IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 5, Issue 5 (Sep. – Oct. 2019), PP 23-30
www.iosrjournals.org

The Type and Biodiversity of Plankton in an Integrated Fishery Activity in Waters of the Bay Awerange

Andi Adam Malik, Andi Sitti Halima
Corresponding Author: Andi Adam Malik

Abstract: *An integration between activities of cultivation, fishing, fishery products processing and fishery agribusiness that have been done by the fishermen individually have to developed and applied. The aims of this research was to determine the community structure, abundance, plankton biodiversity, and the condition of the waters environment in the activities of the integrated fishery activities in the waters of the bay Awerange. A floating fish cage system and model integrated with shallow rumpon (a type of FAD) model was employed. The research results found that the composition of type and abundance of phytoplankton was in general dominated by class Bacilariophyceae, and the most numerous species was chaetoceros. With the diversity index was higher than the uniformity index resulting really supported the plankton life, plankton may adapt itself for the balance of its life.*

Key words*: integrated fishery, floating fish cage system*

Date of Submission: 29-08-2019 Date of acceptance: 14-09-2019

I. Introduction

Plankton is an organism living in waters column area where the swimming ability of the organism is weak enough so that its moving ability is controlled by water movement. This is opposed with nekton organisms namely sea organism of which their swimming movement is strong enough against the currents of the sea (Fulton, 1984). Plankton is an inseparable part of the aquatic ecosystem, and it fulfills a great variety of important function as secondary producers. To species diversity indices of zooplankton communities are used to evaluate the quality of water. Hence, zooplankton can be used as an indicator of sorority. In addition, species diversity, abundance and biomass of zooplankton determine production of fish in the ecosystem (Manickam, Bhavan, & Santhanam, 2017; Mishra & Panigrahy, 1996). These small animals are very important for the marine ecosystem economy since they are primary herbivorous in the sea. Therefore, zooplankton plays a very important chain between the primary production of phytoplankton and big and small carnivorous (Hutabarat, & Evans, 2000; Effendi, et.al. 2016).

There are 27 species of plankton identified, which can be classified into three groups. Diatom group consists of 18 species with a 74.56% abundance. The nonlitoral group consists of 6 species with a 23.35% abundance. Moreover, dinoflagellate group consist of 3 species with a 2.09% abundance. An abundance of plankton greater than 10 4 cell.L was found in diatome group (*Nitzschia* sp., *Thalassiosira* sp., *Chaetoceros* sp., *Flagillaria* sp., *Thalassiothrix* sp., and *Melosira* sp.) and non-litoral group (*Oscillatoria* sp. and *Spirogyra* sp.). The abundance of those species indicated the algae bloom phenomenon. *Dinophysis* sp. was also identified, which was harmful algal blooms (Setiabudi, Bengen, Effendi, & Radjasa, 2016).

Zooplankton consisted of *Acartia*, *Euterpina*, *Oithona*, *Oncaea*, *Paracalanus*, *Corycaeus*, *Labidocera*, *Macrosetella*, *Microsetella*, *Temora*, copepod copepodid, copepod nauplii, Barnacle, Polychaeta, Conchoecia (Ostracoda), Hyperid, Decapoda (zoea and megalopa), Actinula, Echinopluteus, Mollusca, *Tintinnopsis*, *Boliopsis*, *Discorbis*, *Diastylis*, Siphonophora and Phialidium, *Pratylenchus*, *Oikopleura*, fish eggs and fish larvae. The seasonal abundance (density) of zooplankton was 21,237±2,419, 45,739±6,053, 5,242±648, and 12,905±1,867ind./m. In summer, autumn, winter and spring, respectively. There was a significant correlation ($P<0.01$) between zooplankton abundance as well as biomass with salinity, dissolved oxygen and chlorophyll *a*. Based on PCA (Principal Component Analysis), the most important factors in mudflat shallow river–estuarine system that could describe most changes of biomass and abundance of zooplankton were salinity, chlorophyll *a*, temperature and pH, respectively (Farhadian &Pouladi, 2014) .

Some phytoplankton is known to effectively absorb some compounds with virus characteristics for other organisms and may improve soluble oxygen due to photosynthesis activities and may control the CO_2 content. Some types of phytoplankton may also play roles as antibacterial and supplier of foods for zooplankton to be developed as the source of one-cell protein. At present, some phytoplankton has been developed as the health food for human beings. The potency of this development has been greater than the high-level plants (Isnansetyo & Kurniastuty, 1995).

Phytoplankton abundance in Indonesia waters is dominated by class diatom (*Bacillariophyceae*), while what dominates the East Indonesia Waters is class *Crustacea* for zooplankton (Wulandari, 2009; Romimohtarto, 1999). Three most important classes of phytoplankton exist namely class *Bacillariophyceae* (Diatom) which is directly eaten by many types of fishes possessing high economic value (Rajkumar, Santhanam, & Perumal, 2004). This can be used as an indicator that the waters is fertile. This fertility indicator is reinforced by Fahrunnisa, Nurgayah, and Irawati (2017) stating that phytoplankton important for waters fertility is from class *Bacillariophyceae*, class *Cyanophyceae* and class *Chlorophyceae.*

According to Davis (1955), the abundance of a type of phytoplankton is caused by stimulation of the organism supported by appropriate environmental factors. The abundance of phytoplankton from class *Bacillariophyceae* is certainly related to the environmental condition of the waters in the research site, either physically, chemically and biologically since the environmental condition is appropriate for the phytoplankton growth of class *Bacillariophyceae*. The abundance of phytoplankton was quite varied with relatively large number of 22 species (Femi, Alfi, Baruadi, & Sri, 2017). Chyanophyta was the phylum of phytoplankton with the highest abundance. The total abundance of phytoplankton in the study sites was still in optimum condition with the values ranging from 22093-29514 cells L-1 and its productivity rate categorized as moderate.

Pello, Adiwilaga, Huliselan, and Damar (2014) founded 4 classes of phytoplankton which consist of Bacillariophyceae (38 genera), Dinophyceae (13 genera), Cyanophyceae (1 genus), and Chrysophyceae (2 genera). Genus *Trichodesmium*, Cyanophyceae class dominated waters in East Season. the abundance of phytoplankton obtained significant differences in the distribution of the both temporal and spatial, the correlation of the physical and chemical characteristics of the waters with an abundance of phytoplankton showed that East Season dominated by *Gonyaulax* (Dinophyceae) and *Bellerochea* (Diatom) which is influenced by phosphate, silica, ammonia, turbidity, pH and DIN:DIP. Transition Season I and West Season dominated by *Triceratium, Skeletonema, Bacillaria, Planktoniella, Ditylum, Diploneisv* and *Prorocentrum* are affected by temperature, salinity, nitrite, ration of dissolved inorganic nitrogen to dissolved silicon, secchidepth and euphotic zone

Criterion of the water environment quality is based on the biodiversity index $H < 1$ where the biodiversity is low, the spread of the number of individual species is low, and its community stability is low; $1 < H < 3$ where its biodiversity is moderate, its spread of the number of individual species is moderate and the community stability is moderate; $H > 3$ where its biodiversity is high, the spread of the number of individual species is wide and the community stability is high (Mason, 1991).

Based on the condition of the waters quality, some experts said that there is a close relation to the type biodiversity index on the basis of the fact that an imbalanced environment will influence the life of an organism living in a waters. The higher the biodiversity index, the higher the number of organism living in the area will be.

Fishery activities that have been being done so far are merely intended to maximize production and proceed without any relation among one and another. Even, the fishery activities often conflict among themselves. Fishing activities often conflict with conservation and water cultivation activities. Abundance products from cultivation production and fishing activities by fishermen cause the price of the products to be low even rotten. It has been occurring up to now. Therefore, it is necessary to make researches on how to develop fisheries which is the integration between friendly-fishing activities integrated with conservation, cultivation, post-procession of fishery products and independent marketing of products resulted from the integration of the fisheries activities.

This present research is understanding the community structure, abundance, plankton biodiversity and the condition of waters environment in the integrated fisheries activities in the bay Awerange. The results of this research was expected to be able to become information on an integrated and sustainable fisheries activities that may be made use of by the concerned parties in planning the management and development of fisheries activities.

II. Materials and Method

This research was conducted in Barru regency, South Sulawesi province, Indonesia. The sampling method was made by determining stations and choosing areas condisered to be very good for making research. The plankton abundance was determined based on the **Sedgwick-Rafter** counting cell, and expressed quantitatively in the number of cell/liter. The plankton abundance was counted based on the following formula (Fachrul, 2007) :

N = n x (Vr/Vo) x (1/Vs)

N= Number of cell/liter

n= Number of cell observed

Vr= Volume of filtered water (ml)

Vo= Volume of examined water (ml)

Vs= Volume of filtered water(l)
To understand the water volume of water entering into the net (volume of the filtered sample) may be calculated using the following formula:

Filtered volume = A x t

A= plankton net circle width (π. r2)
t = pull length (m)

1. Plankton Identification

Plankton identification conducted in this present research followed the identification manual guide where the preparation of the water sample in the Sedgwick-Rafter was examined. The plankton found was used to represent the area where the plankton was from, and then the found plankton was matched with the identification book. The name of the plankton found was noted.

2. Calculation of the Number of Plankton

Data analyze for the low magnification was made through the following process:

1. Filling Sedgwick-Rafter (S-R)

S-R deg-glass was put in a diagonally crossed position and the sample was entered into it using a pipette to avoid any bubbles. The deg-glass was rotated slowly until the S-R deg-glass was full of the water sample. The water sample filled in should exceed 1 mm because it can cause improper calculation.

2. Counting Strip

Strip of the S-R is the arrangement of the sample water volume with the length of 55 mm, the height of 1 mm and the width of 2 mm. The number of the strips counted is the precision and the value of the calculation number of organism per strip.

Calculation of plankton in the S-R was made follows:

Number of Organism/mL

$$= \frac{C \times 1000\ mm^3}{L \times D \times W \times S}$$

C = Number of organism found
L = Length of strip (S-R) mm
D = Height of strip (S-R) mm
W= Width of strip (S-R) mm
S = Number of strip counted

To count the plankton abundance, formula was used (Michael, 1995) :

$$n = \frac{(a \times 1000) \times c}{l} \text{ plankter / liter}$$

n=plankton abundance (number of plankter/L)
a=average number of plankter in 1 mL
c=mL thick plankton of filtered water volume
l = Sample volume of filtered water

3. Calculating Diversity Index

To calculate diversity, Sannon's Diversity Index was used (Odum, 1971) :

$$H^1 = - \Sigma (ni/N) \ \ln (ni/N)$$

S=Number of the whole species
ni=Number of individual/species
N=Number of the whole individuals

To count the diversity, Evnennes' Index was used.

$$E = H^1 / H^1 ma$$

S = Number of the whole species
H max =Maximum diversity
E =Uniformity Index

III. Results and Discussion

Structure of plankton communities has a lot of varieties where there are many species distributed. In general, 32 phytoplankton species with 3 classes exist namely *Bacillariophyceae* (27), *Dynophyceae* (7) and *Chlorophyceae* (1). Meanwhile Zooplankton has 8 species from Class *Crustacea*, that can be found out between one station and other stations where their existence varied. They all founded in research location and highly varied between stations similar opinion was earlier given by Baba and Pandit (2014)

Tabel 1. shows the highest number of the types of phytoplankton in the class *Bacillariophyceae* with the average number of 59 and the lowest number with the average number of 0.67, while zooplankton merely possesses one class namely crustacean with the average number of 5.3. The highest percentage of plankton was shown by class *Bacillariophyceae* namely 93.15% and the lowest one was shown by the class of

Cholophyceae namely 1.06%. Moreover the whole percentage for phytoplankton was 92.24%, while for zooplankton for class crustacean was 100% and the whole percentage was 7.76%.

Table 1. Number and Percentage of Plankton Found

No	Plankton	Station			Average	Type Percentage (%)	Whole Percentage(%)
1.	*Phyitoplankton*	I	II	III			
	Bacillariophyceae	34	79	64	59	93.15	-
	Dynophyceae	4	7	-	3.67	5.79	-
	Chlorophyceae	1	-	1	0.67	1.06	
	Number	39	86	65	63.34	100	92,24
2.	*Zooplankton*						
	Crustacea	16	-	-	5.33	100	-
	Number	16	-	-	5.33	100	7,76
	Total	89	71	87	68.67	93.15	100

Abundance the highest average of phytoplankton was by species *Chaetoceres* in station 1 with the average value of 58.97667, with the lowest was species *Biddulphia mobiliensis, Chaetoceros leave, Leptocylindrus danicu, Ceratium furca* with average value of 5,896667. In station 2, the average value of 225.587 iwas occupied by the species *Chaetoceros teres*, while the lowest value was shown by the species *Biddulphia sinensis, Biddulphia auritas, Hemialus indicus, Rhizosolenia cylindrus, Pleurosigma Sp, Rhizosolenia styloformia, Skeleto costatum, Ceratium fusus, Ceratium articum, Protoperidiumn ovum, Protoperdinium aceanicum, Pyropphagus horologium.* In station, the average value of 77.20667 was shown by Chaetoceros teres, while the lowest value is shown by B*idddulphia sinensis, Melosira salina, Skletonema costatum, Thallossionema nitzchiodes and Nitrium digitus* with value of 4,826667. For phytoplankton, the highest average abundance was found in the species of *Rhoncalanus notusus* with the value of 94.35 and the lowest one was shown by species *Temora longicornis, Metridia lucens, Ortona halgolandica Dan Balanus balanoides* with the value of 23,59.

The composition of the phytoplankton and zooplankton in the waters of Barru tended to be dominated by certain species which is abundant. Based on the results of lab observation, the highest percentage value was shown by class *Bacilariophycea* in each station and this signs that the abundance and composition of the class were high in number (Table2).

Table 2. Number and Average Abundance of Plankton Found

No	*Spesies*	Station			
		I	II	III	IV
1	*Chaetoceros teres*	58,97667	25,5867	77,20667	
	Chaetoceros decipiens	17,693 33	0	33,77667	
	Chaetoceros densum	0	66,34667	28,95333	
	Chaetoceros leave	5,896667	0	0	
	Chaetoccina poravianum	0	26,53667	28,95333	
	Biddulphia sinensis	0	6,633333	4,826667	
	Biddulphia aurita	0	6,633333	0	
	Biddulphia mobiliensis	5,896667	0	0	
	Bacillaria paradoxa	11,86333	0	0	
	Bacteriastrum varlava	17,69	13,26667	9,65	
	Hemialus indicus	0	6,633333	0	
	Leptocylindrus danicus	5,896667	13,26667	28,95333	
	Melosira salina	0	0	4,826667	
	Pleurosigma sp	29,48667	6,633333	28,95	
	Pleurosigma compaeto	0	0	14,47667	
	Rhizosolenia stolterfothi	17,76	39,80667	9,65	
	Rhizosolenia devu	0	13,27	0	
	Rhizosolenia alata	0	46,44333	28,95	
	Rhizosolenia cylindrus	0	6,633333	14,47667	
	Rhizosolenia styloformia	0	6,633333	0	
	Skletonema costatum	11,79333	6,633333	4,826667	
	Thallassionema nitzchiodies	17,69	13,27	4,826667	
	Ceratium arcticum	0	6,633333	0	
	Ceratium furca	5,896667	0	0	
	Ceratium fusus	0	6,633333	0	
	Ceratium trichoceros	0	13,27	0	
	Protoperidinium ovum	17,76	6,633333	0	
	Protoperidinium oceanicum	0	6,633333	0	
	Pyrophagus horologium	0	6,633333	0	
	Nitrium digitus			4,826667	
	Paracelus edwardsii				47,18
	Rhincalanus nasutus				94,36

Temora longicornis				23,59
Metridia lucens				23,59
Ortona halgolandica				23,59
Paracalanus panvus				70,77
Balanus balamoides				23,59
Calanus finmarchius				70,77
Chaetoceros teres	58,97667	25,5867	77,20667	

Note : Stations I,II and III for Phytoplankton and IV for Zooplankton

Composition average of each class between phytoplankton and zooplankton does not show something different where in phytoplankton, there was merely one class dominating namely class *Bacilariophyceae.* The species existing in general was the same. This is also the case of Zooplankton. The Diversity Index (H) is the diversity of species from phytoplankton and zooplankton dwelling in a community, where the value of the diversity was closely related to the number of species existing in the community. From the observation, it is obtained that the index of diversity for phytoplankton was between 2.36 – 2.40, while for Zooplankton was about 2.34 (Table 3).

Table 3. Diversity Index

No.	*Plankton*	Station		
		I	II	III
1.	Phytoplankton	2.345761	2.403779	2.364469041
2.	Zooplankton	-	-	2.345761

Note :
Station 1 : seaweed *Sargassum*
Station II : seaweed *Euchema Spinosum*
Station III : floating net fish cage and seaweed

Uniformity index may reach the maximum value if the distribution of the number of each individual is equal in a community. Based on the results of observations, the uniformity index for phytoplankton was around 0.6, while for phytoplankton was 0.92 (Table 4). This signs that the composition of types and abundance of plankton depends on the condition of waters environment.

Table 4. Uniformity Index

No.	*Plankton*	Station		
		I	II	III
1	Phytoplankton	0.682241552	0.676843	0.693584
2	Zooplankton	-	-	0.928361038

Note :
Station 1 : seaweed *Sargassum*
Station II : seaweed *Euchema Spinosum*
Station III : floating net fish cage and seaweed

Condition of Waters Environment

Waters environment condition is greatly influenced the composition and abundance of plankton where the chemical and physic parameters of the waters greatly influence the physiology and the characteristics of planktons. It is a key to know the adaptation model of the plankton. The parameters of the waters environment are shown in Table 5. One of the physic characteristics giving a great effect on the life of plankton is salinity, where marine organism especially plankton has different ability to adapt to the salinity and this shows that salinity is the determinant of plankton distribution. The salinity value measured in the research site was 34 $^{o}/_{o.}$

Table 5. Water Quality

No	*Spesies*	Station		
		I	II	III
1	Salinity (‰)	34	34	34
2	Water temperature (^oC)	28	28.5	28
3	Temperature (%)		7,5	
4	Current speed (m/s)	0,047	0,083	0,077
5	DO (ppm)	5.28	5.44	5.12
6	Nitrate (ppm)	2,2746	2,054	2,515
7	Phosphate (ppm)	0,8064	0,7104	1,498
8	Ammoniac (ppm)	0,034	0,038	0,035

Another factor of the waters environment measured was temperature, where the temperature measured during the observations ranged from 28-28.5 ^{o}C. This value is the same for each observation station, where water temperature influences physic, chemical and biological characteristics of the waters environment. the increase of temperature causes the metabolism system of water environment to increase. This causes the reduction of gasses dissolving in water. Among the various factors examined, abrupt change in salinity caused by rainfall can be considered as the most important water quality parameter which affects zooplankton abundance as reported previously by many workers Watanabe, Kitajima, and Fujita (1983); Rajkumar, Santhanam, and Perumal (2004); Nassar, Mohamed, Khiray, and Rashedy (2014). The results of the present study showed that a combination of factors influence the zooplankton distribution and abundance in estuary. Among the various factors examined, abrupt change in salinity caused by rainfall can be considered as the most important water quality parameter which affects zooplankton abundance (Thirunavukkarasu, Soundarapandian, Varadharajan, & Gunalan, 2013).

The temperature in the three observation stations was still under fair category for the growth of phytoplankton. The optimum temperature for the growth of diatomae is 30^{o}C (Prescott, 1970; Sankar & Padmavati, 2012)

In the waters environment, a hydrodynamic process is very important to the selection of phytoplankton. The average value of the currents speed measured during the observation was 0-.04 – 0.08, where the highest current occurred at Station II (0.08 m/s). Current really influences the plankton spread which is greatly influenced by current movement.

Acidity content (pH) is a theory used to explain the characteristics of compounds in water. The characteristics of compounds in water may be in the form of acid or base. Acid is a compound producing hydrogen ion when it is dissolved in water, and base is a compound producing hydroxyl ion in water. Waters brightness is one of the determinants for plankton abundance. The brightness value in the observation location was not measurable. However, based on the fact, high brightness influences productivity and plankton distribution and other marine organisms.

The results of measurement made to the environment parameters (N, P, Nh3, and DO) showed significant values on phytoplankton and zooplankton abundance for among others nitrate, phosphate, ammoniac, and DO where nitrate and phosphate influenced the growth and the extent of the productivity of plankton, specially phytoplankton.

Oxygen content dissolved in water is really needed by each marine organism. The results of measuring the DO in the location ranged from 5.1 – 5.4 ppm. The range really supports the life of plankton, since the oxygen content for the growth of plankton should not be less than 4 ppm. . Based on the measurement result, DO level in the waters around Barru is proper for plankton's growth. Similar opinion was earlier given by Ramakrishna (2014); Nowrouzi and Valavi (2011); Fathi, Al-Fredan, and Youssef (2009); Dong Ji, Zhou, Song, and Li (2015); Luyiga and Kiwanuka (2003). From the value of the DO measured, it can be said the the waters around Barru is still good for the growth of plankton.

Ammoniac content is one of the important elements for the growth of organism and is one of the main elements for the protein shaper. The value of the ammoniac content measured in the observation areas ranged from 0.034 – 0.0418 ppm. This high ammonia content caused by by domestic waste disposal and supply from the river and it can affect the growth of the plankton (Periyanayagi, Sasikala,Venkatesan, Karthikayen, & Balasubramanian, 2007; Bahaar, & Bhat, 2011). The ammoniac content is caused by the domestic trash to the rivers flowing into the sea. High value of the ammoniac content in the waters influences the growth of plankton.
Average abundance of phytoplankton from the three stations in the waters of Barranglompo was dominated by class *Bacillariophyceae.* It is presumed that the class *Bacillariophyceae* is able to make use of nutrients in the waters such as phosphate or nitrate, and to adapt to its environment. The nitrate content obtained from all stations ranged from 2.054 – 2.515. The range of nitrate content from the whole stations is adequate to support the development of phytoplankton. The lowest tolerance limit of the nitrate content is 0.1 ppm and the highest one is 3.0 ppm (Boyd & Litchkopper, 1979).

The results of measuring phosphate for all stations ranged from 0.614- 1.498ppm. These results contradict with Weitzel (1979) opinion that when the phosphate content is low (0.00 0.02 pp), the waters is dominated by class *Bacillariophyceae*, when it is moderate (0.02 – 0.05ppm), the waters is dominated by class *Clorophyceae*, and if the content is high (0.10mm) it is *Cynophycea* which is dominant. This might be caused by other supporting factors which are more dominant, for example, the silicate content as explained by Niartiningsih (1996) that in the community mangrove forest Tongke-Tongke, silicate is the main material for forming the shells of *Bacillariophyceae.*

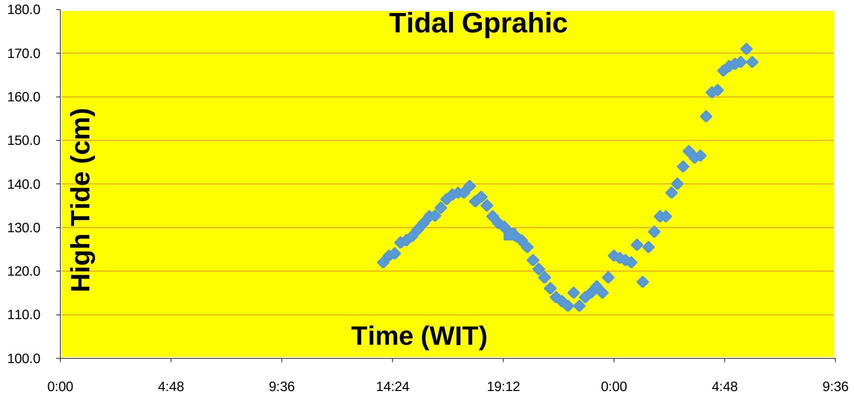

Figure 1. Tidal Graphic

The tidal type shown by the graphic is *diurnal.* Tide is one of symptoms of sea water that gives a great effect on the life of sea biota and its characteristics of life, especially in coastal regions. There are four types of tide in Indonesia sea namely: semi diurnal or multiple daily tide (twice high and twice low in 24 hours), diurnal or single daily tide (once high and once low in 24 hours), a mix between the two namely dominant multiple and single tides. Tide may influence the spread of organism and sea biota. The influence occurred vertically and horizontally in the water column and this may influence that the plankton distribution would be different in each place (Cardosoa, Rolanda, Loverde, & Oliveira, 2014).

Based on the parameters of the environment measured as a whole during the observations, it can be stated that the condition of the waters Barru may be still be said to be adequate for the growth and development of plankton.

IV. Conclusion

From the descriptions above, three conclusions are drawn : (1) The composition of type and abundance of phytoplankton in general is dominated by class Bacillairophyceae, where the percentage of this class is 93.5%. The most species found s chaetoceros. (2) The value of the diversity index of phytoplankton ranges from 2.3 – 2..4 where its existence tends to be stable, while the value of the uniformity index ranges from 0.67 – 0.69 and tends to be stable. Therefore it can be stated that the diversity index is higher than the uniformity index, where this is caused by the fact the the research location has a diversity of each type of plankton. And (3) The condition of the water in the research location principally support the life of plankton. This waters condition causes the plankton to adapt itself for the balance of its life.

Acknowledgement

We thank to Ministry of Research and Technology and Higher Education for approving this advance applied research for university.

The Highlights

1. This research is to develop and implement the integration between the activities of aquaculture, capture, conservation, processing, and fishery agribusiness that taking place separately
2. The purpose of this study was to find out community structure, abundance, biodiversity of plankton, and environmental condition within integrated fishery activity in the waters of Bay Awerange
3. This research expected to become a reference in other places for integrated and sustainable of fishery activities subject that hopefully can be utilized by anyone who involved in the process of fishery planning and developing.

References

[1]. Baba AI, & Pandit AK (2014). Species Composition, Diversity and Population Dynamics of Phytoplankton at Saderkot in Wular Lake, Kashmir. *J Ecosys Ecograph* 4:142. https://doi.org/10.4172/2157-7625.1000142

[2]. Bahaar, S.W.N., & G.A. Bhat, (2011). Aquatic Biodiversity in The Paddy Fields of Kashmir Valley (J and K) India. *Asian J. Agric. Res*., 5: 269-276. https://doi.org/10.3923/ajar.2011.269.276

[3]. Boyd. C.E., & Frank Litchkopper, (1979). Water Quality Management In Pond Fish Culture. Research and Development Series No. 22 Project: AID/DSAN-G 0039. International Center For Agriculture, Agriculture Station, Auburn University, Alabama. p30

[4]. Cardoso S. J, Rolanda F, & Loverde S.M – Oliveira. (2014). Vera Lúcia de Moraes Huszar. Phytoplankton Abundance, Biomass, and Diversity Within and Between Pantanal wetland Habitats. *Limnologica* 42 (2012) 235– 241. https://doi.org/10.1016/j.limno.2012.01.002

[5]. Davis CC. (1955). The Marine and Fresh Water Plankton. Michigan State University Press, East Lansing. 562pp.

[6]. Dong, J., Zhou W., Song L., & Li G. (2015). Responses of Phytoplankton Functional Groups to Simulated Winter Warming. *Ann. Limnol. - Int. J. Lim.* 51 : 199-210. https://doi.org/10.1051/limn/2015014

[7]. Effendi H, Kawaroe M, Dea Fauzia, Lestari D. F, Mursalina, & Permadi T. (2016). Distribution of Phytoplankton Diversity and Abundance in Mahakam Delta, East Kalimantan. *Procedia Environmental Sciences* 33 (2016) 496 – 504. https://doi.org/10.1016/j.proenv.2016.03.102

[8]. Fachrul, M.F. (2007). Metode Sampling Bioekologi. Bumi Aksara, Jakarta. 199 hlm.

[9]. Fahrunnisa, H., Nurgayah, & Irawati N. (2017). Studi Kesuburan Perairan Berdasarkan Unsur Hara dan Klorofil-a di Perairan Pulau Saponda Laut Kecamatan Soropia, Kabupaten Konawe. *Sapa Laut*, Februari Vol. 2(1) : 15-23

[10]. Farhadian, O., & Pouladi, M. (2014). Seasonal Changes in The Abundance and Biomass of Zooplankton From Shallow Mudflat River-Estuarine System in Persian Gulf . Braz. *J. Aquat. Sci. Technol*. 18(2):19-29. https://doi.org/10.14210/bjast.v18n2.p19-29.

[11]. Fathi, A.A., M.A. Al-Fredan, & A.M. Youssef, (2009). Water Quality and Phytoplankton Communities in Lake Al-Asfar, Al-Hassa, Saudi Arabia. *J. Environ. Sci*., 3: 504-513. https://doi.org/10.3923/rjes.2009.504.513

[12]. Femy M. Sahami, Alfi S., R. Baruadi, & Sri N. Hamzah (2017). Phytoplankton Abundance as a Preliminary Study on Pearl Oyster Potential Culture Development in the North Gorontalo Water, Indonesia. *AACL Bioflux*, 2017, Volume 10, Issue 6. http://www.bioflux.com.ro/docs/2017.1506-1513.pdf

[13]. Fulton RS (1984). Distribution and Community Structure of Estuarine Copepods. *Estu* 7: 38-50. https://link.springer.com/article/10.2307/1351955

[14]. Hutabarat, S., & Evans, S. (2000). Pengantar Oseanografi. Universitas Indonesia Press : Jakarta. ix + 159 hlm.

[15]. Isnansetyo, & Kurniastuty. (1995). Teknik Kultur Phytoplankton dan Zooplankton. Kanisius, Yogyakarta. 116 hlm

[16]. Luyiga, S., & Kiwanuka S. (2003). Plankton Composition, Distribution and Significance in a Tropical Integrated Pilot Constructed Treatment Wetland in Uganda. *Water Sci Technol* ; 48(5):241-8. https://www.ncbi.nlm.nih.gov/pubmed/14621170

[17]. Manickam N, Bhavan P. S, & Santhanam P. (2017). Evaluation of Nutritional Profiles of Wild Mixed Zooplankton in Sulur and Ukkadam Lakes of Coimbatore, South India. *Turkish Journal of Fisheries and Aquatic Sciences* 17: 509-517. https://doi.org/10.4194/1303-2712-v17_3_07

[18]. Mason, C. F. (1991). Biology of Freshwater Polution. 2nd edition. Longman Scientific and Technical. New York. 351pp.

[19]. Michael P. (1995). Ecological Methods for Field and Laboratory Investigations. Translated by . Yanti R. Koestoer. UI-Press, Jakarta. 616pp.

[20]. Mishra S., & Panigrahy RC (1996). Copepods of Bahuda Estuary (Orissa), East Coast of India. *Indian J Mar Sci* 19: 120-124. http://nopr.niscair.res.in/handle/123456789/37097

[21]. Nassar M. Z, Mohamed H. R, Khiray H. M, & Rashedy S. H. (2014). Seasonal Fluctuations of Phytoplankton Community and Physico-chemical Parameters of The North Western Part of the Red Sea Egypt. *Egyptian Journal of Aquatic Research* (2014) 40, 395–403 https://doi.org/10.1016/j.ejar.2014.11.002

[22]. Niartiningsih A. (1996). Study of the Community in the Rainy and Dry Season in East Sinjai People's Mangrove Forest, East Sinjai Sub-district, Sinjai District (Thesis). Hasanuddin University, Makassar, Indonesia.

[23]. Nowrouzi, S., & H. Valavi, (2011). Effects of Environmental Factors on Phytoplankton Abundance and Diversity in Kaftar Lake. *J. Fish. Aquat. Sci*., 6: 130-140. https://doi.org/ 10.3923/jfas.2011.130.140

[24]. Odum EP. (1971). Fundamental of Ecology. 3rd edition. W.B Saunders Co. Philadelphia. 574pp

[25]. Pello F. S., E. M. Adiwilaga, N. V. Huliselan, & A. Damar. (2014). Seasonal Variation of the Composition and Density of Phytoplankton in Inner Ambon Bay. *Aquatic Science and Technology* . ISSN 2168-9148. 2014, Vol. 2, No. 1. https://doi.org/10.5296/ast.v2i1.4808

[26]. Periyanayagi, R., V. Sasikala, R. Venkatesan, R. Karthikayen, & T. Balasubramanian, (2007). Phytoplankton in Relation to Pollution in Uppanar Estuary Southeast Coast of India. Res. *J. Environ. Toxicol*., 1: 153-157. https://doi.org/ 10.3923/rjet.2007.153.157

[27]. Prescott, G. W. (1970). How to Know Freshwater Algae. Dubuque. Lowa. WM. C.Brown Company Publishers. 348pp.

[28]. Rajkumar M, Santhanam P, & Perumal P (2004). Laboratory Culture of Calanoid Copepod, Acartia Clause Giesbrecht. *Appl Fish Aqua* 4: 5-8.

[29]. Ramakrishna, S. (2014). Seasonal Abundance in Relation to Physicochemical Feature in Yelahanka Lake, Bangalore, India. *Global J. Res. Anal*., 3, p218-219.

[30]. Romimohtarto K. (1999). Biologi Laut, Ilmu Pengetahuan Tentang Biota Laut. Pusat Penelitian dan Pengembangan Oseanologi-LIPI Jakarta. 527 hlm

[31]. Sachlan, M. (1982). Planktonologi. Fakultas Peternakan dan Perikanan Universitas Diponegoro. Semarang. 117 hlm

[32]. Sankar R. Siva, & G. Padmavati, (2012). Species Composition, Abundance and Distribution of Phytoplankton in the Harbour Areas and Coastal Waters of Port Blair, South Andaman. *International Journal of Oceanography and Marine Ecological System*, 1: 76-83. https://scialert.net/abstract/?doi=ijomes.2012.76.83

[33]. Setiabudi, G. I., Bengen, D. G., Effendi, H., & Radjasa, O. K. (2016). The Community Structure of Phytoplankton in Seagrass Ecosystem and its Relationship with Environmental Characterstics. *Biosaintifika: Journal of Biology & Biology Education*, 8(3), 257-269. https://doi.org/10.15294/biosaintifika.v8i3.6549

[34]. Thirunavukkarasu K, Soundarapandian P, Varadharajan D, & Gunalan B (2013). Zooplankton Composition and Community Structure of Kottakudi and Nari Backwaters, South East of Tamil Nadu. *J Environ Anal Toxicol* 4: 200. DOI: https://doi.org/10.4172/2161-0525.1000200

[35]. Watanabe T, Kitajima C, & Fujita S (1983). Nutritional Values of Live Organisms Used in Japan for Mass Propagation of Fish-A Review. *Aquacul* 34: 115-143. https://doi.org/10.1016/0044-8486(83)90296-X

[36]. Weitzel, R. L. (1979). Methods and Measuremants of Perifiton Communities: A Review of the American Society for Testing and Materials. Philadelphia.183pp

[37]. Wulandari, D. (2009). Keterikatan Antara Kelimpahan Fitoplankton Dengan Parameter Fisika Kimia Di Estuaria Sungai Brantas (Porong) Jawa Timur. Departemen Manajemen Sumberdaya Perairan. Fakultas Perikanan dan Ilmu Kelautan, IPB-Indonesia. http://repository.ipb.ac.id/handle/123456789/11992

Andi Adam Malik. " The Type and Biodiversity of Plankton in an Integrated Fishery Activity in Waters of the Bay Awerange." IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB) 5.5 (2019): 23-30.