Food habits of greenback mullet *Liza subviridis* at Lampon Estuary, Banyuwangi, East Java

N S Langsa¹, L Sulmartiwi²,³ and L Lutfiyah³

¹ Program Study of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Kampus C Jalan Mulyorejo, Surabaya 60115 Jawa Timur, Indonesia.
² Faculty of Fisheries and Marine, Universitas Airlangga, Campus C 60115, Surabaya, East Java, Indonesia.
³ Faculty of Fisheries and Marine, Universitas Airlangga Campus Banyuwangi, Wijaya Kusuma 113, 68423, Banyuwangi, East Java, Indonesia.

Corresponding author: laksmi-s@fpk.unair.ac.id

Abstract. The mullet is a fish that dominates the Lampon Estuary. These waters contain Pb and Hg that exceed the threshold. This study aims to look at the mullet food habits, water quality, and the relationship between water quality and mullet food habits. This research was conducted for three months, from November 2019 to January 2020 at Estuary Lampon, Pesanggrahan, Banyuwangi, East Java. This research used a survey method (non-experimental) and observation method. The number of fish samples was 171 fish. Based on the analysis, the composition of mullet fish feed consists of Diatoms, Flagellates, Chlorophyceae, Bacillariophyta, Xanthophyta, and Dinoflagellates. The composition of plankton as food in polluted waters obtained a different type of plankton from normal waters. Based on the index value of food choices, the most popular food is Diatoms and can be categorized as herbivorous fish.

1. Introduction

Lampon is one of the river and beach estuaries located in Pesanggrahan District, Banyuwangi Regency, East Java. The Lampon Estuary faces the Indian Ocean and has a geographical location: 8° 37' 05.39" S 144° 05' 11.46" E. Rainfall: 1,000 - 2,500 mm / year [1]. Along the Lampon River, there are many activities such as gold mining, ponds, fishing from fishing or fishing using ships, as well as a fairly dense residential area. The situation has great potential to produce various wastes and pollute the surrounding environment. These various waste sources are the main sources of heavy metal pollution [2].

Estuary Lampon is recorded to have heavy metal content of lead (Pb) and mercury (Hg), which exceeds the threshold standard of aquaculture water quality according to Government Regulation No. 82 of 2001. Due to the many activities around the waters of Lampon, which are the main sources of heavy metal pollution. The results of the analysis of lead content (Pb) were 0.019 ppm [3] and mercury (Hg) of 38.01 ppm [4].

Heavy metals that exceed this threshold result in changes in environmental conditions that trigger biological aspects of biota. One component of the environment is food. Food is an ecological factor that plays an important role in determining the level of population density, population dynamics, growth, reproduction, and condition of fish [5]. Biological aspects of the habit of eating mullets in Estuary Lampon need to be known because it is related to the growth and development of mullets.
This study of eating habits can provide an overview of the species of mullets in the Lampon Estuary ecosystem and the allocation of natural food resources that are there. These waters are active in fishing. One of the catches in the Lampon Estuary is mullet (Liza subviridis). Quite a lot of mullet populations are found in the Banyuwangi Pesanggrahan Lampon Estuary. The total production of sub-sector capture fisheries in the Banyuwangi Regency in 2017 was 473 tons. The development of mullet fish production from catches in Banyuwangi reached the largest yield in 2013, amounting to 1,388 tons [6].

Utilization and catching mullet fish is now a lot, but studies on the biological aspects of mullet have not been done in Indonesia. Therefore, it is necessary to study the food habits of mullets as one of the biological aspects of mullets, the quality of water exposed to heavy metals, and the relationship between water quality and food habits of mullets in the Lampon Estuary.

2. Material and methods
This study was conducted in the Lampon Estuary, Banyuwangi, East Java, and in Anatomy Laboratory of PSDKU Universitas Airlangga.

2.1. Fish sampling
A sampling of fish is obtained from the catch of local fishermen using throwing nets. The fish collection is done in 3 months as much as 3 times of taking. The retrieval time is by the fishing time carried out by the fisherman. An intake of fish is done using a simple random sampling technique. According to Sugiyono [7], simple random sampling is a way of taking samples where each unit in the population has the same opportunity to be chosen as a sample member. Fish samples used in this study were caught mulls at 3 stations with sizes over 10 cm. As already mentioned by Collins [8], mullet samples used to be measured i.e., at the young to adult level with a body size of 10-40 cm.

2.2. Plankton sampling
Plankton sampling in the field is done by the pouring method, by taking water with a volume of approximately 30 liters of water at each observation station, then the water is filtered using a plankton net that has a size of 30µm [9]. Plankton samples are placed in dark sample bottles, after which the samples are put into a cool box and given ice, then taken to the Anatomy Laboratory of PSDKU Universitas Airlangga in Banyuwangi for observation.

2.3. Water sampling
According to Damaianto and Masduqi [10], water samples were taken from 30 - 50 meters depth, because at this depth, it is considered sufficient to represent the vertical homogeneity of pollutant dispersions and avoid surface effects. The water taken is placed in a dark sample bottle that has been washed clean and is confirmed to be in good condition and does not leak. The amount of water taken for the analysis of heavy metals is 250 ml. Then it is stored in a cool box for heavy metal analysis in the laboratory.

2.4. Sediment sampling
Sediments were taken 500 grams using polyethylene pipes on the surface of the sediments (10-15 cm) [11]. Then the sediment is put into a dark sample bottle using a funnel and stored in a cool box that has been filled with ice gel at 4°C for heavy metal content analysis in the laboratory.

2.5. Data analysis
The data obtained in the form of quantitative data and qualitative data from observational variables. The variables, namely; fish weight, fish length, calculation of type and amount of food, calculation of plankton in waters, and determination of food selection index. Data calculation of the type and amount of food, calculation of plankton in the waters, and determination of the index of food choices obtained followed by an analysis. Then explained descriptively to determine the food habits of mullet fish and
whether the presence of heavy metals influences the eating habits of mullet fish in the Lampon Estuary. Analysis of the heavy metal content in water and sediments is also correlated with the food habits of mullets and then compared with water quality standards and sediments suitable for fisheries activities.

3. Result and discussion

3.1. Results
Mullet fish caught from November 2019 to January 2020 are listed in Table 1. The results of determining the food choice index are presented in Table 2, data on the results of heavy metal testing are presented in Tables 3 and 4, and water quality data are presented in Table 5.

Table 1. Composition of mullet fish catch during the research at Lampon Estuary

| Month      | N male | N female | Total |
|------------|--------|----------|-------|
| November   | 16     | 30       | 46    |
| December   | 16     | 37       | 53    |
| January    | 23     | 49       | 72    |
| Total      | 55     | 116      | 171   |

Table 2. Results of calculation of mullet food choice index.

| Type of Food       | November | December | January |
|--------------------|----------|----------|---------|
|                    | St 1     | St 2     | St 3    | St 1     | St 2     | St 3    |
| Diatoms            |          |          |         |          |          |         |
| Thalassiosira sp.  | 0.04     | 0.15     | 0.09    | 0.04     | 0.54     | 0.74    | -       | -       | -       |
| Licmophora sp.     | -0.56    | 0.18     | 0.65    | 0.01     | 0.32     | 0.28    | -0.3    | 0.46    | -0.56   |
| Navicula sp.       | -        | -        | -       | 0.29     | 0.49     | -0.37   | 0.48    | -0.06   | 0.07    |
| Pinnularia sp.     | -        | -        | -       | 0.23     | -0.44    | 0.16    | -0.86   | -0.47   | -0.38   |
| Nitzchia palea     | -        | -        | -       | 0.13     | 0.23     | -0.52   | -       | -       | -       |
| Coscinodiscus sp.  | -        | -        | -       | 0.25     | 0.83     | 0.56    | 0.67    | 0.21    | 0.51    |
| Cocconeis sp.      | -        | -        | -       | 0.22     | 0.55     | -0.52   | -       | -       | -       |
| Melosira nummuloides| -       | -        | -       | -        | -        | 0.48    | 0.66    | 0.07    |         |
| Flagellates        |          |          |         |          |          |         |         |         |         |
| Rhodomonas sp.     | 0.09     | -0.3     | -0.6    | -        | -        | -       | -       | -       |         |
| Chlorophyceae      |          |          |         |          |          |         |         |         |         |
| Sphaerocystis schroeteri | 0.06 | -0.72   | -0.61   | -        | -        | -       | -       | -       |         |
| Bacillariophyta    |          |          |         |          |          |         |         |         |         |
| Triceretarium impressum | 0.25 | -0.6    | 0.49    | -        | -        | -       | -       | -       |         |
| Xanthophyta        |          |          |         |          |          |         |         |         |         |
| Tribonema sp.      | -        | -        | -       | -0.58    | -0.81    | -0.44   | -       | -       | -       |
| Dinoflagellates    |          |          |         |          |          |         |         |         |         |
| Scrippsiella sp.   | -        | -        | -       | 0.47     | 0.8      | 0.67    | -0.21   | 0.43    | 0.26    |

Information:
0 < E < 1: favored feed
-1 < E < 0: feed is not popular
E = 0: there is no fish selection of food
(1): not found
The food choice index is a formula used to determine food choices in the fish's stomach [12]. The results of the study can be seen in each index value of food choices from each food mullet fish in the Lampon Estuary (Table 3). When compared with previous studies, there are similarities in the main food of the mullet fish because basically, these fish are herbivorous fish species that consume a lot of Diatoms, in the Lampon Estuary also shows the results that the Diatom group is a food that dominates the fish's stomach. Diatoms have a role as a food resource for mullets in the Lampon Estuary. This is supported by McDonough [13] research, which states that Diatoms found in estuaries are important food resources for many species of herbivorous fish.

Favored or non-favored feeds may be related to their abundant availability in the waters. The index value of food choices can increase with increasing fish size, presumably caused by the ability to move in the search for food and increased food needs [14].

All Hg concentrations every month exceed the threshold, as well as Pb only in certain months, and stations do not exceed the threshold. Maximum mercury levels for fisheries activities, according to Government Regulation No. 82 of 2001, is less than 0.002 ppm. In contrast, the maximum level of lead concentration for fishery activities is 0.03 ppm.

Results in polluted Lampon waters obtained various types of plankton from normal waters, the results of Indrawan research [15] in normal waters most of the phytoplankton from the diatom class, namely, Leptocylindrus danicus, Chaetoceros sp., and Nitzschia seriata, whereas in Lampon, the highest yield is dominated by Thalassiosira sp., Nitzchia palea, and Pinnularia sp., the plankton group is a microalga that is abundant in water because of its ability to survive even in extreme conditions [16]. This can be interpreted, mullets that are there consume the type of feed because of the availability of natural foods that are indeed there. Heavy metals that are dissolved in water bodies at certain concentrations will change their function to be a source of poison for aquatic life. Furthermore, this situation can certainly destroy the parasitic exocytic sequence.

The composition and abundance of phytoplankton in water are very dependent on the availability of nutrients [17]. Besides, the light intensity, temperature, brightness, pH, and dissolved gases also affect the presence of phytoplankton [18]. Phytoplankton abundance is closely related to changes in water quality where waters with poor water quality tend to live in phytoplankton classes that are tolerant of these conditions [19]. Salinity is a limiting factor for phytoplankton that live in coastal waters.
because they live through adaptation to osmotic pressure caused by salinity. Changes in salinity will significantly influence the rate of phytoplankton growth [20]. The increasing abundance of phytoplankton due to the supply of nutrients from the land causes the color of the waters to become turbid. So that the brightness of these waters will decrease. This will also affect the presence of dissolved oxygen in the waters. Furthermore, higher temperatures cause a decrease in dissolved oxygen levels in the waters [21, 22]. The availability of DO in waters strongly supports the growth of phytoplankton.

4. Conclusion
Based on the research that has been done, it can be concluded that the food habits of mullet (*L. subviridis*) at each station in the Lampon Estuary are herbivorous fish that eat Diatoms, Flagellates, Chlorophyceae, Bacillariophyta, Xanthophyta, and Dinoflagellates. In general, the most popular food of mullet fish in the Lampon Estuary is diatoms. It is seen from the value of the index of food choices 0 < E < 1 (favored feed). This is by the catch of mullet fish, which on average, is an adult fish where the mullet fish does consume diatoms and algae.

5. References
[1] Susintowati and Hadisusanto S 2015 *Kne Life Sciences/International Conference on Biological Sciences (ICBS-2013)* pp 451-457.
[2] Schwarzenbach R P, Escher B I, Fenner K, Hofstetter T B, Johnson C A, von Gunten U, and Wehrli B 2006 *Sci. 313*(5790), 1072-1077.
[3] Setyaningrum E W, Dewi A T K, Yuniartik M, and Dewi E 2018 *Prosiding Seminar Nasional Kelautan dan Perikanan IV* pp 144-153 [in Indonesian].
[4] Siahaan B C, Utami S R, and Handayanto E 2014 *JTSI.* 1(2), 38-48 [in Indonesian].
[5] Nikolsky G V 1963 *The Ecology of Fishes* (New York: Academic Press) p 352.
[6] Dinas Perikanan dan Pangan Kabupaten Banyuwangi 2017 *Laporan Tahunan Tahun 2017.* (Banyuwangi: Dinas Perikanan dan Pangan) [in Indonesian].
[7] Sugiyono 2009 *Statistika untuk Penelitian* (Bandung: Alfabeta) [in Indonesian].
[8] Collins M R 1985 *Biological Report 82*, 2-4.
[9] Fachrul M F 2007 *Metode Sampling Bioekologi* (Jakarta: Bumi Aksara) [in Indonesian].
[10] Damaianto B B and Masduqi A A 2014 *Jurnal Teknik ITS.* 3(1), D1-D4 [in Indonesian].
[11] Welda A 2018 *Kajian Kandungan Logam Beralat Timbal (Pb), Kadmium (Cd), Tembaga (Cu), Kromium (Cr) dan Mangan (Mn) pada Ikan Kurisi (Nemipterus japonicus) di Perairan Teluk Lampung secara Spektrofotometri Serapan Atom* (Digital Repository Unila : Kota Bandar Lampung) [in Indonesian].
[12] Titrawani T, Elvyra R, and Sawalia R U 2013 *Jurnal Biologi* 6(2), 85-90 [in Indonesian].
[13] McDonough C, Roumillat W A, and Wenner C A 2005 *Fish Bull.* 103, 601–619.
[14] Rahardjo M F, Brojo M, Simanjuntak C P H, and Zahid A 2006 *Jurnal Perikanan* 8(2), 247-253 [in Indonesian].
[15] Indrawan E D 2016 *Studi Kebiasaan Makanan Ikan Belanak (Mugil Dussumieri) Pada Bulan Penangkapan Yang Berbeda Di Perairan Gresik, Jawa Timur* (Surabaya: Universitas Airlangga) [in Indonesian].
[16] Abida I W 2010 *Jurnal Kelautan* 3(1), 36-40 [in Indonesian].
[17] Radiarta I N 2013 *Jurnal Bumi Lestari* 13(2), 234-243 [in Indonesian].
[18] Wijaya H K 2009 *Komunitas Perifiton dan Fitoplankton serta Parameter Fisika-Kimia Perairan sebagai Penentu Kualitas Air di Bagian Hulu Sungai Cisadane, Jawa Barat* (Bogor: Institut Pertanian Bogor) [in Indonesian].
[19] Rashidy E A, Litaay M, Salam M A, and Umar M R 2013 *Jurnal Alam dan Lingkungan* 4(7), 12-16 [in Indonesian].
[20] Ganguly D, Robin R S, Vardhan K V, Muduli P R, Abhilash K R, Patra S, and Subramanian B R 2013 *J. Exp. Mar. Biol. Ecol.* 440, 244-249.
[21] Irawan A, Hasani Q, and Yulianto H 2015 *JPPPT.* 15(1), 48-53 [in Indonesian].
[22] Astuti R P, Imanto P T, and Sumiarsa G S 2012 *JITKT.* 4(1), 97-106 [in Indonesian].

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