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# ECOLOGICAL NICHE BASED ON FISH FOOD COMPETITION AND FEEDING HABIT PATTERNS IN THE JATIBARANG RESERVOIR

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**ABSTRACT**

The purpose of this study was to determine ecological niche, the types of fish caught using gillnet and fishhook, the abundance of plankton, feeding habits and food competition in Jatibarang reservoir. The research was conducted from July until October, 2020. Tilapia (*Oreachromis niloticus*), Milkfish (*Chanos chanos*), Grass Carp (*Ctenopharyngodon idella*), Java Barb (*Barbonymus gonionotus*), and Red Devil (*Amphilophus amarillo*) were several types of fish found in the Jatibarang Reservoir. The total abundance of plankton was 4220 ind /, with L.Chlorophyceae dominating with a value 1780 ind / L and Zooplankton with the lowest abundance value of 20 ind / L. The result of the dominant *Index of Preponderence* (IP) showed Chlorophyceae class as the staple food of Tilapia, Grass Carp and Java Barb with values of 49.86%, 45.16% and 52.34% respectively. Milk fish and Red Devil had no main food (IP < 40%). The others class of plankton (*Bacillariophyceae, Coscinodiscophyceae, Dinophyceae, Euglenoidea Cyanopyceae, Fragilariophyceae, and Zygnematophyceae*) appeared as complementary foods (IP value 4-40%) and as additional food (IP value lesser than 4%). Milkfish was also found to have the highest ecological niche value of 4.577 and the Red Devil with the lowest value. The result of the niche overlap indicated the strongest good competition occurred between Tilapia and Gras Carp with a yield value of 1, and the lowest overlap value was found between Milkfish and Red Devil.

**Keywords**: Food Competition, Feeding habit, Ecological Niche, Jatibarang Reservoir

## INTRODUCTION

In an ecosystem, there are ecological components that interact with each other to create an ecological balance. The interaction between ecological components include interactions between organisms, populations, and between communities. Interactions between populations include the competition toward natural resources which drive out certain organisms from certain habitat due to limited resources (Block and Brennan, 1993; Wotton and Emmerson, 2005). Territorial competition often occurs in aquatic ecosystems can where organisms are competing for a territory or place to live. Intraspecific competition generally occurs during the mating seasons, and competition for resources which can affect the structure of certain species population as well as life history of species (Shome, *et al*., 2016). Another competition is a food competition (Begon *et al*., 1996) where individuals fight for their survival in the populations (McNaughton and Wolf, 1992).

Food competition in an aquatic ecosystem can be observed through the feeding habits of the fish, whether they are herbivorous, carnivorous or omnivorous fish. Feeding habit refers to fish's behavior in consuming and searching for food. Feeding habit represents the quality and quantity of food eaten by fish. Accurate description of fish diet and feeding habits are the basis for understanding trophic interactions in aquatic food webs (Garvey *et al*. 1998). Fish feeding habit reflects the extent to which fish like natural foods available (Effendie, 1997). Fish feeding habits can show the ecological relationships between organisms in certain waters, such as predation, competition and the food chain.

The study of competition for fish food is very much relevant to be carried out in water ecosystems, especially at Jatibarang Reservoir (WJB) which has many functions as flood control, tourism attraction, sources for drinking water, and aquatic organism habitats for both endemic and restocking fish. According to Sujono and Anggoro (2018), Jatibarang Reservoir stores water during the dry season and it controls the flood during rainy season. The biodiversity in the site is quite high, making it interesting to study the ecological niche of the fish community in the reservoir as a basic information for fisheries resource management. The purpose of this study was to determine the types of fish caught using gillnet and fishhook, the abundance of plankton, feeding habits and food competition in Jatibarang reservoir. Food competition was included as a variable as it is the most basic interaction between populations to survive as individuals and as population.

## RESEARCH METHODS

### Material

Some tools were used, including fishing gear (fishing line and gill net) for catching fish, plankton net for filtering plankton, cool box for storing samples, sample bottles for sample containers, and section kits to dissect fish. The laboratory equipment included a microscope, Sedgwick rafters, and dropper pipettes. The materials were fish samples, water samples (plankton), distilled water to dilute the intestines of the fish, and 4% alcohol as a sample preservative

### Sampling Technique

Purposive sampling was performed to take water samples from several points which were considered to represent water conditions. The data of this study were obtained by dissecting fish samples and taking the intestines to be preserved in 4% formalin. The contents of the intestine were removed and diluted with distilled water to be identified using Sedgwick Rafter under a microscope. Check list method was employed to identify the plankton by matching the types of plankton found with the image in the identification book written by Edmonson (1959) entitled 'Fresh Water Biology'.

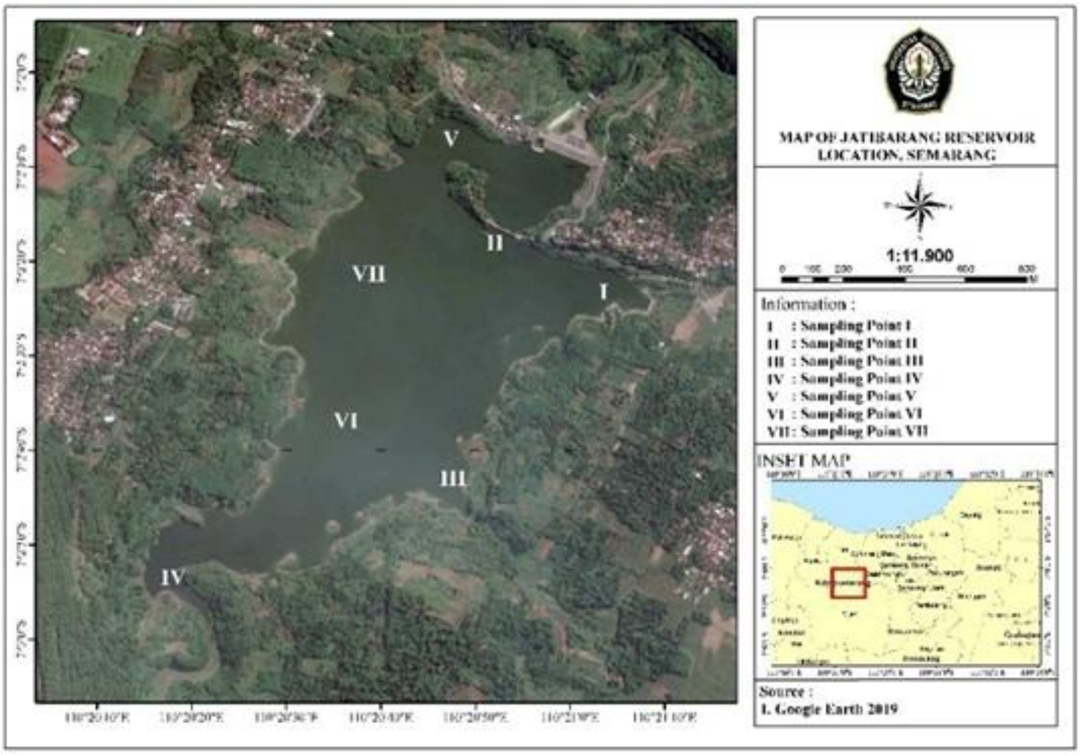


**Figure 1.** Sampling Points at Jatibarang Reservoir

### *Data Analysis*

a. Analysis of plankton abundance

Types of plankton were identified using check list method based on plankton identification book by Edmonson (1959) entitled Fresh Water Biology. The abundance of plankton was measured using the Sedgwick Rafter according to the APHA (2005) and Ikhsan *et al*., (2020).

$$N = n \; x \; \frac{A_{cg}}{A_a} \; x \; \frac{V_t}{V_s} \; x \; \frac{1}{A_s} \qquad \text{.......................................... (1)}$$

Remarks: N = Phytoplankton abundance (individual / l);N = number of individuals observed (individuals); Acg = Sedgewick Rafter Counting Cell (1000 mm2) surface area; AA = observation area (10 mm2); Vt = filtered volume (50 ml); Vs = sample volume of filtered water (10 l); As = volume of concentration in Sedgewick Rafter Counting Cell (1 ml).

b. Analysis index of preponderence (Effendi,1997)

$$IP = \frac{Ni \; x \; Oi}{\sum Ni \; x \; Oi} \; x \; 100\% \qquad \text{.......................................... (2)}$$

Information:IP = *Index of Preponderance;* Ni = Percentage of the amount of one kind of food; Oi = Percentage frequency of occurrence of one type of food.

Based on the IP value obtained, the order of fish food could be divided into three categories based on the Index of Preponderance (IP) percentage, namely:

- IP > 40% : Main / staple food
- 4% < IP < 40% : Complementary foods
- IP < 4% : Additional food

c. Analysis of preference index (Krebs, 1989)

$$E = \frac{ri - pi}{ri + pi} \qquad \text{.......................................... (3)}$$

Information: E = (Index of Selectivity) ; ri = Percentage of natural food found in fish intestines; pi = percentage of natural food found in the water

The E (food selection) index ranges from +1 to -1. If the value is positive, there will be a selection of feed for the intended natural feed. If the E value is negative, there will be no selection of feed. The price of E = 0, means that there is no selection of fish from natural food in their intestines (Elizabeth *et al*., 2020).

d. Analysis of Ecological niche

The niche area was used to determine the selectivity of groups of fish species for food. The area of the niche was identified based on the food consumed by fish and Levin's index (Hespenheide, 1977)

$$B_j = \frac{1}{\sum Pi^2} \quad \text{.........................................} \quad (4)$$

Information: Bj = area of food niche;Pi = Proportion of fish species related to food type

There is no criterion for the value of the niche area, because fish that has a wide niche area value means that the fish is utilizing the available food in large quantities. Fish that have a narrow niche area value means that the fish is selective in choosing the food available in the water (specialist).

e. Analysis of food competition

Overlapping food niches lead to food competition (competition) among organisms of the niche. The analysis was done using the Simples of The Available Index method by Krebs, (1989)

$$Ch = \frac{2 \sum Pij \, . \, Pik}{\sum Pij^2 + \sum Pik^2} \quad \text{.........................................} \quad (4)$$

Remarks: Ch = Overlapping of the food niches between fish species i and h types; Pik = Proportion of the "i" fish species associated with the k-th food resource; ij = The proportion of h-fish species associated with the "j" food resource

The overlap value of the food niches close to the value of one (1) indicates a high competition between the two types of fish being analyzed. An overlap of food niches occurs when there are similarities in the types of food used by two or more groups of fish. Conversely, value close to zero (0) means that the same types of food are not obtained.

## RESULT AND DISCUSSION

Jatibarang Reservoir is one of the reservoirs located in Semarang, Central Java at a coordinate point of 1100 21 '01 "East Longitude and 70 02' 12" South Latitude. Administratively, Jatibarang Reservoir is located in two sub-districts, Gunung Pati District which includes Jatirejo and Kandri Villages, and Mijen District which includes Jatibarang and Kedungpane Villages. The main water source for the Jatibarang Reservoir comes from Kreo River in all seasons and from Kandri River during the rainy season.

The operation and management of the Jatibarang Reservoir is carried out by the Pamali-Juana River Basin (BBWS Pamali Juana). Jatibarang Reservoir mainly functions as flood control in Semarang City. In addition, the reservoir also provides raw water, fisheries resource and tourism attraction (culinary tours, photo spot, fishing spot and speed boat). Furthermore, Jatibarang Reservoir will also be used as a hydropower plant in the near future. The exploration of fisheries resources in the reservoir should take into account the carrying capacity of the environment, one of which is the ecological niche for sustainable management.

### Composition of Fish

Fish samples in the Jatibarang Reservoir were caught using fishing line and gill nets. Types of fishing gear used for sampling include fishing line with hook sizes 02, 03 and 04, bottom gill nets with a mesh size of 4 inches and surface gill nets with mesh sizes of 3 inches and 4 inches. Tilapia was the most dominant fish found in the waters of Jatibarang Reservoir, particularly the black tilapia

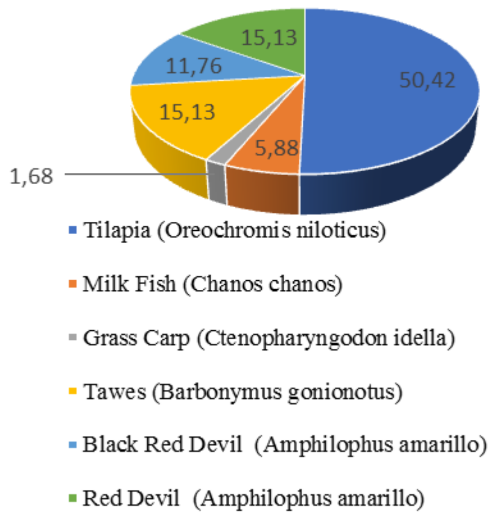


**Figure 2.** The Composition of Fish Caught in Jatibarang Reservoir

### Palnkton Abudance

Phytoplankton are the main source of natural food in aquatic ecosystems for aquatic biota (Hader and Gao, 2015). Determining the abundance of plankton allows the measurement of natural food availability for fish in the waters of the Jatibarang Reservoir. The abundance of plankton in the waters of the Jatibarang Reservoir based on the plankton classification is presented in Table 1.

**Table 1.** The Abundance of Plankton in Jatibarang Reservoir

| No | Type of Plankton | N (ind/L) | Percentage % |
|---|---|---|---|
| 1 | Bacillariophyceae | 1540 | 36.49 |
| 2 | Chlorophyceae | 1780 | 42.18 |
| 3 | Coscinodiscophyceae | 40 | 0.95 |
| 4 | Cyanopyceae | 280 | 6.64 |
| 5 | Dinophyceae | 40 | 0.95 |
| 6 | Dictyochophyceae | 60 | 1.42 |
| 7 | Euglenoidea | 200 | 4.74 |
| 8 | fragilariophyceae | 60 | 1.42 |
| 9 | Mediophyceae | 100 | 2.37 |
| 10 | Zygnematophyceae | 100 | 2.37 |
| 11 | Zooplankton | 20 | 0.47 |
| | Total | 4220 | 100 |

The results of previous research in Jatibarang Reservoir showed the abundance of phytoplankton rangeing between 1.667 – 275.833 ind/l (Ikhsan *et al*., 2020). The abundance of phytoplankton correlates with nutrient e.g. phosphate and the characteristics of the surrounding environment Elizabeth *et al*., (2020).

**Analysis of Preference Index**

The food choice index was calculated by comparing the food contained in the stomach contents of the fish with the food available in the waters. The food choice index value (E) ranges from -1 to 1. Food with value closer to 1 indicates that the fish prefer the food. Lima-Junior and Goitein (2001) showed that simplest measurement is based on the frequency of occurrence since it is easily observed. However, the measurement results in incomplete information, since distinct food categories may be consumed with the same regularity, albeit in distinct. Consequently, one of the three other methods may be necessary to evaluate the abundance of the food item in the sample. The calculation of the index of food choices for fish in the Jatibarang Reservoir is presented in Table 2.

Table 2 shows that tilapia do not prefer eating plankton from the Bacillariophyceae, Euglenoidea, Fragilariophyceae, Mediophyceae and Zooplankton classes. Milkfish choose foods from the Coscinodiscophyceae, Cyanopyceae and Zooplankton classes, while the food that is not selected is from the Bacillariophyceae, Chlorophyceae, Dinophyceae Euglenoidea Fragilariophyceae, and Mediophyceae classes. The results of the choice of Grass Carp food showed that the food that was not selected was plankton from the class Bacillariophyceae, Chlorophyceae, Dinophyceae, Fragilariophyceae, Mediophyceae and Zygnematophyceae while for fish Zooplankton was not found in the digestive contents of Grass Carp. Java Barb choose foods from the Coscinodiscophyceae, Cyanopyceae, Dinophyceae and Zygnematophyceae classes, while the Fragilariophyceae and Mediophyceae classes are not chosen at all by Java Barb, and Zooplankton is not found in the digestive contents of the Java Barb fish. The analysis showed that the Red Devil (Black and Red) had the same food selection index where both only chose to eat from the Coscinodiscophyceae and Cyanopyceae classes.

**Ecological Niche Area**

The area of niche was analyzed to measure the amount of food consumed by these fish species and to determine the species selectivity in the group. No specific criteria were set in calculating the area of the niche, because the higher the value of the niche area of a type of fish indicated large amount of food consumed by the fish. Thereby it showed that the fish is a general type of fish. On the other hand, smaller niche area value showed specialist type of fish that were rather selective in choosing food. The availability of additional food in the ecological system was also analyzed through the modification of functional response term (Srinivasu and Prasad 2010). Prey which is the object of interspecific competition represents an important dimension of the niche. Higher position in the food chain indicates greater competition. (Zander, 1982) The calculation the fish niche in the waters of the Jatibarang Reservoir is presented in the Table 3.

Overlapping niches were analyzed to determine food competition in these waters by looking at the similarities of the food in the digestive organs of the fish. Food overlap among fish species or populations will lead to intense food competition. Niche overlap is usually high in this situation, and intense competition may cause the rapid decline and even the extinction of native populations which will affect the whole aquatic ecosystems (Sanches et al., 2012).

Table 4 presents the values of the overlap between fish in the Jatibarang Reservoir which range from 0.652 to 1. The value indicates that the most intense competition occurs between Tilapia and Grass Carp with a value of 1, and the least strong overlap occurs between Milkfish and Red Devil fish. The greater the overlap value, the higher possibility of food competition between these fish species. Ecological niche value shows that in the waters of Jatibarang Reservoir, the generalist fish are milkfish, while Java Barb fish are selective ones. Milkfish has the widest ecological niche, while the smallest one is the one of the Red devil (Figure 3).

**Table 2.** Analysis of Preference Index

| No | Type of Plankton | Preference Index | | | | | |
|---|---|---|---|---|---|---|---|
| | | Tilapia | Milk Fish | Grass carp | Java Barb | Red Devil (Black) | Red Devil (Red) |
| 1 | Bacillariophyceae | -0.84 | -3.10 | -2.13 | -1.52 | -3.13 | -5.02 |
| 2 | Chlorophyceae | 0.76 | -0.41 | -0.92 | -0.98 | -0.85 | -0.01 |
| 3 | Coscinodiscophyceae | 1.98 | 1.57 | 0.00 | 0.00 | 0.00 | 1.13 |
| 4 | Cyanopyceae | 1.62 | 1.26 | 0.44 | 0.66 | 2.12 | 0.52 |
| 5 | Dinophyceae | 0.25 | -1.00 | -1.00 | 0.36 | -1.00 | -0.83 |
| 6 | Euglenoidea | -0.46 | -0.29 | 0.12 | -0.34 | -1.00 | -0.86 |
| 7 | Fragilariophyceae | -0.55 | -1.00 | -1.00 | -1.00 | -0.63 | -0.69 |
| 8 | Mediophyceae | -0.87 | -1.00 | -1.00 | -1.00 | -0.87 | -1.00 |
| 9 | Zygnematophyceae | 0.00 | 0.00 | -1.00 | 0.25 | -1.00 | -1.00 |
| 10 | Zooplankton | -2.00 | 4.04 | -2.00 | -2.00 | -0.87 | -2.00 |

**Table 3.** Calculation of Niche Area

| No | Type of Plankton | Tilapia | Milk Fish | Grass carp | Java Barb | Red Devil (Black) | Red Devil (Red) |
|---|---|---|---|---|---|---|---|
| 1 | Bacillariophyceae | 0.048 | 0.010 | 0.115 | 0.068 | 0.001 | 0.000 |
| 2 | Chlorophyceae | 0.249 | 0.099 | 0.204 | 0.274 | 0.096 | 0.039 |
| 3 | Coscinodiscophyceae | 0.018 | 0.012 | 0.002 | 0.001 | 3.01E-07 | 0.002 |
| 4 | Cyanopyceae | 0.019 | 0.013 | 0.009 | 0.004 | 0.429 | 0.546 |
| 5 | Dinophyceae | 1.71E-05 | 0 | 0 | 9.70E-06 | 0 | 1.22E-08 |
| 6 | Euglenoidea | 4.10E-05 | 1.80E-04 | 0.004 | 1.19E-04 | 0 | 1.76E-06 |
| 7 | Fragilariophyceae | 1.19E-08 | 0 | 0 | 0 | 5.35E-07 | 1.10E-07 |
| 8 | Mediophyceae | 0 | 0 | 0 | 1.19E-04 | 3.35E-08 | 0 |
| 9 | Zygnematophyceae | 8.38E-07 | 2.22E-06 | 0 | 6.56E-03 | 0 | 5.93E-06 |
| 10 | Zooplankton | 0 | 0.080 | 0 | 0 | 3.01E-07 | 6.00E-07 |
| 11 | undefined | 0 | 0.004 | 0 | 0 | 3.35E-08 | 1.22E-08 |
| | $\sum Pi^2$ | 0.333 | 0.218 | 0.335 | 0.354 | 0.526 | 0.588 |
| | Niche Area | 3.002 | 4.577 | 2.989 | 2.825 | 1.901 | 1.701 |

**Table 4.** Overlapping of Ecological Niche

| No | Type of Plankton | Niche | Overlap | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tilapia | Milk Fish | Grass carp | Java Barb | Red Devil (Black) | Red Devil (Red) |
| 1 | Tilapia | 3.002 | 1 | | | | | |
| 2 | Milk Fish | 4.577 | 0.917 | 1 | | | | |
| 3 | Grass carp | 2.989 | 1 | 0.916 | 1 | | | |
| 4 | Java Barb | 2.825 | 0.998 | 0.894 | 0.998 | 1 | | |
| 5 | Red Devil (Black) | 1.901 | 0.904 | 0.708 | 0.906 | 0.926 | 1 | |
| 6 | Red Devil (Red) | 1.701 | 0.858 | 0.653 | 0.860 | 0.884 | 0.994 | 1 |
| 7 | Tilapia | 3.002 | 1 | | | | | |

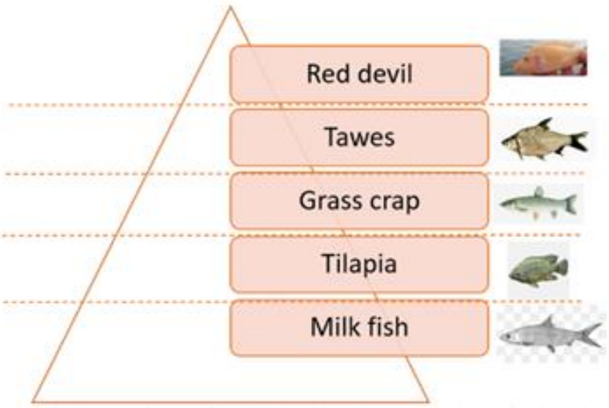


**Figure 3.** The level of Utilization of Natural Food (Plankton) Based on the Calculation of Ecological Niche

Same as with Tjahjo *et al.*, 2000 a study of potential feed resources and community ecological niches can be used as a source of information for rehabilitation and restocking programs. Interspesific relation is a requirement to manage fishery resources. Interspecific competition is defined as the demand of more than one organism for the same resource of the environment in excess of immediate supply. When two species are "competing for a niche" the term competition has been used to include phenomena such as predation of the two species on each other (Larkin, 1956).

## CONCLUSION

The dominant *Index of Preponderence* (IP) show that the Chlorophyceae class is the staple food of Tilapia, Grass Carp and Java Barb showing values of 49.86%, 45.16% and 52.34% respectively. Milk fish and Red Devil have no main food (IP < 40%). Other classes of plankton (Bacillariophyceae, Coscinodiscophyceae, Dinophyceae, Euglenoidea Cyanopyceae, Fragilariophyceae, and Zygnematophyceae) appear as complementary food and additional food (IP values lesser than 4%). The highest value of ecological niche was found in Milkfish with 4.577 and the lowest value was obtained by Red Devil (Red). The niche overlap value shows that the most intense competition occurs between Tilapia and Gras Carp with a value of 1, and the smallest overlap value was found between Milkfish and Red Devil.

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