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Food Habits of Indigenous Fish Groups Caught in Lake Rawa Pening, Indonesia

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A B S T R A C T

Lake Rawa Pening is a freshwater body located in Semarang Regency, Central Java, with an area ± 2,670 hectares. One potentially widely used sector is the fisheries sector, which includes Indigenous and exogenous fish. However, the number of Indigenous fish in Lake Rawa Pening is decreasing due to continuous fishing by fishermen, competition for food, and the change in the aquatic environment. This research aimed to determine the types of Indigenous fish, the food composition, and the niche breadth of Indigenous fish in Lake Rawa Pening. This research was carried out in October – December 2023. The determination of the sampling point using the accidental sampling method. Sampling was conducted using a random sampling method at 3 stations with depths including 0 m, 1 m, and 2 m. Data analysis using Index of Preponderance and niche breadth. Indigenous fish species found include Striped snakehead and Climbing perch. Food composition was divided into five types: litter, phytoplankton, zooplankton, small fish, and unidentified. The food habits of this fish group were dominated by using litter as the primary food. All fish used phytoplankton as central, complementary, and additional food. Zooplankton, small and unidentified fish, were used as extra food. This fish group is generalist in utilizing food resources in the waters (1.02 – 2.08). The opportunity for food competition shows high competition (>0.6).

Keywords: Food Habits; Indigenous Fish; Lake Rawa Pening; Index of Preponderance

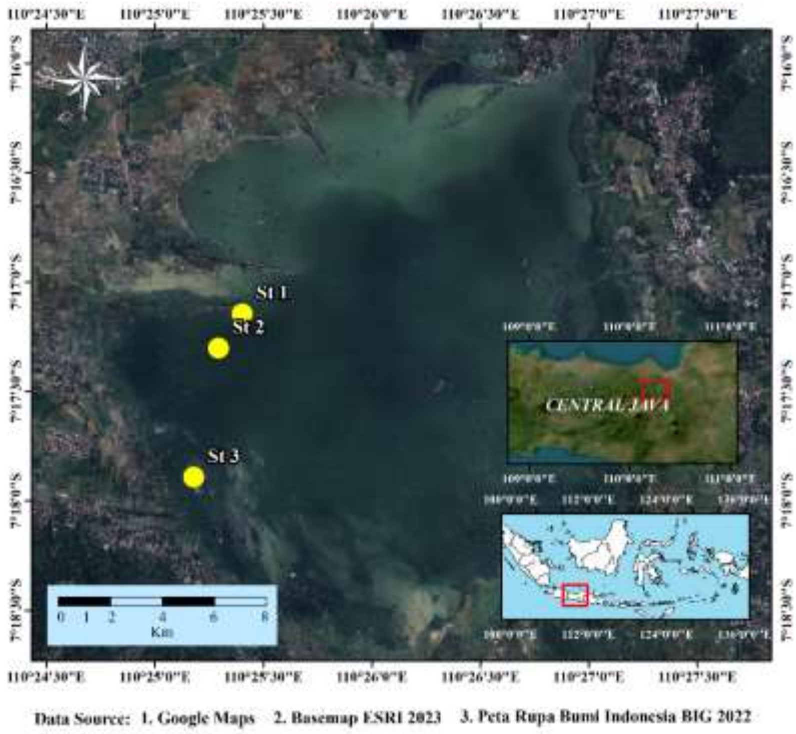
1. Introduction

Rawa Pening Lake is a freshwater body of water on Java Island located in Semarang Regency, Central Java Province, Indonesia, with an area of ± 2,670 hectares. This lake stretches across Semarang's Ambarawa, Bawen, Tuntang, and Banyubiru districts (Fadilah et al., 2018). Rawa Pening Lake has high ecological, historical, and economic functions. Local communities widely use this function as an economic resource. Some economic activities in Rawa Pening Lake include agriculture, trade, fishing, looking for water hyacinth, peat mining, tourism, and other service activities (Purwanto et al., 2020). One potential that is widely utilized is in the field of fisheries. The fish resources of Lake Rawa Pening include Indigenous and exogenous fish groups. Indigenous fish are native fish from Indonesian waters that can grow and develop in other waters. These fish play a role in the diversity and balance of the lake ecosystem (Iskandar *et al*., 2020). Exogenous fish are intentionally or unintentionally introduced to the ecosystem with a specific purpose (Dewantoro and Rachmatika, 2016). Research by Ramadhan et al. (2023) mentioned that fish found in Lake Rawa Pening include tilapia, marble goby, Snakehead, three-spot gourami, Rasbora, Osteochilus, Red Devil, Javanese Belida, and Catfish. It is also mentioned by Weri and Sucahyo (2017), that indigenous fish found in Lake Rawa Pening include Striped Snakehead, Wader, Tawes, Climbing Perch, Sepat, Betutu, and Hampala as for exogenous fish such as tilapia, Red Devil, Lou Han, Bawal and Gurami. The presence of these fish species is influenced by the productivity of waters, indicated by the abundance of phytoplankton and high chlorophyll-a. This allows food sources to attract fish to adapt, grow, and spawn (Demena et al., 2017). However, adaptable exogenous fish may interfere with indigenous fish in the aquatic environment, limiting aquatic productivity. Fish food habits are essential in determining habitat, promoting fish growth and development, and fisheries management. Similarities in food composition between species or groups can lead to food competition. Competition for food is the ability of organisms to maintain their habitat. The balance of a community is due to the variation in the amount of food utilized and the amount of food utilized. Fish-feeding behavior can be seen in food composition in the digestive tract (Wagner et al., 2009). Based on these problems, indigenous fish's eating habits need to know their food composition to determine the breadth of fish niches and food selection in waters to determine food utilization and competition in Lake Rawa Pening.

2. Research Method

This research was conducted in the Rawa Pening Lake area, Semarang Regency, from October to December 2023. It was carried out at the Fish Resources and Environmental Management Laboratory, Department of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Universitas Diponegoro, Semarang. The indigenous fish were identified, plankton abundance and fish food composition were analyzed.

Determining the location of sampling points using the accidental sampling method, namely a method of determining sampling points by chance based on the catches of fishermen found at the sampling location. The sampling location consisted of 3 observation points based on fishermen's fishing areas according to traps spread across Lake Rawa Pening (Fig 1). The characteristics and description of the sampling points' location represent waters. The research was carried out 3 times over 3 months by taking fish and water samples in Rawa Pening Lake, Semarang Regency.



Figs1. Map of sampling locations for Lake Rawa Pening

The fish sampling method was carried out randomly through field observations by determining the location following the fishermen's fishing ground. Field data was collected by participating in fishing operations (trips) three times using wire traps and bamboo traps. Water sampling is used to collect plankton samples and water quality data simultaneously with fish sampling. Water quality data measured directly (in situ) at the sampling point includes chemical (DO and pH) and physical (temperature, depth, and brightness) factors. Analysis of fish food composition using the Index of Preponderance using the formula (Effendie,1997):

$$IP = \frac{N_i \times O_i}{\sum N_i \times O_i} \times 100\% \quad (1)$$

Information:

IP = Index of Preponderance

Ni = Percentage of the amount of one type of food

Oi = Percentage of frequency of occurrence of one type of food

$\sum N_i \times O_i$ = Number of Ni×Oi of all kinds of food

The percentage amount is expressed using the formula:

$$Ni = \frac{N}{\Sigma N} \times 100\% \quad (2)$$

$$N = \frac{1000}{10} \times 50 \times x \quad (3)$$

The percentage frequency of occurrence is calculated using the formula:

$$Oi = \frac{\text{a stomach containing one type of food}}{\text{the entire stomach containing food}} \times 100\% \quad (4)$$

The composition of fish food is divided into three categories based on **the** percentage Index of Preponderance (IP), namely, main food IP > 25 %, complementary foods IP 5% - IP 25%, and additional food IP < 5% (Febryanti et al., 2021). Niche area is calculated using the Levins index formula (Tresna et al., 2012), i*n* Isroliyah et al., 2021):

$Bi = \frac{1}{\sum Pi^2}$ (5)

Information:

Bi = Food niche area of fish group i

Pi = Proportion of types of food consumed

Standardize calculations so that the resulting niche area value ranges from 0 – 1 with not too large intervals.

$BA = \frac{Bi - 1}{n - 1}$ (6)

BA = Standardization of food niche area (range 0 – 1)

Bi = Food niche area of fish group i

n = Number of all food organisms used

Overlapping food niches show similarities in the type and composition of food used by fish based on gender, fish size, or other species groups. Overlapping niches will result in competition for food between niche occupants. Calculation of niche overlap using Horn's simplified Morisita index method (Krebs, 1989) in (Ghiffary et al., 2018):

$Ch = \frac{2 \sum Pij \times Pik}{\sum Pij^2 + \sum Pik^2}$ (7)

Ch = Overlapping food niches

Pij and Pik = Proportion of the i-th type of food organism used by the j-th and k-th 2 groups of fish

A food overlap value close to one (1) means high competition between the two types of fish being analyzed. Food overlap occurs when two or more types of fish use similar types of food. Conversely, when the value is close to zero (0), then the same type of food is not obtained. The overlap value is categorized into 3, namely, low competition (< 0.33), medium competition (0.33 – 0.67), and high competition (> 0.67) (Melisa et al., 2021)

3. Result and Discussion

Food Composition

There were 2 types of indigenous fish caught, with 10 fish. The most common type of indigenous fish is 6 Climbing perch with a percentage of 60% (Fig 2).

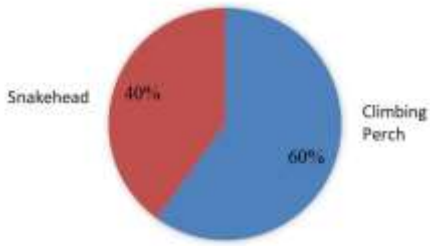


Fig. 2 - Percentage of Indigenous Fish Catch in Lake Rawa Pening

The food composition found in the stomachs of Indigenous fish groups in Rawa Pening Lake consisted of litter, phytoplankton, zooplankton, and small and unidentified fish. The litter group found was crushed plant parts or leaves in the form of litter. This group was highest in Climbing Perch IP 97.88% and lowest in Striped snakehead fish IP 97.67%. Phytoplankton groups are often found in Climbing Perch with an IP of 2%. The unidentified group with the highest IP was found in snakehead fish at 1.62%, and the lowest was in Climbing Perch fish with an IP of 0.12% (Fig 3).

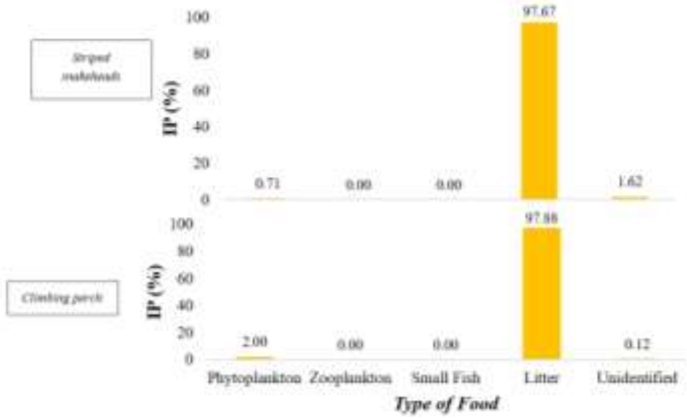


Fig. 3- Food Composition of Indigenous Fish Groups

Niche Breadth

In general, the value of the indigenous fish niche area in Rawa Pening Lake was 1.06 (Fig 4). The value of the niche overlap of indigenous fish groups *in Rawa Pening Lake has the potential for high competition, with a value of 1 (Table 1).*

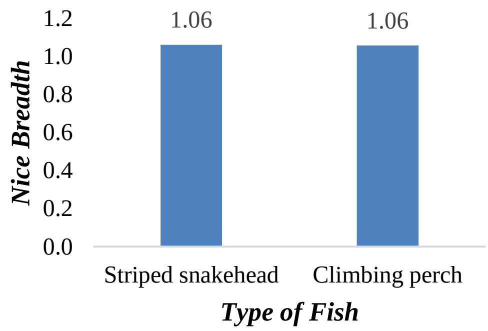


Fig. 4- Niche Breadth of Indigenous Fish Groups in Lake Rawa Pening

Table11. Niche Overlap of Indigenous Fish Groups in Lake Rawa Pening

Types of Fish	**Overlap**		**Niche Breadth**	**Niche Standardization**
	Striped Snakehead	Climbing Perch		
Striped Snakehead			1.06	0.01
Climbing Perch	1		1.06	0.01
Amount			2.12	0.02

Water quality

Rawa Pening Lake water quality measurements were carried out at 3 sampling points at depths of 0 m, 1 m, and 2 m. According to quality standards, the water quality measurement results obtained are in the optimum category for fish growth (Fig 5).

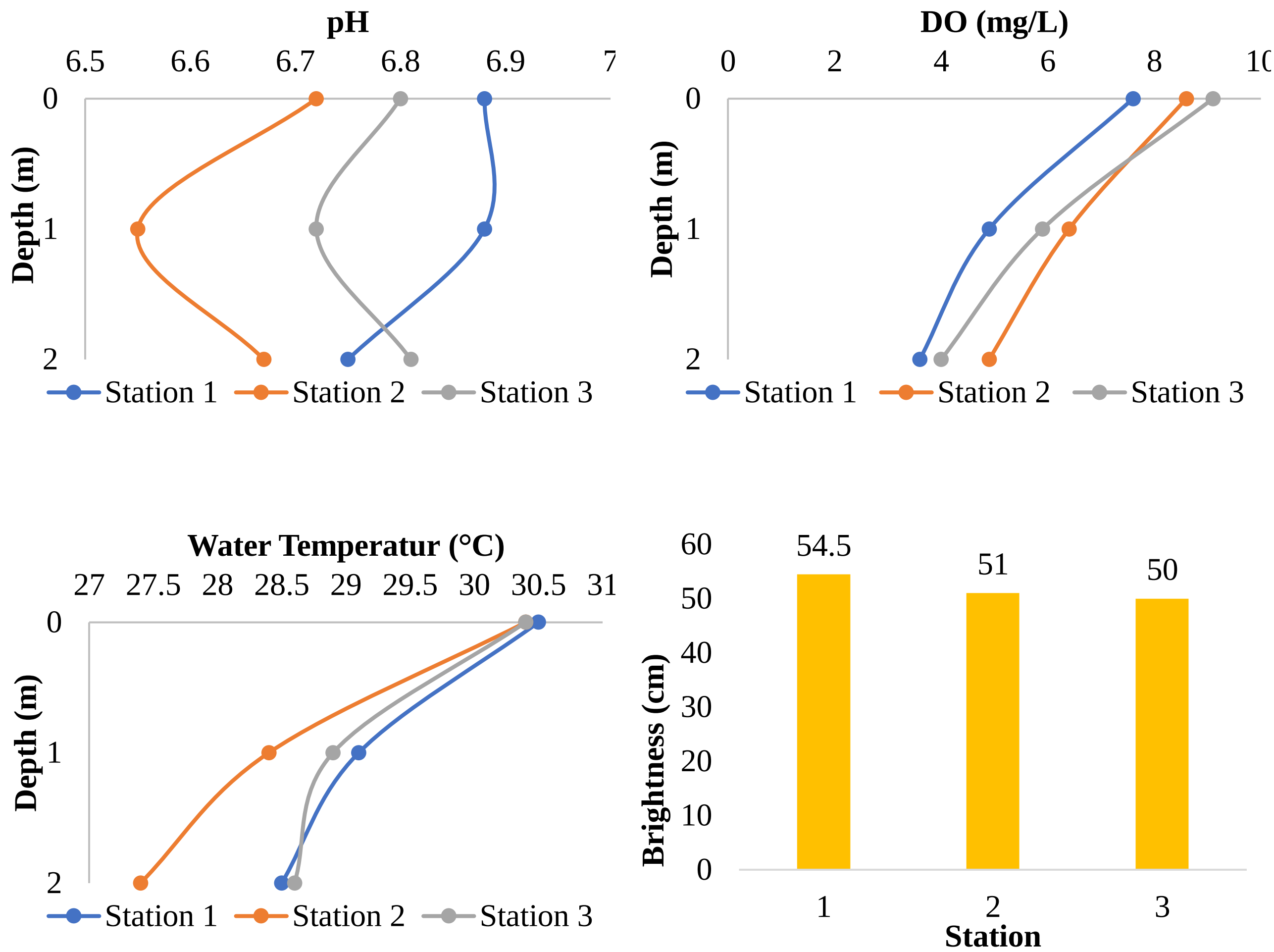


Fig. 5 - Water Quality of Lake Rawa Pening

The pH from the three stations obtained results ranging from 6.55 – 6.88. The highest pH was at station 1, ranging from 6.75 – 6.88, while the lowest pH at station 2 was around 6.55 – 6.77. Dissolved oxygen (DO) concentration was obtained as big as 3.6 – 9.1 mg/L. The highest dissolved oxygen was at station 3 at a depth of 0 m with a value of 9.1 mg/L, while the lowest was at station 1 with a value of 3.6 mg/L at a depth of 2 m. Temperature measurements obtained results between 27.4 – 30.5°C. The highest temperature measurement value was at station 1 at a depth of 0 m with a value of 30.5°C, while the lowest temperature was at station 2 at a depth of 2 with a value of 27.4°C. The highest depth is at station 3, with a value of 250 cm, while the lowest is at station 1, with a value of 195 cm. The brightness at the three stations obtained results ranging from 50 – 54.5 cm. The highest brightness was obtained at station 1 at 54.5 cm, and the lowest brightness at station 3 was 50 cm.

Discussion

Indigenous Fish Types in Rawa Pening Lake

The results of the indigenous fish catch in this study were 2 types with 10 fish. These fish are Snakehead (*Channa striata*\) and Climbing Perch (*Anabas testudineus*). The most commonly found type is 4 snakehead fish with a percentage of 60%. The dominance of snakehead fish is because snakeheads are freshwater fish that live in waters with dense water plants, such as Lake Rawa Pening. Snakehead fish are passive predators that have flat heads. The habitat of this fish is around water plants as a place to shelter and find food (Muliani et al., 2021). Also, Striped Snakehead are easy to catch and have high economic value. The sampling process also influences the variety of fish obtained in the morning, making catching easier. Fish food habits and food availability influence this. Fish are actively looking for food in the morning. The high abundance of plankton in the morning is also due to the optimum light intensity for photosynthesis, producing water nutrients. (Desmawati et al., 2020).

One factor in the difference in fish numbers is that the water quality conditions in Rawa Pening Lake are relatively good for the survival of aquatic organisms. Differences in the number of fish in waters are influenced by fish activity, season, temperature, feeding habits and availability, age of the fish, fishing gear used, and conditions of the aquatic environment.(Cia et al., 2018). The results of water quality measurements in this study are based on quality standards. The acidity (pH) obtained ranged from 6.55 – to 6.88. The pH that has been measured is considered suitable for the survival of fish in waters with an optimum pH ranging from 6 – 9(Febrian et al., 2022).Differences in pH values at each station are influenced by photosynthesis, respiration, and temperature. Some aquatic organisms are sensitive to changes in pH. A high pH value will increase the growth rate of fish and increase ammonia, which is toxic to fish. A low pH value will be followed by a decrease in oxygen content, which can cause fish growth to be hampered so that the fish can be easily infected by bacteria and even die.

The DO concentration at the three stations in Rawa Pening Lake ranges from 3.6 – 9.1 mg/L. This concentration is considered good enough to support the survival of aquatic organisms with a concentration of 2 mg/L (Lastari and Handayani., 2022). This difference in concentration is due to the different water conditions around the station location. Shallow waters have a high dissolved oxygen content because photosynthesis and gas exchange between water and air occur optimally. The deeper the water, the dissolved oxygen content becomes lower due to reduced sunlight, so the process of photosynthesis decreases. This is also related to the brightness value obtained at 50 – 54.5 cm. The low brightness at station 3 is because this location is close to population activities, tourism areas, and rice fields. The presence of suspended organic matter influences the brightness of the waters. The more organic material, the brighter it decreases. According to Putrisia et al. (2022), brightness is related to the photosynthesis process; the lower the brightness, the more it will affect dissolved oxygen levels, so the photosynthesis process will not run well.

The temperature measurement results obtained were also in optimum conditions for fish survival. Based on the Decree of the Minister of Environment Number 5 of 2014, the temperature obtained is still within the normal limits for fish survival, namely below 38°C. This difference is due to the measurements being carried out at different times and the influence of sunlight, weather, and water depth. This will affect the metabolic processes, physiology, and growth of fish. High temperatures can increase aquatic biota's metabolic and respiration processes so that oxygen demand increases. According toAlfatihah et al. (2023), The optimal temperature for fish growth in tropical waters is around 25 - 32°C.

Depth measurement from the three stations at Rawa Pening Lake, 195 – 250 cm, was obtained. This difference is due to differences in sampling locations, which determine the location following the fishermen's fishing ground. The depth at station 3 is high due to its location far from land. High and low depth affects water quality and the organisms that live in the waters. This is related to the availability of dissolved oxygen in the waters. The deeper the water, the lower the DO content because the intensity of light entering the water is less, so the photosynthesis process is hampered.(Siswansyah and Kuntjoro, 2023)This influences metabolic processes, mortality, and survival of aquatic organisms. These aquatic environmental conditions support fish's ability to adapt and grow well. Fish growth is influenced by the presence of food in the waters. The large number of different types of fish in the waters shows that these waters provide a variety of niches (habitat and food).(Astuti and Fitrianingsih, 2018).

Food Composition

The food composition of Indigenous fish caught in Rawa Pening Lake is grouped into 5, namely phytoplankton, zooplankton, small fish, litter, and unidentified. In general, the food composition of the 2 types of fish obtained was dominated by litter. The litter group consists of crushed plant parts or pieces of plant parts. The striped Snakehead (*Channa striata*) observed consisted of 3 tails containing food and 1 tail containing only litter. Based on Fig 4.3, snakehead fish eat more litter as their primary food. According toLiana et al. (2020), The litter in the snakehead fish's stomach is likely prey for the snakehead fish eating leaves. Snakehead fish in Rawa Pening Lake also use phytoplankton as additional food. The most significant use of phytoplankton from the Bacillariophyceae class, namely the genus *Asterionella* sp., *Fragilaria* sp., Nitzschia sp., and *Synedra* sp. This is because the abundance of the Bacillariophyceae class is found in Rawa Pening Lake. According to Ansari et al. (2020), based on research in Bangau, Anjir Muara and Sungai Batang, when snakehead fish larvae consume phytoplankton from the phylum Chlorophyta (31.11%), Cyanophyta (14.67%), Chrysophyta (19.11%), protozoa (14.67%), crustaceans (10.22%), rotifers (8.89%) and insects (1.33%). When mature, this fish eats small fish, frogs, mollusks, and algae. This fish utilizes food in the waters according to its habitat, availability, and environmental conditions. Snakehead fish are high-level predatory and carnivorous fish active at night or a group of nocturnal fish. The food that this fish likes is frogs, mollusks, crustaceans, algae, and others.(Ahmadi and Ansyari, 2022).

The results of the IP value of Climbing Perch fish (Anabas testudineus) were observed to eat much litter as the leading food and the rest as complementary food. The contents of the stomach of this fish were found to be food in the form of plant parts in the form of litter; phytoplankton mainly was found from the Chlorophyceae class, genus *Chlorella* sp., Coelastrum sp., and Pediastrum sp. According to Aryzegovina et al. (2022) Climbing Perch fish is a type of omnivorous fish because its digestion contains plankton from the class *Bacillaryophyceae*, Chlorophyceae, Ciliata, Cyanophyceae, Protozoa, Rotifera, and Crustaceans. In research Mustakim et al. (2020)A. testudineus in Lake Semayang, including omnivorous fish, tend to be carnivorous. The composition of this fish food includes animals such as fish, insects, and crustaceans as the leading food and complementary food in the form of plants and plankton as additional food. Climbing Perch in Rawa Pening Lake can be categorized as omnivorous fish because their digestion is dominated by litter, phytoplankton, and unidentified organisms.

Overall, the indigenous fish in Rawa Pening Lake use litter as their primary food. Phytoplankton is used by all Indigenous fish found in Rawa Pening Lake as a complementary food for the Gabus and Climbing Perch. Moreover, it is not identified as being used as additional food for all fish obtained. Changes in eating habits are influenced by the distribution of food organisms, food availability, fish size, and environmental factors (Effendie, 2002). Based on this, phytoplankton is widely used by all fish obtained because it is related to the abundance of plankton in Rawa Pening Lake. This group of fish most widely uses phytoplankton from the class Chlorophyceae, namely the genus *Pediastrum* sp. and *Coelastrum* sp. This is based on the results of plankton abundance in this study, where the most dominant plankton is the phytoplankton class Chlorophyceae. The most dominant genus is *Coelastrum*sp. With a total abundance of 413,167 Ind/L and Pediastrum sp. amounting to 308,500 Ind/L. Good water conditions influence the high abundance of this genus. One factor is light, which can support the growth and development of a species. According to Zikriah et al. (2021), Chlorophyceae can grow and develop quickly with sufficient sunlight intensity. Another factor is the importance of high nutrient content, such as nitrate and phosphate, for phytoplankton growth.

There is a difference between the availability of food in the water and the composition of the food found in the fish's stomach. Fish *indigenous* in Rawa Pening Lake are thought to have adapted to the food available in the waters. The availability of phytoplankton is the most significant component of providing food in water. According to Safitri et al. (2021), Differences in the composition of food eaten by fish are caused by differences in the distribution of organisms in each region. Factors influencing fish eating habits include habitat, preferences for certain types of food, season, size of food, color of food, and fish age.

Niche Breadth

In general, the value of the indigenous fish niche in Rawa Pening Lake was 1.06, with a niche standardization of 0.01. The variety of food for indigenous fish is relatively the same. This fish is classified as able to utilize the relatively similar availability of natural food as its leading food. A broad niche can indicate that an organism is a generalist in utilizing food.(Widarmanto et al., 2019).Fish with a large niche area indicate that this fish is a generalist in utilizing food resources in the waters. On the other hand, if the niche area is small or narrow, only use one type of feed available.

Based on the overlap analysis of indigenous fish groups in Rawa Pening Lake, a value of 1 is classified as high competition. This competition occurs because there are similar types of food and habitat use. Apart from that, the availability of natural food in waters, such as less plankton, is not proportional to the amount of plankton consumed. According toGhiffary et al. (2018)The low overlap in food is because the types of food used are not the same, and the abundance of food is high in the waters, so food competition does not occur. Climbing Perch and Gabus are demersal fish that search for prey at the bottom of the water and have wide mouths. According toChaudhuri et al., (2014), The influence of differences in the type of food organisms eat includes morphology (size and shape of the mouth) and how to obtain food. This difference results in low competition for food.

Food competition occurs between types of carnivorous fish, namely snakeheads, and omnivorous fish, namely Climbing Perch. The value obtained reaches 1 or close to 1, indicating high competition. This is due to the limited food available in nature. If it is related to the indigenous fish catches obtained in Rawa Pening Lake, the number of carnivorous fish obtained dominates more than omnivorous fish. If the trophic balance is low, then the food chain in the waters is very dangerous because it can result in high food competition. According toSulardiono et al. (2022), It should be noted that in the waters, the trophic level of carnivores is higher because it unbalances the predator-prey ratio and affects competition between fish.

4. Conclusion

The conclusions obtained based on the results of the research that have been carried out are as follows:

1. Types of fish Indigenous who was caught in Rawa Pening Lake consist of 2 types include, Striped Snakehead (*Channa striata*) and Climbing Perch (*Anabas testudineus*);
2. Food composition was grouped into 5 types, namely litter, phytoplankton, zooplankton, small fish, and unidentified. The indigenous fish group of Rawa Pening Lake is dominated by using litter as the primary food. Phytoplankton is used as additional food. Not identified as using all fish obtained as additional food; And
3. Food competition occurs between Climbing Perch and Striped Snakehead. Food competition opportunities show that there is high competition.

5. Acknowledgment

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