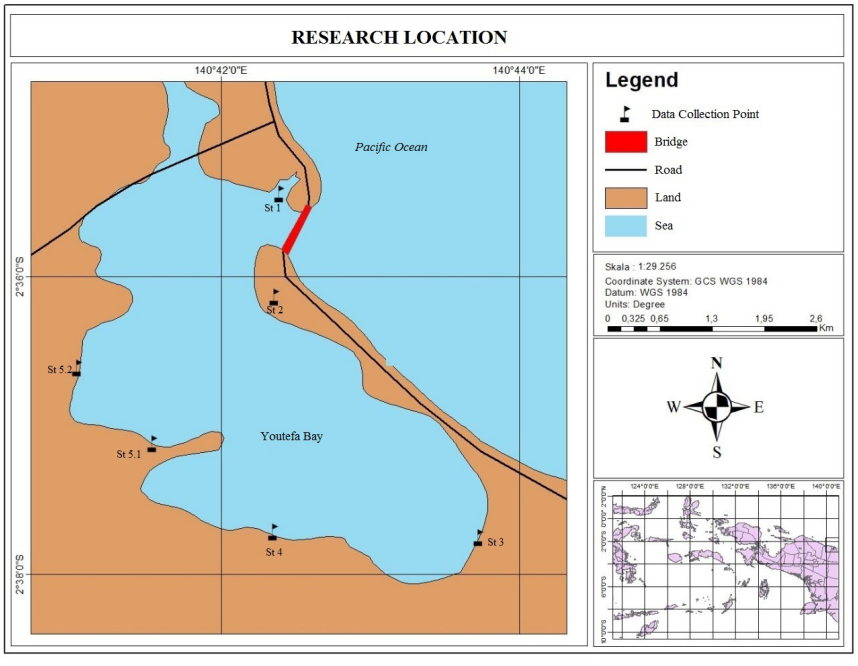

Figure 1. Research Site.

is used as a residential area and road widening); Abe Beach and Youtefa Bay Pier. The research location can be seen in Figure 1.

Sampling Method

The equipment used in this study is the Global Positioning System (GPS) to determine the position of the sampling station and parameter measurements. Plankton net has taken for samples. Thermometer for temperature measurement, sample bottle, pH meter for measuring acidity, refractometer for measuring salinity, pipette drops, sechii disks for measuring water brightness, microscopy, object-glass, cover glass, and identification book for plankton identification. The research material in the form of plankton was obtained from seawater sampling, formalin 4% to preserve the sample, while the identification of plankton used: (Davis,1955; and Al-kandari *et al*., 2009).

At each location, sampling was carried out three times using a plankton net. The plankton net is pulled from a depth of 1.5 meters while being moved horizontally in the range of 20 meters at each location. Seawater is put into a sample bottle and then preserved with 4% formalin and taken to the Cenderawasih University, Marine and Fisheries laboratory to be identified.

Data Analysis

Plankton Abundance (Phytoplankton and Zooplankton)

Plankton abundance is calculated using the formula (APHA, 1989):

$$N = Oi/Op \times Vr/Vo \times 1/Vs \times n/p$$

where,
N : Number of individuals per liter
O : area of the glass cover of the preparation (mm)
Op : Area of one field of view (mm)
Vr : volume of filtered water (ml)
Vo : observed water volume (ml)
Vs : the volume of filtered water (L)
n : Number of plankton in all fields of view
p : Number of fields of view observed

Diversity Index (H ‘)

To find out the diversity of biota in the study location, a calculation using the Shanon-Wiener Diversity Index (Odum 1996):

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right) Ln\left(\frac{ni}{N}\right)$$

where,
H ‘= Diversity Index;
Ni = Number of individual types 1;
N = the total number of individuals.

Diversity criteria used:
H ‘<1: low diversity
1 <H ‘<3: moderate diversity
H ‘> 3: high diversity

Diversity index value (H ‘) is related to water quality:
> 3 = Not polluted
1 - 3 = Half polluted
<1 = heavily polluted

Similarity Index (E)

The Similarity Index is calculated using the following formula (Odum 1996):

$$E = \frac{H'}{H_{maks}}$$

where,
E = similarity index
H ‘= diversity index
H max = ln S (S = number of species)

Criteria used:
H <0.4: Small similarity
0.4 <H <0.6: Medium similarity
H> 0.6: High similarity

Dominance Index (D)

The Dominance Index is calculated using the following formula: (Odum 1996):

$$D = \sum_{i=1}^{s}\left(\frac{ni}{N}\right)^2$$

where,
C = Index of dominance
ni = Number of individuals of type i
N = total number of individuals
n = Number of genera (types)

Values range from 0-1, the greater the dominance index, the greater the tendency for one species to dominate a population.
Criteria used:
D <0.4: Small dominance
0.4 <D <0.6: Medium dominance
D> 0.6: High dominance

RESULTS AND DISCUSSION

Plankton abundance

The results showed that at six observation stations twenty-eight (28) of phytoplankton types were

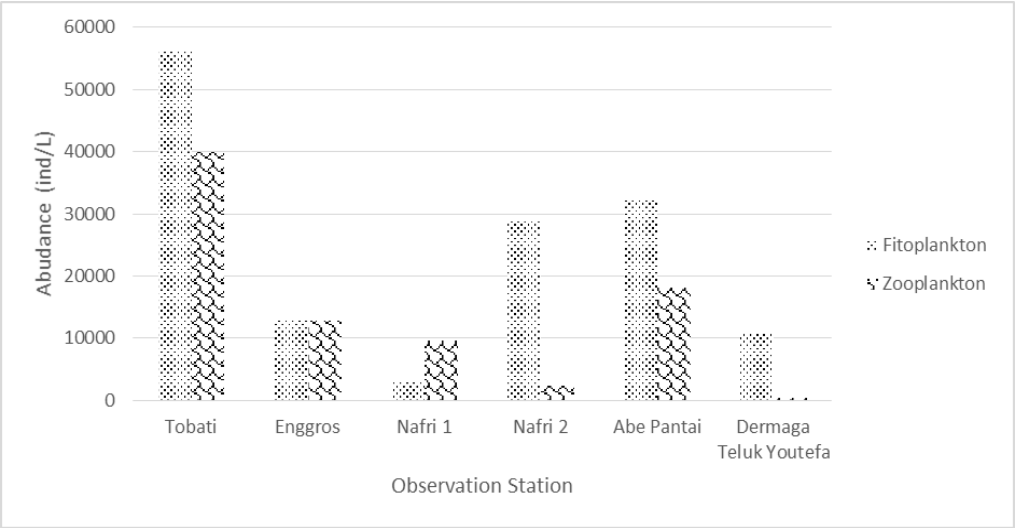

Figure 2. Comparison of phytoplankton and zooplankton abundance. (Source: Research Data, 2019)

found and fifteen (15) of zooplankton types were found. Total abundance of phytoplankton 160,000 ind/L; while the total abundance of zooplankton is 84,200 ind/L. A comparison of abundance between observation stations can be seen in Figure 2.

Overall the highest abundance of phytoplankton is the type of Nitzchia curvula (29,200 ind./L). Nitzchia curvula is a diatom type phytoplankton derived from the Bacillariophyceae class.

N. curvula was found in Tobati Village, Nafri and Youtefa Bay Pier. The lowest abundance of phytoplankton is Metacylis peresehkowskii, Colpes sp., And Corethon oriphilum. The abundance of phytoplankton in the Youtefa Bay waters area can be seen in Figure 3.

The highest abundance of zooplankton is the type of Acartia omorii (37,600 ind./L) from the Copepoda class. A. omorii was found in almost every observation station, namely Tobati, Nafri 1 and 2, Abe Pantai and Youtefa Bay Pier. The lowest type of zooplankton is Diaptomus vulgaris (200 ind./ L) which is only found in Nafri village 1. The total abundance of zooplankton can be seen in Figure 4.

Diversity Index

The index of diversity (diversity, similarity, and dominance) of phytoplankton at the six observation points varies greatly. The Diversity Index (H ‘) ranges from 0.90-2.2, the highest Diversity Index (H’) found in Nafri 1 (Mangrove Conditions are relatively natural and located in the Youtefa bay basin section far from settlements) and the lowest is found in the Youtefa Bay Pier. Based on the Diversity Criteria (H ‘) shows that

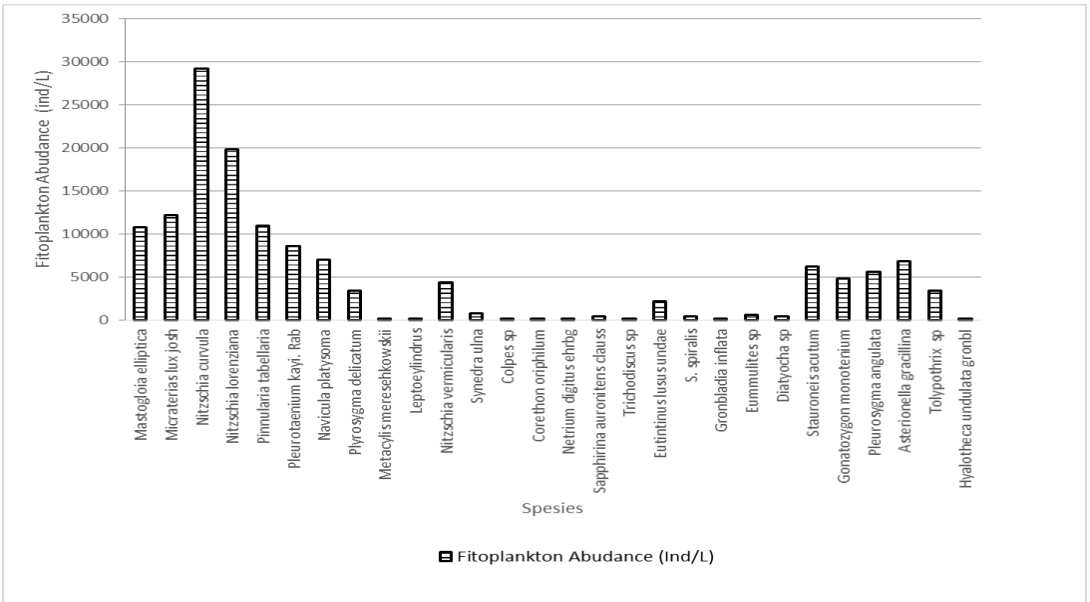

Figure 3. Phytoplankton abundance per species. (Source: Research Data, 2019)

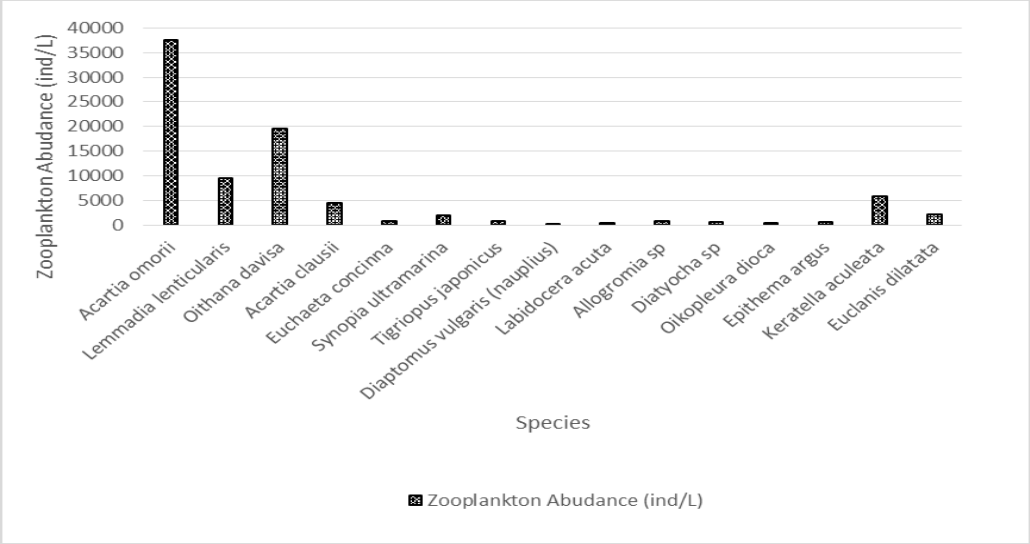

Figure 4. Zooplankton abundance. (Source: Researcher data, 2019)

Youtefa bay is in the category of moderate diversity (1 <H' <3: moderate diversity), while the water quality criteria based on H' youtefa bay is included in the half polluted.

The Similarity index (E) ranged from 0.56-1, the highest was found in Tobati (Mangrove ecosystems that are close to residential areas and some mangrove lands were converted into ring road bridge construction areas) and the lowest was found at Youtefa Bay Pier. Youtefa Bay has a moderate to high similarity index.

The dominance index (D) ranges from 0.12 to 0.49, the highest is found in Enggros and Youtefa bay pier and the lowest is found in Nafri 1. The dominance in Youtefa bay shows that there is no phytoplankton that dominates in these waters. The results of the phytoplankton diversity index analysis in the Youtefa Bay Tourism Park can be seen in Table 1.

Zooplankton Diversity Index (H ') at six observation stations ranged from 0.27 to 1.26, this value indicates that the diversity of Zooplankton in Youtefa bay is included in the low criteria with a half-polluted waters quality level. The Similarity index (E) ranges from 0.59 to 0.88, it shows that zooplankton has a moderate similarity, while the index of dominance (D) ranges from 0.07 to 0.42, this value explains that there are no specific species or species that dominate in waters the.

Quality of Aquatic Environment at Youtefa Bay

Based on the results of measurements and analysis of water quality parameters in the Youtefa Bay waters compared with seawater quality standards for marine biota (KEP NO. 51 / MENLH / 2004) (Table 2). In general, the physical-chemical characteristics of the Youtefa bay waters are relatively stable and are still in a good range.

Table 1. Field observation results

Indeks	Tobati		Enggros		Nafri 1		Nafri 2		Abe Pantai		Youtefa Bay Pier	
	Phyto	Zoo	Phyto	Zoo	Phyto	Zoo	Phyto	Zoo	Phyto	Zoo	Phyto	Zoo
H'	1.79	0.97	1	0.99	2.21	1.26	1.39	1.05	1.77	1.21	0.90	0.27
D	0.17	0.2	0.4	0.35	0.12	0.36	0.39	0.07	0.17	0.34	0.49	0.40
E	1.00	0.88	0.91	0.71	0.96	0.70	0.59	0.59	0.99	0.87	0.56	0.76

Source : data analysis, 2020

Table 2. Quality of Aquatic Environment

Parameter	Enggros	Tobati	Nafri 1	Nafri 2	Abe Pantai	Youtefa Bay Pier
Temperature (° C)	29	29	28	29	30	29
pH	8.4	8.4	7.5	8	7.5	7.8
Salinity (‰)	28	32	5	7	20	20
Brightness (m)	2.8	2.5	0.7	0.75	1	2.2
TDS (mg / L)	851	867	291	807	741	741
Current Speed (m / s)	1.2	2.2	1.5	1	7.3	0.82

Discussion

Plankton abundance

The highest total abundance of phytoplankton individuals is the type of Nitzchia curvula is a diatom type phytoplankton derived from the Bacillariophyceae class. According to the results of research by Suharno & Lantang (2010), phytoplankton found in the waters of Jayapura City are diatoma sp., Nitzschia sp. and Microcyatus sp. whereas according to research results Nurfadillah *et al*. (2012) that Nitzschia sp. is a type of phytoplankton that is abundant in the waters of Lake Laut Tawar, Central Aceh Regency, Aceh Province; a study conducted by (Ngamelubun, 2013 and Sulistiowati *et al*, 2016) regarding plankton abundance in Youtefa Bay also found plankton that dominated in the waters of the Bacillariophyceae class. This phenomenon is in accordance with Nontji's statement, 2008 which explains that Indonesian waters of the Bacillariophyceae class are the most frequently and widely found because these species can adapt to the conditions of the aquatic environment, have broad tolerance and resilience in extreme environmental changes. Bacillariophyceae class phytoplankton also has a great influence on aquatic life because it acts as a food source in the food chain and carbon transfer and can be used as a bioindicator of aquatic environments (Novia *et al*, 2016). Phytoplankton can be used as a bioindicator of the aquatic environment because plankton is a food source for other organisms so that if there is an imbalance in the aquatic environment or nutrient content that is highly watered, toxic blooming Plankton will occur and can cause death in biota (fish and shellfish) in these waters.

The large amount of phytoplankton can also be caused by the sampling area which is only on the surface of the water and is carried out around 8-10 am so that it has a greater light intensity. Phytoplankton is an autotrophic organism that needs the sun for its survival, especially to carry out photosynthesis so that the sea surface area becomes a suitable habitat (Ngamelubun, 2013). Current velocity also affects plankton abundance in waters. The same thing was also found by Sulistiowati *et al*. (2016) that currents affect plankton abundance, because the velocity of currents in the Acai river estuary waters in the dry and rainy season is higher than that of the Kali Entrop estuary waters (Sulistiowati *et al*., 2016). The current velocity at each observation station varies so that the abundance value is also different because the current will carry the nutrients needed in the growth and development of plankton.

The total abundance of zooplankton individuals found in Youtefa Bay waters is smaller than phytoplankton. This is because zooplankton in the waters of the Youtefa bay is less because the time of sampling is done in the morning where more light intensity enters the waters while zooplankton is more active at night to find food, food from zooplankton is phytoplankton. According to Ngamelubun research results, 2013 that the low zooplankton is caused by vertical distribution. Vertical distribution of zooplankton occurs at night, when zooplankton rises to the surface of the sea to prey on phytoplankton, then return to deeper waters during the morning until noon.

Diversity Index

Diversity Index (H')

The Diversity Index (H') ranges from 0.90-2.2, the highest Diversity Index (H') found in Nafri 1 (Mangrove Conditions are relatively natural and located in the Youtefa bay basin section far from settlements) and the lowest is found in the Youtefa Bay Pier. Based on the Diversity Criteria (H ') shows that Youtefa bay is in the category of moderate diversity (1 <H' <3: moderate diversity) it explains that the ability to spread individuals of each species is moderate and the stability of the community is moderate. Whereas in the Youtefa Bay pier shows a low H 'index because it has a diversity value of less than one, where the ability of the distribution of each individual is low and the stability of the community is low. The low diversity index at Youtefa Bay Pier is also likely due to environmental conditions that are not compatible with plankton growth. In accordance with the opinion of Odum (1996) that a low diversity index indicates that the station is not suitable for plankton growth, whereas the criteria for the level of water quality based on H' Youtefa bay is included in the half polluted.

Zooplankton Diversity Index (H') at six observation stations ranged from 0.27-1.26, this value indicates that the diversity of zooplankton in Youtefa bay is categorized as low (H'<1) at Youtefa Bay Pier station and moderate diversity (1 <H '<3) found in other observation stations (Tobati, Enggros, Nafri 1 and Nafri 2 and Abe beach. According to Novia *et al* 2016 that a low diversity index indicates that the station is not suitable for plankton growth, this is also indicated by quality conditions half-polluted waters.

Dominance Index (D)

The phytoplankton dominance index (D) ranged from 0.12 to 0.49, the highest was found in Enggros and Youtefa bay docks and the lowest was found in Nafri 1. The dominance of Youtefa bay showed that there was no dominating phytoplankton in these waters. The same thing was also found by Kubelabobir *et al*. (2015). Dominance index value during the observation was seen <0.5 or close to 0, this can be interpreted that the plankton community that was observed did not have a genus that extreme dominated the other genera. This shows the community structure is in a stable condition, the environment is quite prime, where there is no ecological pressure on the biota in the habitat in question.

Zooplankton dominance index (D) ranges from 0.07 to 0.42, this value explains that there are no specific species or species that dominate in these waters. In the Tobati and Youtefa Pier area, the D value is 0.4-0.42, this can be interpreted that there is a dominant zooplankton species, namely the Acartia omorii species which is one type of copepod in the Youtefa bay waters. This is allegedly due to the unstable water conditions, which are the influence of several different environmental factors or there are phenomena that occur in the waters such as the upwelling phenomenon. According to Novia *et al*. (2016), upwelling not only uses chemical physics parameter data but also biology. One of the biological parameters offered to uncover the phenomenon of upwelling is using a zooplankton bioindicator, namely copepod.

Similarity Index (E)

The Similarity index was analyzed in order to find out how similar the number of individuals distributed to the community both in each location and season. The phytoplankton Similarity index (E) ranges from 0.56-1, while the zooplankton similarity index (E) ranges from 0.59 to 0.88, it shows that zooplankton has a moderate similarity. The similarity index which is close to One shows that similarity between species is evenly distributed and similarity value that is close to zero shows similarity between species is classified as low. According to Kubelabobir *et al*. (2015). if the similarity index value is close to one, it means that similarity among genera can be said to be relatively evenly distributed; or it can be said that the number of individuals in each genus is relatively evenly distributed, the difference is not striking. When related to the condition of the community and its environment, a similarity index near zero tends to indicate an unstable community. The community can also be said to be in a state of stress, due to experiencing environmental stress or unstable environmental conditions.

Quality of Aquatic Environment at Youtefa Bay

The temperature range ranges from 28-30 oC, this is consistent with what was stated by Effendi (2003) that the optimum temperature range for phytoplankton growth is 20-30°C. Thus the process of metabolism of phytoplankton can run well so that the process of growth and development of phytoplankton can also run well. Efrizal (2001) said that the temperature will be higher or hotter causing a high level of brightness, the abundance of plankton in the waters will be higher.

The degree of acidity (pH) ranges from 7.5 to 8, the pH value is still in the range of good tolerance for plankton growth. Plankton abundance will decrease with higher pH. If the pH is high or alkaline it will endanger the survival of plankton organisms, because it will cause metabolic and respiratory disorders.

The salinity in Youtefa bay waters varies (5-32 ppm), the salinity value is still in the salinity range that is in accordance with the sea water quality standards for marine biota. Variation in salinity is caused by the influence of river water that enters through the anafre river to the anaphre river estuary, during that rain also affects salinity because when it rains there will be dilution in the waters.

The TDS (Total Dissolved Solid) shows a range of 291-867 which means that the TDS will be higher with decreasing plankton abundance. If the TDS value is high then the sunlight penetration will decrease due to photosynthesis also will reduce plankton abundance or water productivity (Sastrawijaya, 2000).

The brightness measurement results are 0.7-2.8 meters; during the study the highest was 2.8 meters and the lowest was 0.7 meters. Brightness is determined by the amount of suspended solids and floating microorganisms, or by the turbidity and color of the water. High turbidity value causes phytoplankton to not be able to carry out photosynthesis effectively, as a result zooplankton in these areas cannot grow properly.

The measured current speed range in the waters of Youtefa Bay is classified as very strong (1-8.2 m/sec). This is according to what was stated by Ngamelubun (2013) that the current speed> 0.100 m/sec is classified as a very strong current type.

CONCLUSION

The results showed that at six observation stations twenty-eight (28) of phytoplankton types were found and fifteen (15) of zooplankton types were found. Total abundance of phytoplankton 160,000 ind/L; while the total abundance of zooplankton is 84,200 ind/L. Overall the highest abundance of phytoplankton is the type of Nitzchia curvula (29,200 ind/L) and the highest abundance of zooplankton is Acartia omorii. The Diversity Index (H') shows that Youtefa bay is in the category of moderate diversity and the criteria for the level of water quality based on H' Youtefa bay is included in the half polluted. The phytoplankton and zooplankton dominance index (D) shows that showed that there was no dominating plankton in these waters. The Similarity Index (E), it shows that phytoplankton and zooplankton has a moderate Similarity

ACKOWLEDGEMENTS

The author would like to thank Mr. Palengge Andi Nyompa, S.IP. for the help of field data retrieval and research funding assistance, the authors also thank the Lecturer Team of the Faculty of Fisheries and Marine Sciences who have helped field data collection and processing.

REFFERENCE

APHA (American Public Health Association). (1989). *A standard method for the examination of water and wastewater. American Public Health Association*. Water Pollution Control Federation. Port City Press.

Effendi, H. (2003). *Telaah kualitas air bagi pengelolaan suber daya dan lingkungan perairan*. Yogyakarta: Kanisius.

Efrizal, T. (2001). Kualitas perairan di sekitar lokasi penambangan pasir Desa Pongkar Kabupaten Karimun. *Berkala Perikanan Terubuk, 74*(28), 50 -58.

Janviter, M. (2012). *Model Pengelolaan Teluk Youtefa Terpadu Secara Berkelanjutan*. Disertasi. IPB. Bogor.

Kubelabobir, T.M., & Akerina, J. (2015). Keanekaragaman Dan Kemelimpahan Plankton Di Perairan Teluk Youtefa, Jayapura. *The Journal Of Fisheries Development, 1*(2), 71-78.

Ngamelubun, G. (2013). *Keanekaragaman Dan Kemelimpahan Plankton Di Perairan Teluk Youtefa Jayapura*. Thesis. Universitas Kristen Satya Wacana.

Nontji, A. (2008). *Plankton laut*. Lembaga Ilmu Pengetahuan Indonesia. LIPI Press. Jakarta.

Novia, R., Adnan., & Ritonga, I.R. (2016). Hubungan parameter fisika-kimia perairan dengan kelimpahan plankton di Samudera Hindia bagian Barat Daya. *Depik, 5*(2), 67-76. DOI: http://dx.doi.org/10.13170/depik.5.2.4912.

Nurfadillah, A., Damar., & Adiwilaga, M. (2012). Komunitas fitoplankton di perairan Danau Laut Tawar Kabupaten Aceh Tengah Provinsi Aceh. *Depik, 1*(2), 93-98.

Nybakken, J.W. (1992). *Biologi Laut, Suatu Pendekatan Ekologis*. Penerjemah: H.M. Eidman dkk; Penerbit PT. Gramedia Pustaka Utama. Jakarta.

Odum, E.P. (1996). *Dasar-dasar ekologi*. Edisi ketiga. Penerjemah: T. Samingan. Gadjah Mada University Press. Yogyakarta.

Paulangan, Y.P. (2014). Potensi Ekosistem Mangrove Di Taman Wisata Teluk Youtefa. *Jurnal Kelautan 7*(2), 60-68.

Romimohtarto, K., & Juwana, S. (2009). *Biologi Laut*. Ilmu Pengetahuan Tentang Biologi Laut. Djambatan. Jakarta.

Sastrawijaya, A.T. (2000). Pencemaran Lingkungan. Jakarta: Rineka Cipta.

Suharno., & Lantang, D. (2010). Keragaman jenis plankton di perairan laut Kota Jayapura, Papua. *Jurnal Biologi Papua, 2*(1), 1-6.

Sulistiowati, D., Tanjung, R.H.R., & Lantang, D. (2016). Keragaman dan Kelimpahan Plankton Sebagai Bioindikator Kualitas Lingkungan di Perairan Pantai Jayapura. *Jurnal Biologi, 2*(8), 79-96.

Tebaiy, S. (2004). *Kajian Pengembangan Ekowisata Mangrove Berbasis Masyarakat Di Taman Wisata Teluk Youtefa Jayapura Papua*. Thesis. Pascasarjana Program Studi Pengelolaan Sumberdaya Pesisir dan Lautan. IPB. Bogor.