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International Journal of Environmental & Agriculture Research (IJOEAR) ISSN:[2454-1850] [Vol-5, Issue-12, December- 2019]

Abundance Plankton and Analysis Stomach Content and Trophic Level in Makassar Strait at East Season

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1 ***Abstract***— *The research aims to know the condition of environmental parameters both from biological factors and physical factors of the Makassar Strait during the East season. The usability of the research ie can be to build and simulate dynamic models of fisheries systems. Data Collection has been carried since May 2019 to November 2019. Data collection on environmental parameters (temperature, salinity, pH, dissolved oxygen, flow velocity) and nutrients (nitrates and phosphates), phytoplankton and zooplankton abundance, , and gastric contents analysis were carried out, Method for analysing was used analysis of variance (ANOVA) to compare environmental parameters, nutrients and abundance of plankton between the three districts observed. The relationship between the abundance of plankton with environmental parameters was analyzed by using multiple linear regression analysis. Determination of trophic level is based on analysis of gastric contents using the TrophLab 2K program. Results of analysis of variance (ANOVA) between observation stations grouped in 6 months of observation showed that salinity was significantly different between locations and months of observation, temperature and pH were significantly different between months but did not differ according to location of observation, whereas DO levels did not show differences either between locations. The results of identification of phytoplankton types obtained during this research were dominated by diatoms. The type of zooplankton obtained is generally dominated by copepods. The result of gastric surgery is 10 dominant and economically valuable fish's species belonging to planktivor, omnivor and carnivor fish, and based on ecosystems including pelagic and demersal fish.*

Keywords— Abundance Plankton, phitoplankton, zooplankton, gastric contents, Makassar Strait.

I. INTRODUCTION

1.1 Background

Geographically and ecologically, the Makassar Strait is a waters where is located between two seas (the sea of Sulawesi and Jawa) and flanked by two lands (Kalimantan and Sulawesi). Moreover, Makassar Strait have abundant natural resources such as mining minerals that has an impact on progress in the economic, mining and transportation sectors for Indonesia and local governments (Kunarso, 2011).

The Makassar Strait with its strategic location is one of a regional area which has quite high diversity of water resources (Susetiono, 2013), therefore it becomes the target of foreign fishermen to catch underwater biodiversity around the location. Accordingly, the potential of the natural wealth possessed by the Makassar Strait must continue to be pursued to be beneficial for life. An expedition or research is a way that can be done to realize these goals.

Information derived from environmental factors from physical factors as well as biological factors is something that is beneficial to the life of organisms in waters and fisheries activities. Deputy of Earth Sciences LIPI, Dr. Iskandar Zulkarnain revealed that the sea waters throughout the year are crossed by a mass of sea water from the Pacific Ocean to the Indian Ocean, part of the global ocean current circulation. This ocean current is an important element for determining the nutrient cycle and the food chain in the sea globally is also influenced by the mass of cold, nutrient-rich sea water, and raised to the surface together with the upwelling process (increasing of sea water mass). Keulartz and Zwart (2004) stated that environmental degradation in the waters of the Makassar Strait led to an erosion process that resulted in sedimentation along the Mahakam watershed and finally an accumulation of sediment in the estuary and coastal areas of the Mahakam delta coast, East Kalimantan. Based on the case of the phenomenon described above, the researchers tried to conduct a research related to the fertility of the Makassar Strait, both in terms of the aquatic environment and in terms of the organisms that live in the vicinity.

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II. RESEARCH METHODS

This research has been conducted from May to October 2019. Data collection on environmental parameters was executed in the coastal waters of Pinrang, Barru and Bantaeng Districts; Measurements of environmental parameters (temperature, salinity, pH, DO and current velocity) were measured by insitu.

Measurement of nutrient concentration (nitrates and phosphates) is done by taking water samples and then analyzed in a laboratory using a spectrophotometer. At the same time, measurement of in-situ environmental parameters and nutrient sampling were collected by taking plankton abundance data using layered plankton net by filtering as much as 100 liters of water. Samples of plankton were preserved by using 4% lugol of solvent (APHA, 1989). The measurement of environmental parameters, nutrients and plankton was conducted at 3 stations in 3 districts (Pinrang, Barru and Bantaeng), therefore there are 9 stations of total observations with frequency of observations every month for 6 months (May until October).

Observation of gastric contents was accomplished by dissecting the contents of the stomach and recording food items on 10 types of dominant fish caught from 11 districts with a frequency every month (Pauly, 1998). Fish species are classified as planktivor, omnivore, carnivore and high level carnivore, and demersaL fish.

Method for analysing was used analysis of variance (ANOVA) to compare environmental parameters, nutrients and abundance of plankton between the three districts/locations observed (Zar, 1984). The relationship between the abundance of plankton with environmental parameters was analyzed by using multiple linear regression analysis (Kleinbaum, 2010) . Determination of trophic level is based on analysis of gastric contents using the TrophLab 2K program (Pauly, 1998).

III. RESULT AND DISCUSSION

3.1 Environmental Parameters

Measurement of environmental parameters that has been conducted at 9 observation stations in 3 districts or locations (Pinrang, Barru and Bantaeng) every month from May to October 2019 revealed that the range value (minimum-maximum) of each measured environmental parameter namely; the temperature of surface water ranges between 30.0 - 33.0 °C, salinity (30.0 - 34.0 o/oo), pH (7.0 - 8.5) and dissolved oxygen levels (4.1 - 6.9 ppm). When compared with the results of measurements in 2018, there is a difference of increasing of temperature and salinity values, especially in September and October.

1 Results of analysis of variance (ANOVA) between observation stations grouped in 6 months of observation showed that salinity was significantly different between locations and months of observation, temperature and pH were significantly different between months but did not differ according to location of observation, whereas DO levels did not show differences either between locations

The results of the mean difference in environmental parameters between locations and months of observation are summarized in Table 1.

TABLE 1
THE RESULT OF THE AVERAGE TEST DIFFERS IN ENVIRONMENTAL PARAMETERS IN EACH LOCATION FOR 6 MONTHS OF OBSERVATION

Environmental Parameter	Location		
	Pinrang	Barru	Bantaeng
Temperature (°C)	31.58 ± 0.75^a	31.42 ± 0.75^a	31.19 ± 0.52^a
Salinity (o/oo)	32.78 ± 1.10^a	31.61 ± 0.87^b	31.56 ± 0.73^b
pH	8.11 ± 0.50^a	8.14 ± 0.48^a	7.97 ± 0.50^a
DO level (ppm)	5.62 ± 0.65^a	5.53 ± 0.57^a	5.41 ± 0.73^a

Note: Different letters in the same line indicate differences in environmental parameters between observations based on the Tukey HSD test (α = 0.05)

Based on the time of observation, the results of the Tukey HSD test (Table 2) show that there is a tendency to increase in temperature and salinity from May to October. The average of temperature and salinity in May differ significantly lower than the average temperature in September and October. The highest average temperature in October was significantly different than the average temperature of the five months preceding it. The pattern of changes in salinity shows trends similar to

Temperature (°C)	31.58 ± 0.75 [a]	31.42 ± 0.75 [a]	31.19 ± 0.52 [a]
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International Journal of Environmental & Agriculture Research (IJOEAR) ISSN:[2454-1850] [Vol-5, Issue-12, December- 2019]

changes in temperature where the mean salinity is lower in May and June significantly different than the average salinity in September and October.

TABLE 2
AVERAGE AND DIFFERENCE TEST IN ENVIRONMENTAL PARAMETERS BETWEEN MONTHS FROM 3 OBSERVATION LOCATIONS.

Environmental Parameter	Month					
	May	June	July	August	September	October
Temperature (°C)	30.83 ± 0.43 [a]	30.89 ± 0.49 [ab]	31.39 ± 0.55 [ab]	31.39 ± 0.55 [ab]	31.56 ± 0.46 [b]	32.33 ± 0.50 [c]
Salinity (o/oo)	31.00 ± 0.56 [a]	31.39 ± 0.96 [ab]	31.89 ± 0.86 [abc]	32.22 ± 0.97 [bcd]	32.44 ± 1.01 [cd]	32.94 ± 0.81 [d]
pH	7.28 ± 0.36 [a]	8.22 ± 0.51 [b]	8.17 ± 0.35 [b]	8.28 ± 0.26 [b]	8.28 ± 0.26 [b]	8.22 ± 0.26 [b]
DO level (ppm)	5.30 ± 0.51 [a]	5.79 ± 0.68 [a]	5.20 ± 0.79 [a]	5.46 ± 0.68 [a]	5.79 ± 0.58 [a]	5.59 ± 0.50 [a]

Note: Different letters in the same rowmean it different environmental parameters between months of observation based on the Tukey HSD test (α = 0.05)

3.2 Plankton Abundance

The output of plankton counting at 3 locations and 6 months of observation. The results of identification of phytoplankton types obtained during this research were dominated by diatoms. Some types of diatoms that are abundant and have a high frequency of occurrence include *Bacteriastrum, Biddulphia, Chaetoceros, Coscinodiscus, Ditylum, Eucampia, Melosira, Navicula, Nitzschia, Rhizosolenia, Skeletonema, Thalassionema, Thalassiosira, and Thalassiothrix*. The total abundance of phytoplankton obtained ranged from 458 - 4443 cells/liter with a monthly average at 3 locations as shown in Figure 1.

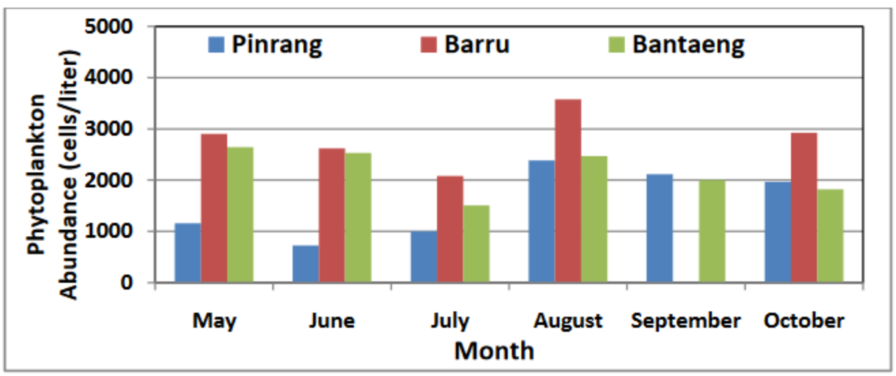

FIGURE 1. Average total abundance of phytoplankton at each location and month of observation

The type of zooplankton obtained is generally dominated by copepods. Some types of copepods that are often found in large quantities include Acartia, Oitona, Tartonus and nauplii and copepod's eggs. The total abundance of zooplankton gained ranged from 531 to 1157 individuals/liter with a monthly average at 3 locations as shown in Figure 2.

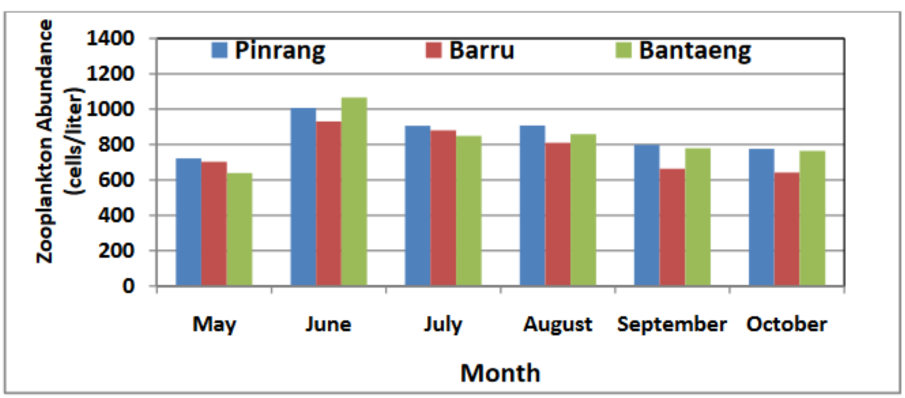

FIGURE 2. Average total abundance of zooplankton at each location and month of observation

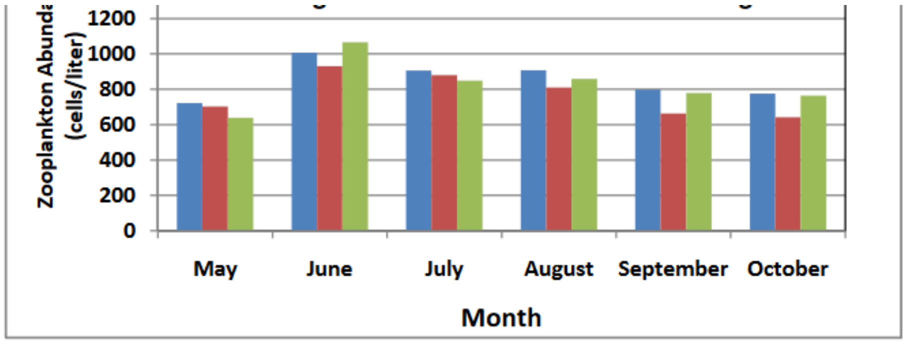

FIGURE 2. Average total abundance of zooplankton at each location and month of observation

International Journal of Environmental & Agriculture Research (IJOEAR) ISSN:[2454-1850] [Vol-5, Issue-12, December- 2019]

The results of analysis of variance (ANOVA) for total abundance of phytoplankton and zooplankton revealed that phytoplankton abundance was significantly different based on location and month of observation according to F test in ANOVA table ($p<0.05$), while total abundance of zooplankton only differed by month of observation but did not differ according to location observation. Mean different test results using Tukey HSD total abundance of phytoplankton and total abundance of zooplankton based on location and month of observation are summarized in Tables 3 and 4.

The average abundance of phytoplankton in Pinrang (1557 ± 729) and Bantaeng (2161 ± 819) cells/liter differed significantly lower than in Barru (2864 ± 930) cells/liter. The average abundance of zooplankton did not indicate differences between the three observation sites.

TABLE 3
AVERAGE AND DIFFERENCE TEST OF PLANKTON AND CHLOROPHYLL-A ABUNDANCE BETWEEN LOCATIONS FOR 6 MONTHS OF OBSERVATION

The Abundance of Plankton	Location		
	Pinrang	Barru	Bantaeng
Abundance of Phytoplankton	1557 ± 729^{a}	2864 ± 930^{b}	2161 ± 819^{a}
Abundance of Zooplankton	852 ± 150^{a}	771 ± 167^{a}	825 ± 144^{a}

Based on the month of observation, it is seen that the average abundance of phytoplankton in August (2810 cells/liter) was significantly different compared to July (1528 cells/liter). The average abundance of zooplankton in June (1001 individuals/liter) was significantly different than the average abundance of zooplankton in May (687 individuals/liter). The difference in average abundance of plankton is caused by changes in nutrient and zooplankton predation to phytoplankton.

TABLE 4
AVERAGE AND DIFFERENCE TEST OF PLANKTON ABUNDANCE AND CHLOROPHYLL-A BETWEEN MONTHS FROM 3 OBSERVATION STATIONS

The Abundance of Plankton	Month					
	May	June	July	August	September	October
Abundance of Phytoplankton	2233 ± 1006^{ab}	1958 ± 1334^{ab}	1528 ± 773^{a}	2810 ± 957^{b}	2399 ± 699^{ab}	2237 ± 698^{ab}
Abundance of Zooplankton	687 ± 91^{a}	1001 ± 149^{c}	878 ± 105^{bc}	859 ± 125^{bc}	746 ± 105^{ab}	727 ± 111^{ab}

Note: Different letters in the same line indicate differences in plankton abundance between months of observation based on the Tukey HSD test (α = 0.05)

3.3 Stomach Content and Trophic Level

The result of gastric surgery is 10 dominant and economically valuable species belonging to planktivor, omnivor and carnivor fish, and based on ecosystems including pelagic and demersal fish. The result of identification for gastric contents is shown in Table 5.

TABLE 5
FOOD ITEMS OF SEVERAL TYPES OF FISH THAT ARE PREDOMINANTLY OBTAINED AND OF IMPORTANT ECONOMIC VALUE

No	Fiashes Species	Food Items
1	*Stolephorus commersoni*	Phytoplankton, zooplankton
2	*Sardinella fimbriata*	Phytoplankton, zooplankton
3	*Leiognathus* sp	Phytoplankton, zooplankton
4	*Decapterus ruselii*	Phytoplankton, zooplankton, zooplankton, crustaceans, small shrimp, fish larvae
5	*Rastrelliger kanaguarta*	Phytoplankton, zooplankton, crustaceans, small shrimp, fish larvae
6	*Selaroides crumenopthalmus*	Zooplankton, crustaceans, small shrimp, fish larvae, cephalopods and nekton, and worms
7	*Katsuwonus pelamis*	Zooplankton, nekton, molluscs, cephalopods, fish, shrimp and squid
8	*Epinephelus coioides*	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid, small fish and crabs
9	Lutjanus campechanus	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid, small fish and crabs
10	*Caranx ignobilis*	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid and small fish

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International Journal of Environmental & Agriculture Research (IJOEAR) ISSN:[2454-1850] [Vol-5, Issue-12, December- 2019]

TABLE 6
RANGE AND AVERAGE TROPHIC LEVEL OF 10 FISHES SPECIES THAT ARE PREDOMINANTLY OBTAINED AND HAVE IMPORTANT ECONOMIC VALUE

No	Fishes Species	Trophic Level		
		Minimum	Maximum	Mean
1	*Stolephorus commersoni*	2.29 ± 0.00	3.35 ± 0.46	3.07 ± 0.52
2	*Sardinella fimbriata*	2.53 ± 0.00	3.62 ± 0.50	3.29 ± 0.67
3	*Leiognathus sp*	2.64 ± 0.00	3.68 ± 0.53	3.42 ± 0.42
4	*Decapterus ruselii*	2.86 ± 0.30	4.08 ± 0.67	3.95 ± 0.64
5	*Rastrelliger kanaguarta*	2.96 ± 0.34	4.04 ± 0.70	3.87 ± 0.60
6	*Selaroides crumenopthalmus*	3.40 ± 0.54	4.40 ± 0.87	4.17 ± 0.96
7	*Katsuwonus pelamis*	3.80 ± 0.67	4.61 ± 0.94	4.25 ± 0.89
8	*Epinephelus coioides*	3.93 ± 0.67	4.50 ± 1.10	4.35 ± 0.94
9	*Lutjanus campechanus*	4.03 ± 0.77	4.50 ± 0.97	4.45 ± 0.90
10	*Caranx ignobilis*	4.00 ± 0.64	4.40 ± 0.97	4.25 ± 0.88

The abundance of plankton in waters tends to affect changes in food items for planktivorous fishes. This is related to the nature of planktivorous fishes that eats plankton by filtering it, consequently the candlenut in the intestines of planktivorous fishes with the type of plankton in waters very high correlated. In contrast, omnivorepou fishes more adjust the availability of food items. If the availability of the main food is limited, then it tends to choose other more abundant food items.

Carnivorous fishes have transformations of trophic level according to change and food availability besides competition factors as stated by Binder T.R. et. al, (2011), that one of the causes of migration from fish is due to food.. Based on food items, pelagic carnivorous fishes tend to have gastric contents according to their availability and abundance on the water surface. Carnivorous fishes that live in the bottom show that the contents of the stomach contain many types of fishes and shrimps that live in the benthic system. This evidences that carnivorous fishes use habitat both in the pelagic and demesal areas to find their food.

IV. CONCLUSION

Some conclusions that can be drawn from the results of this research include:

- There are dynamics of environmental parameters that affect plankton productivity and fish growth in the sea.
- Different catch rates for fish at different trophic levels affect population dynamics and the sustainability of fishes resources in the Makassar Strait.
- Planktivorous fishes play an important role in the fishes food chain in the pelagic system. If the population of planktivorous fishes is caught too much, the population of omnivorous and up carnivorous will decrease.

SUGGESTION

To get parameters of environmental dynamics trends, plankton abundance, determination of trophic level structures in the Makassar Strait it is necessary to do the same research for the West Season.

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