SHORT COMMUNICATION

Gut Content Analysis of Freshwater Fishes in Lake Wood, Zamboanga del Sur, Philippines

Floriefe M. Gonzaga-Torino[1,2*], Alejandro M. Gonzaga Jr.[3], Floriele M. Gonzaga[4], Albaris B. Tahiluddin[5], Fiona L. Pedroso[2]

[1]*College of Fisheries, Mindanao State University-Buug, Datu Panas, Buug, Zamboanga Sibugay 7009 Philippines*
[2]*School of Marine Fisheries and Technology, Mindanao State University at Naawan, Naawan, Misamis Oriental 9023 Philippines*
[3]*College of Fisheries and Aquatic Sciences, Mindanao State University Main Campus, Marawi City, Lanao del Sur 9700 Philippines*
[4]*Faculty of Bioscience Engineering, Ghent University, Gent, 9000 Belgium*
[5]*College of Fisheries, Mindanao State University - Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga Bongao, Tawi-Tawi 7500 Philippines*

ABSTRACT

This study presents a gut content analysis of nine freshwater fish species representing six families from Lake Wood, Zamboanga del Sur, Philippines. A total of 144 stomach samples were examined to assess dietary composition and feeding strategies using frequency of occurrence ($\%O_i$), volumetric composition ($\%V_i$), Index of Preponderance (IP_i), and Index of Relative Importance (IRI_i, $\%IRI_i$). Algae emerged as the dominant food item, indicating its foundational role in the lake's food web. *Oreochromis niloticus* and *O. aureus* were primarily herbivorous, while *Oreochromis* sp. exhibited an omnivorous diet dominated by mollusks. *Cyprinus carpio* showed generalist feeding, consuming algae, mollusks, fish, and sand. *Barbodes binotatus* fed mainly on algae but also ingested mollusks and sand, indicating benthic foraging. *Rasbora* sp. was strictly herbivorous, feeding on algae. Air-breathing species such as *Anabas testudineus* and *Clarias batrachus* consumed algae and sand equally, suggesting substrate feeding. *Channa striata* displayed omnivory with notable insect consumption. The diversity of food items and trophic roles highlights a multi-guild but algae-driven ecosystem. Comparisons with regional studies affirm the prevalence of algae as a key dietary component in Philippine inland waters. This baseline information enhances our understanding of trophic interactions and resource use in Lake Wood and can inform future ecological monitoring and sustainable fisheries management efforts in the region.

*Corresponding Author: *floriefe.torino@msubuug.edu.ph*
Received: *April 19, 2024*
Accepted: *May 26, 2025*

Keywords: *food preferences, feeding behavior, "porang", minor lakes, Philippine lakes*

Inland water bodies such as rivers and lakes are vital components of global hydrological systems and play a significant role in supporting fisheries, biodiversity, and human livelihoods (Jenkins 2003). These ecosystems are particularly crucial in developing regions, where they serve as primary sources of food, income, and freshwater supply (Van der Ploeg et al. 2017). However, research efforts have historically favored large and prominent lakes, often overlooking the ecological contributions and management needs of smaller freshwater systems (Ganzon and Demayo 2022).

Lake Wood, located in the Municipality of Lakewood, Zamboanga del Sur, Philippines, is one such understudied but ecologically important lake. It is situated at an elevation of approximately 318–320 m above sea level, with a surface area ranging between 7.38 km² and 740.66 ha and a reported maximum depth of up to 109.73 m (Baludo et al. 2021). The lake is primarily fed by rainfall, small rivers, and groundwater, with the Biswangan River serving as its only outlet, draining into Dumanquilas Bay. Variations in the recorded physical parameters of the lake across studies suggest a need for further hydrographic validation.

Despite its ecological and socio-economic significance, Lake Wood remains insufficiently documented. Pioneering limnological and faunal surveys by Supersales et al. (2014) identified eleven freshwater fish taxa in the lake, including *Rasbora* sp. —locally known as "porang"—a small, endemic schooling fish of high commercial value. "Porang" supports local livelihoods through both fresh catches and dried fish production, with seasonal variations in catch volumes suggesting fluctuations in population dynamics (Andot and Pobar 2017). More recent assessments by Ganzon and Demayo (2022) report a decline in fish diversity, with only eight species documented, potentially indicating ecological stress or sampling limitations.

Lake Wood warrants closer scientific attention as a key resource for food, agriculture, and biodiversity conservation. Sustainable fisheries management depends on understanding trophic dynamics and species interactions. One foundational approach is the analysis of fish gut contents, which offers insights into feeding behavior, habitat use, prey availability, and trophic roles (Nath et al. 2015; Kamimura 2022). Dietary analysis not only informs on species ecology and energetic strategies but also supports conservation planning, especially in resource-limited inland waters (Chipps and Garvey 2006; Manko 2016).

Feeding habits influence fish physiology, migration, growth, and ecological interactions (Saikia 2015; Allan and Castillo 2007). Understanding what fish consume—whether algae, invertebrates, or detritus—reveals their role within the food web and contributes to broader ecosystem assessments (Sagar et al. 2019). However, a noticeable lack of published studies on the feeding ecology of freshwater fishes in Lake Wood remains. This study aims to fill this knowledge gap by establishing baseline data on the dietary composition of freshwater fishes in Lake Wood. Specifically, it examines the stomach contents of fish species to determine the frequency of occurrence of food items, their volumetric proportions, and their relative importance within the fish diet, thereby contributing to future resource management and ecological assessments of this valuable freshwater system.

Lake Wood, located in the municipality of Lakewood, a fourth-class municipality in Zamboanga del Sur, Philippines, served as the study site for this research (Figure 1). Situated on the western coast of Mindanao Island, this inland lake ranks eleventh in size within the Philippines (Davies 1992). It rests approximately 48 km north of Dumanquilas Bay and Pagadian City (Pratt 1916). With a maximum area of 4.37 km by 2.10 km and a depth reaching 109.73 m, Lake Wood presents a valuable freshwater ecosystem for investigation.

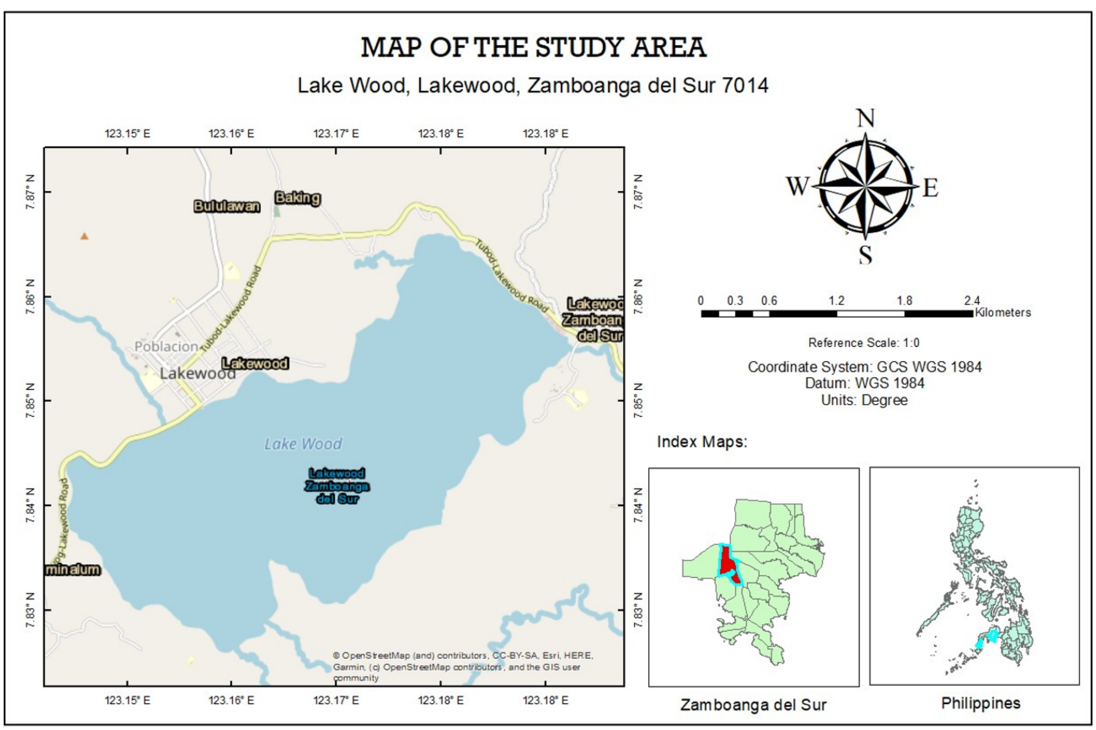

Figure 1. Geographical location of Lake Wood in the Municipality of Lake Wood, Zamboanga del Sur, Philippines

Fish samples were procured directly from local fishers who captured them using cast nets, spear guns, and fishing rods in Lake Wood. The samples were then immediately placed on ice to maintain their freshness during transport to the laboratory, which took approximately two hr. To ensure a thorough and reliable identification process, the fish species were identified morphologically based on external characteristics and verified using FishBase, a comprehensive online database (Froese and Pauly 2023). Prior to dissection, the following morphometric measures were obtained for each individual fish: standard length (SL) using a digital vernier caliper (Mitutoyo, Kawasaki, Japan) and weight using a digital weighing scale (Model D108, General Master, Japan). Weight measurements were recorded to the nearest gram (g), while length measurements were recorded to the nearest centimeter (cm).

Dissection remains the most effective and accurate method for obtaining comprehensive data on the examined fish. Stomach contents were retrieved following the established protocol outlined by Manko (2016). After dissection, the abdominal cavity was meticulously examined, and the digestive tract was carefully separated. Subsequently, the intestinal tract and other organs underwent thorough inspection, weighing, and measuring. Food items found within the stomach were transferred to a Petri dish and examined under a microscope. Prey items were identified based on their morphological characteristics using standard identification keys and published references (Mendoza et al. 2015; Estal-Mercado 2018; Fabay et al. 2021; Paglinawan et al. 2022; Donia et al. 2023).

To assess the dietary composition and relative importance of various food items, the frequency of occurrence (% Oi), was calculated using the formula: $\%Oi = (Ni \div N) \times 100$, where, Ni represents the number of stomachs containing prey item i, and N is the total number of stomachs with food content (Hyslop 1980). The Index of Preponderance (IPi) was used to evaluate the combined effect of frequency and volume of each item, calculated as $IPi = [ViOi/\sum ViOi] \times 100$. Additionally, the Index of Relative Importance (IRI) was employed to further quantify dietary significance by incorporating numerical, volumetric, and occurrence data. It was calculated using the formula: $IRI_i = (\%N_i + \%V_i) \times \%Oi$, where $\%N_i$ is the numerical percentage, $\%V_i$ is the volume percentage, and $\%O_i$ is the frequency of occurrence of food item i. The IRI provides a more comprehensive measure of a food item's contribution to the overall diet by integrating multiple dimensions of feeding behavior.

Fish samples collected from Lake Wood, Zamboanga del Sur, Philippines, revealed nine species representing six families (Table 1, Figure 2). These included the Cichlidae (Nile tilapia *Oreochromis*

Table 1. Species composition of the fish samples and the number of stomachs per species

Local Name	English Name	Family Name	Scientific Name	No. of stomach	Standard Length range (cm)	Average Standard Length (cm)	Body Weight Range (g)	Average Body Weight (g)
Tilapya	Nile Tilapia	Cichlidae	*Oreochromis niloticus*	7.0	7.8-19.0	15.2±1.7	10.4-123.2	83.5±18.3
Tilapya	Tilapia	Cichlidae	*Oreochromis* sp.	4.0	12.9	10.1±1.0	12-23.8	16.3±2.7
Tilapya	Blue Tilapia	Cichlidae	*Oreochromis aureus*	1.0	15.0	15.0±0.0	80.5	80.5±0.0
Karpa	Common Carp	Cypridinae	*Cyprinus carpio*	5.0	9.8-18.5	13.3±1.7	10.5-133.9	55.0±23.9
Paitan	Spotted barb	Cypridinae	*Barbodes binotatus*	3.0	4.9-12.2	9.5±2.3	1.1-33.7	17.9±9.4
Porang	Carp	Danionidae	*Rasbora* sp.	54.0	5.2-8.4	6.8±0.10	0.6-4.3	2.1±0.09
Haloan	Mudfish	Chanidae	*Channa striata*	11.0	7.4-73.0	16.0±5.2	3.4-426.1	48.3±34.0
Pantat	Catfish	Clariidae	*Clarias batrachus*	1.0	19.5	19.5±0.0	55.8	55.8±0.0
Puyo	Climbing Perch	Anabantidae	*Anabas testudineus*	1.0	15.0	15.0±0.0	57.4	57.4±0.0

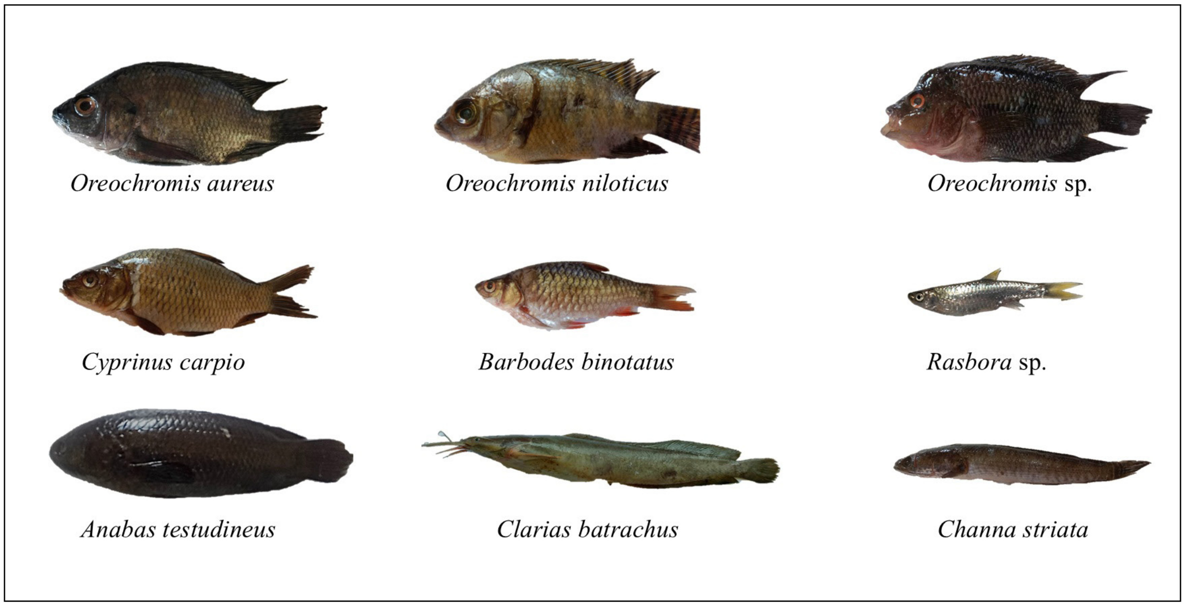

Figure 2. Fish species composition in Lake Wood, Zamboanga del Sur, Philippines

niloticus, blue tilapia *O. aureus*, and *Oreochromis* sp.), Cyprinidae (common carp *Cyprinus carpio* locally known as "karpa" and spotted barb *Barbodes binotatus* or "paitan"), Danionidae (*Rasbora* sp. or "porang"), Channidae (mudfish *Channa striata* or "haloan"), Clariidae (catfish *Clarias batrachus* or "pantat"), and Anabantidae (climbing perch *Anabas testudineus* or "puyu"). The Cichlidae family, which included *O. niloticus*, was characterized by a moderately deep body, olive-gray coloration, faint vertical bars, and a slightly protruding mouth. *O. aureus* displayed a deeper, more compact body with a bluish-silver hue and darker fin margins. The unidentified *Oreochromis* sp. had a mottled appearance, with variable pigmentation and no definitive diagnostic features for precise species identification. This phenotype has not been documented in previous studies from Lake Wood (e.g., Supersales et al. 2014; Ganzon and Demayo 2022). Furthermore, local fishers identify this specimen only as "tilapia," without distinguishing it from other *Oreochromis* species. Its ambiguous morphology suggests it may be a hybrid or an introduced strain of unknown origin. Due to the absence of distinct taxonomic features and genetic confirmation, it was conservatively classified as *Oreochromis* sp., and further molecular analysis is recommended for proper identification. Among the Cyprinidae, *C. carpio* exhibited a stout, torpedo-shaped body covered with large, shiny cycloid scales, two pairs of barbels on the upper jaw, and a bronze to olive-brown coloration. *B. binotatus* was smaller and laterally compressed, with golden-bronze flanks, a distinct black spot near the base of the caudal fin, and reddish pigmentation on the pelvic and anal fins. *Rasbora* sp., now classified under the Danionidae family following current taxonomic standards (Froese and Pauly 2023), is locally known as "porang" and was the most slender among the sampled species. It had a streamlined, fusiform body with silvery scales, a forked caudal fin edged in yellow, and relatively large eyes. While earlier studies in Lake Wood and nearby freshwater systems (e.g., Supersales et al. 2014; Ganzon and Demayo 2022) traditionally classified *Rasbora* under Cyprinidae, recent literature has acknowledged its reassignment to Danionidae. Additionally, the precise species identity remains unresolved, with some authors referring to the Lake Wood population as *Rasbora everetti* (Ganzon and Demayo 2022), while others suggest *R. philippina* (Genovia et al 2023), a species associated with Lake Mainit per FishFase. Due to this ambiguity, we conservatively refer to it as *Rasbora* sp., and recommend further molecular studies to clarify its species identity and possible endemism. *C. striata* possessed an elongated, cylindrical body with a broad head, large mouth, mottled dark coloration, and a prominent air-breathing organ enabling survival in low-oxygen environments. *C. batrachus* was distinguished by its scaleless, smooth skin, broad flat head, long barbels that aid in benthic foraging, and an accessory breathing organ. Finally, *A. testudineus* was recognized by its oval-shaped body, upturned mouth, spiny dorsal fin, and well-developed labyrinth organ, allowing it to breathe air and survive out of water for extended periods.

The observed species composition reflects a diverse, albeit slightly reduced, fish assemblage compared to previous studies. Supersales et al. (2014) reported eleven freshwater taxa in Lake Wood, while Ganzon and Demayo (2022) documented species from seven families, including Osphronemidae and Gobiidae, which were not observed in the present study. This discrepancy may be partly methodological—our sampling relied on actual fisher catches, which tend to be selective and constrained by gear type, fishing location, and declining effort. Based on informal interviews with local fishers (e.g., Ranie Ligasan and Manilyn Tatas, personal communication, April 21, 2023), the number of fish species traditionally caught in the lake has never been particularly high. However, the volume of catch per species—particularly for dominant taxa like tilapia, carp, and especially "porang" (*Rasbora* sp.)—used to be abundant. In recent years, fishers have observed a marked decline in the volume of their catch, with "porang" now rarely seen in significant numbers. Additionally, fishers reported occasional bubbling events in certain areas of the lake, sometimes accompanied by the release of white gas or vapor from the water surface. These emissions were also associated with a distinct sulfide-like odor, which fishers suspect may indicate underlying geothermal activity. While these observations remain anecdotal, they raise important ecological questions. The potential release of sulfide compounds into the water may influence fish health, fish behavior, or habitat preference, possibly contributing to the observed shifts in species abundance and composition. As such, these localized environmental phenomena may be an important factor affecting the lake's current biodiversity. Further limnological or geochemical investigations are recommended to explore the possible influence of geothermal activity on fish diversity and community structure in Lake Wood. Despite the reduced catch volume and local concerns, this study reaffirms the ecological richness of Lake Wood. The presence of both herbivorous and omnivorous species indicates a well-structured trophic system, while the continued dominance of tilapia and carp underscores anthropogenic influences, particularly from aquaculture and small-scale fisheries.

The gut content metrics—including numerical abundance (%N_i), volumetric composition (%V_i), frequency of occurrence (%O_i), Index of Preponderance (IPi), and Index of Relative Importance (IRI_i and %IRI_i)—for the fish species collected from Lake Wood are presented in Table 2. The dietary analysis of nine freshwater fish species collected

Table 2. Gut content metrics of the freshwater fishes in Lake Wood

Fish	Food Item	N_i	%N_i (Ni/ΣN) x100	V_i	%V_i (Vi/ΣV) x100	Oi	%Oi (Ni/N) x100	ViOi	%IPi (ViOi/ ΣViOi) x100	Rank	IRIi (%Ni+%Vi) x%Oi	% IRIi	Rank
Nile Tilapia	Algae	7	70	7	53.8	1	100	7	73.1	I	12385	79.1	I
	Fish	3	30	6	46.2	0.43	42.9	2.57	26.9	II	3264	20.9	II
	Σ	10	100	13	100	1.43	143	9.57	100		15648	100	
Tilapia	Algae	4	44.4	4	13.8	1	100.0	4.00	18.8	II	5819	39.3	II
	Insect	1	11.1	2	6.90	0.25	25.0	0.50	2.35	III	450	3.04	III
	Mollusk	3	33.3	22	75.9	0.75	75.0	16.5	77.6	I	8187	55.2	I
	Shrimp	1	11.1	1	3.40	0.25	25.0	0.25	1.18	IV	364	2.45	IV
	Σ	9	100	29	100	2.25	225	21.3	100		14820	100	
Blue Tilapia	Algae	1	100	1	100	1	100	1.00	100	I	20000	100	I
	Σ	1	100	1	100	1	100	1	100		20000	100	
Common carp	Algae	5	50	5	31.3	1	100	5.00	62.5	I	8125	71.3	I
	Mollusk	2	20	4	25.0	0.40	40	1.60	20	II	1800	15.8	II

Continuation of Table 2. Gut content metrics of the freshwater fishes in Lake Wood

Fish	Food Item	N_i	$\%N_i$ (Ni/ΣN) x100	V_i	$\%V_i$ (Vi/ΣV) x100	Oi	%Oi (Ni/N) x100	ViOi	%IPi (ViOi/ ΣViOi) x100	Rank	IRIi (%Ni+%Vi) x%Oi	% IRIi	Rank
	Shrimp	1	10	2	12.5	0.20	20	0.40	5	IV	450	3.95	IV
	Fish	1	10	4	25.0	0.20	20	0.80	10	III	700	6.14	III
	Sand	1	10	1	6.25	0.20	20	0.20	2.5	I	325	2.85	I
	Σ	10	100	16	100	2	200	8	100		11400	100	
Spotted barb	Algae	3	60	3	75	1	100	3.00	81.8	I	13500	81.8	I
	Mollusk	1	20	1	25	0.33	33.3	0.33	9.09	II	1500	9.09	II
	Sand	1	20	1	25	0.33	33.3	0.33	9.09	II	1500	9.09	II
	Σ	5	100	5	125	1.67	167	3.67	100		16500	100	
"Porang"	Algae	54	100	54	100	1	100	54.0	100	I	20000	100	I
	Σ	54	100	54	100	1	100	54	100		20000	100	
Climbing Perch	Algae	1	50	1	50	1	100	1.00	50	I	10000	50.0	I
	Sand	1	50	1	50	1	100	1.00	50	I	10000	50.0	I
	Σ	2	100	2	100	100	100	100	100		20000	100	
Catfish	Algae	1	50	1	50	1	100	1.00	50	I	10000	50.0	I
	Sand	1	50	1	50	1	100	1.00	50	I	10000	50.0	I
	Σ	2	100	2	100	2	200	2	100		20000	100	
Mudfish	Algae	10	78.6	11	78.6	1	100.0	11.0	92.4	I	15717	92.4	I
	Insect	3	21.4	3	21.4	0.3	30.0	0.90	7.56	II	1285	7.56	II
	Σ	13	100	14	100	1.3	130	11.90	100		17002	100	

from Lake Wood revealed a wide array of food items, including algae, mollusks, insects, shrimp, fish, and sand. These dietary patterns highlight species-specific feeding strategies that reflect ecological roles and habitat utilization within the Lake Wood ecosystem. While genus-level identification of food items can enhance ecological resolution, such taxonomic detail was not always feasible in this study due to the advanced digestion of stomach contents. Many prey items appeared only as partially digested fragments—such as fish bones, mollusk shells, insect wings, or shrimp exoskeletons—making reliable identification beyond broader taxonomic or functional categories difficult. Consequently, food items were conservatively reported as general groups. Similar approaches have been adopted in other gut content studies where digestion obscured fine-scale identification (Mendoza et al. 2015; Manko 2016; Fabay et al. 2021; Kamimura 2022; Paglinawan et al. 2022). This ensures consistency and avoids overinterpretation of dietary data. Future studies are encouraged to incorporate molecular tools or stable isotope analysis to improve dietary resolution and trophic interpretation.

O. niloticus exhibited a mixed feeding strategy, with algae found in 100% of the examined individuals and fish remains present in 42.9%, indicating primarily herbivorous behavior with opportunistic piscivory. This adaptability may enhance its ecological success across variable habitats (Mugiya 1992; Froese and Pauly 2019), echoing similar feeding plasticity reported in Lake Shala, Ethiopia (Wagaw et al. 2022) and Lagos Lagoon, Nigeria (Abidemi-Iromini 2019). *Oreochromis* sp. showed a more diverse and generalist diet: algae were found in 100% of samples, mollusks in

75%, and both insects and shrimp in 25% of stomachs. These figures reflect opportunistic omnivory and are consistent with prior findings that tilapias capitalize on a broad array of resources in productive tropical lakes (Balirwa et al. 2003; Kamimura 2022). *O. aureus* was strictly herbivorous, with algae present in 100% of individuals, supporting its status as a specialist feeder reliant on primary producers. This dietary pattern, aligned with findings from Java, Indonesia (Arfiati et al. 2019) and Ethiopia (Wagaw et al. 2022), underscores its efficiency in algal consumption and its role in energy transfer at lower trophic levels. Among the Cyprinids, *C. carpio* demonstrated omnivory, with algae present in 100%, mollusks in 40%, and fish, shrimp, and sand in 20% of samples. Its substrate-feeding behavior is well-documented (Jenkins and Burkhead 1994; Mangi and Memon 2017), and our findings are consistent with other studies of benthic feeders that disturb sediment to access invertebrates and organic detritus (Dudgeon 2019; Kamimura 2022). *B. binotatus* also showed algae in 100% of samples and mollusks and sand in 33.3%, reflecting its benthic foraging tendencies. These results parallel studies on *Labeo bata* and similar cyprinids exhibiting generalized benthic feeding (Rao and Simhachalam 2018). *Rasbora* sp. ("porang") maintained an exclusively herbivorous diet, with algae detected in 100% of samples. Its dietary specialization is likely driven by morphological constraints, limiting it to phytoplankton and periphyton. This pattern minimizes dietary overlap with larger omnivores and matches findings from other endemic rasborine studies (Kottelat and Witte 1999). For instance, *R. argyrotaenia* from the Komering River in South Sumatra, Indonesia was identified as a plankton feeder, with phytoplankton—particularly diatoms—being the dominant food item (Ridho et al. 2022). Similarly, *R. tawarensis* in Lake Laut Tawar (Indonesia) exhibited a strong preference for algae and phytoplankton, specifically *Closteriopsis longissima*, confirming its classification as a planktonphagous species (Muchlisin et al. 2015). These consistent feeding behaviors among rasborines suggest a common ecological niche as primary consumers in tropical freshwater ecosystems, where they play a vital role in linking primary producers to higher trophic levels. While species-level identification remains uncertain for the Lake Wood population, its exclusive herbivory reinforces its functional role as a specialized herbivore, which is in agreement with patterns seen across Southeast Asian *Rasbora* species. *C. striata* had algae present in all stomachs examined (100%) and insects in 30%, suggesting an omnivorous feeding habit with occasional predatory behavior. This dual strategy is common in lentic snakeheads and mirrors seasonal prey variability in Lake Mainit , Philippines (Paglinawan et al. 2022). Air-breathing fishes like *A. testudineus* and *C. batrachus* each showed 100% frequency of algae and sand, confirming their benthic omnivory. These species are adapted to hypoxic conditions and sediment-rich environments, and their diets reflect flexible feeding on algae, detritus, and sediment-associated invertebrates (Chipps and Garvey 2006; Manko 2016). The presence of sand in 17.4% of the fish units (13.65% volume) further confirms the substrate-foraging habits of multiple benthic species. While not nutritive, sand ingestion is likely incidental during foraging for prey in soft substrates (Dadebo et al. 2014; Nath et al. 2015).

These findings reveal a spectrum of feeding adaptations among the Lake Wood fish community—from strict herbivory (*Rasbora* sp., *O. aureus*), to generalist omnivory (*C. carpio*, *B. binotatus*), and opportunistic predation (*C. striata*, *O. niloticus*). Algae emerged as the most commonly consumed item across species, underscoring their central role in the lake's trophic dynamics. The dominance of algae as a dietary resource may reflect their high availability and productivity in Lake Wood, a feature shared with other tropical freshwater systems in the country such as Liguasan Marsh (Fabay et al. 2021).

The analysis of dietary importance using the Index of Preponderance (IP_i), Index of Relative Importance (IRI_i), and its proportional value ($\%IRI_i$) provides a comprehensive understanding of which food items were most influential in shaping the trophic strategies of fish species in Lake Wood. Higher values indicate a greater contribution of that food item to the overall diet. The accompanying ranking column denotes the relative dominance of each food item within the diet, with "I" representing the most dominant item and "IV" the least (Liao et al. 2001; Hart et al. 2002). Across most species, algae emerged as the most dominant dietary component, highlighting its critical ecological role in this tropical freshwater system. Among the Cichlids, *O. niloticus* primarily consumed algae, which held the highest dietary significance (IP_i = 73.1%; $\%IRI_i$ = 79.1%), while fish contributed a smaller yet notable proportion (IP_i = 26.9%; $\%IRI_i$ = 20.9%). This dual feeding strategy supports the species' classification as a facultative omnivore capable of herbivory and opportunistic predation. *Oreochromis* sp. exhibited a marked shift in feeding strategy, with mollusks ranking as the most important dietary item (IP_i = 77.6%; $\%IRI_i$ = 55.2%), followed by algae (18.8%) and smaller proportions of insects and shrimp. This shift suggests an increased reliance on protein-rich prey, indicative of ecological flexibility and access to varied food resources. *O. aureus* and *Rasbora* sp. ("porang") both demonstrated exclusive herbivory, with algae achieving 100% in all feeding indices (IP_i and $\%IRI_i$). Their diets reflect dietary specialization likely shaped by morphological constraints and the consistent availability of algae in the lake environment. In the Cyprinidae, *C. carpio* ranked algae as the most important dietary item (IP_i =62.5%, $\%IRI_i$ = 71.3%), while mollusks came second (IP_i =20%, $\%IRI_i$ = 15.8%). Fish, shrimp, and sand were minor contributors, each comprising less than 7% of the total dietary importance. This wide dietary spread supports the generalist feeding behavior typically observed in common carp, enabling it to thrive in various freshwater conditions. *B. binotatus* similarly prioritized algae (IP_i and $\%IRI_i$ = 81.8%) but also included mollusks and sand in its diet (9.09% each), reinforcing its benthic foraging behavior in structurally complex habitats. In the case of air-breathing species, both *A. testudineus* and *C. batrachus* showed equal reliance on algae and sand, with each accounting for 50% of their dietary importance. This pattern reflects omnivorous and substrate-associated feeding strategies, which are common among these species in tropical lentic environments. *C. striata* predominantly fed on algae (IP_i and $\%IRI_i$ = 92.4%), with insects contributing a smaller share of the diet (7.56%). This combination reflects a trophic position between herbivore and mid-level predator.

These patterns align with the findings of Fabay et al. (2021), who reported algae as the dominant dietary item among eight prevalent fish species in Liguasan Marsh. Their study, which included families such as Cyprinidae, Anabantidae, Clariidae, Channidae, and Cichlidae, closely mirrors the species composition found in Lake Wood, with the exception of Gobiidae and Osphronemidae, which were not observed in the present study. The consistent dominance of algae in the diets of most species affirms its role as a basal food source within Lake Wood's food web. Its availability, ease of digestion, and high productivity likely contribute to its widespread consumption. Meanwhile, the varying importance of other dietary items—such as mollusks, insects, and detrital components like sand—reflects the influence of ecological niche, foraging strategy, and species-specific morphological adaptations. These trophic structures are parallel observations in other tropical rivers and lakes where herbivory dominates, but secondary trophic strategies provide resilience during prey shortages (Chipps and Garvey 2006; Kamimura 2022).

Table 3 summarizes each food item's cumulative percentage volume (%V) and the percentage of fish units consuming them (%U), offering a broader view of resource availability and dietary preferences within the Lake Wood fish community. Among all food items, algae stood out as the most abundant and widely utilized dietary component. It accounted for 60.43% of the total gut content volume and was present in 43.48% of the fish sampled. This dual dominance in both availability and consumption emphasizes algae's foundational role in sustaining multiple trophic levels in the lake ecosystem. Its dominance was also observed in Liguasan Marsh, Lake Taal, and rivers in Surigao and North Cotabato (Mendoza et al. 2015; Estal-Mercado 2018; Fabay et al. 2021; Donia et al. 2023). Sand, while not a direct nutritional source, was the second most voluminous component (%V = 13.65%) and consumed 17.39% of fish units. Its frequent presence likely reflects incidental ingestion during substrate foraging, particularly among bottom-feeding species such as *C. carpio*, *C. batrachus*, and *A. testudineus*. This observation aligns with Dadebo et al. (2014), who reported similar patterns in benthic fishes, emphasizing that sand often accompanies small prey and detritus in sediment-rich environments. Mollusks were present in 13.07% of total volume and consumed by 13.04% of fish units, notably in *Oreochromis* sp. and *C. carpio*. Their inclusion

Table 3. Cumulative Percentage Volume (%V) for each food item and the percentage of fish units consuming each food item (%U)

Food Item	Cumulative %Volume	%U
Algae	60.43	43.48
Sand	13.65	17.39
Mollusk	13.07	13.04
Fish	7.70	8.70
Insect	3.70	8.70
Shrimp	1.45	8.70
Σ	100.00	100.00

highlights the adaptability of these fish in exploiting benthic macroinvertebrates when available, similar to findings in *O. andersonii* in African floodplains (Kefi et al. 2016). Other dietary components, such as fish, insects, and shrimp, had lower cumulative volumes (%V ranging from 1.45% to 7.70%) and were found in 8.70% of the fish units. Despite their relatively low abundance, these items play an important role in the diets of more predatory or opportunistic feeders, such as *O. niloticus*, *Oreochromis* sp., and *C. striata*. Their inclusion highlights their opportunistic feeding habits and responsiveness to seasonally available protein sources (Tang and Ng 1998).

These feeding patterns suggest Lake Wood supports a multi-trophic yet algae-driven food web. The presence of omnivores and facultative predators enhances ecosystem resilience through trophic plasticity. Similar structures have been documented in other Southeast Asian freshwater systems where nutrient availability, macrophyte density, and seasonal flooding shape food web dynamics (Chipps and Garvey 2006; Allan and Castillo 2007). The reliance on algae by both native and introduced species indicates that primary production is sufficient to support a diverse assemblage. However, the presence of protein-rich items such as mollusks and invertebrates enhances dietary breadth and interspecific coexistence. These findings underline the importance of preserving algal productivity and benthic habitats to sustain Lake Wood's fisheries, as the data may offer significant insights into species diversity, trophic interactions, and overall ecological relevance.

This gut content analysis of freshwater fishes in Lake Wood, Zamboanga del Sur, provides valuable baseline data on the trophic ecology of nine species across six families. The findings revealed varying dietary strategies, from strict herbivory (*Rasbora* sp., *O. aureus*) to omnivory and opportunistic predation (*C. striata*, *O. niloticus*, *C. carpio*). Algae were the most dominant and frequently consumed food item, underscoring their central role in the lake's food web. Other items, such as mollusks, insects, shrimp, and fish, were consumed to lesser degrees, indicating dietary plasticity and benthic foraging behavior among several species. The application of feeding indices (%Oi, %Vi, IPi, IRI) highlighted differences in trophic importance and resource use. These results suggest that Lake Wood supports a multi-trophic, algae-driven ecosystem. Sustaining primary productivity and benthic habitat quality is vital for maintaining fish biodiversity and ecosystem resilience, particularly amid increasing anthropogenic pressures and environmental variability.

AUTHORS CONTRIBUTIONS

Gonzaga-Torino FM: Conception and design of study, Investigation, Writing – Original draft preparation. **Gonzaga Jr AM:** Investigation, Data Analysis, Writing – Original draft preparation. **Gonzaga FM**: Data Analysis and Interpretation of Data, Writing – Original draft preparation. **Tahiluddin AB**: Writing – Reviewing and Editing. **Pedroso FL:** Conception and design of study, Writing – Reviewing and Editing.

CONFLICTS OF INTEREST

We declare no conflict of interest in doing this work.

ETHICS STATEMENT

This study did not deal with live animals nor humans as subjects.

REFERENCES

Abidemi-Iromini A. 2019. Assessment of stomach contents of *Oreochromis niloticus* from the Lagos Lagoon, Nigeria. Int J Fish Aquat. 11:1–6. https://doi.org/10.5897/IJFA2018.0687

Allan J, Castillo M. 2007. Stream ecology: structure and function of running waters. Dordrecht (Netherlands): Springer.

Andot LP, Pobar RA. 2017. Dried porang industry in Lakewood, Zamboanga del Sur, Philippines. Int J Environ Rural Dev.

Arfiati D, Kertikasari FS, Cokrowati N, Puspitasari AW. 2019. Gut content analysis of tilapia (*Oreochromis niloticus*) from Jagir River, Surabaya City, East Java. AIP Conf Proc. 2120(1):040007. https://doi.org/10.1063/1.5115645

Balirwa JS, Chapman CA, Chapman LJ, Cowx IG, Geheb K, Kaufman L, Welcomme RL. 2003. Biodiversity and fishery sustainability in the Lake Victoria basin: an unexpected marriage? BioScience. 53(8):703–715.

Baludo MY, Papa RDS, Magbanua FS. 2021. Limnology of Lake Wood: an ancestral lake of the Subanen tribe. Philipp J Sci. 150(4):1231–1243.

Chipps SR, Garvey JE. 2006. Assessment of food habits and feeding patterns. In: Guy CS, Brown ML, editors. Analysis and interpretation of freshwater fisheries data. Bethesda (MD): American Fisheries Society. p. 473–514.

Dadebo E, Tekle-Giorgis Y, Tizazu E. 2014. Food and feeding habits of the African big barb Labeobarbus intermedius in Lake Koka, Ethiopia. Int J Curr Microbiol App Sci. 3(5):882–894.

Davies J. 1992. Types of wetlands and their protection in the Philippines. In: Protection and sustainable use of wetland resources in the Philippines. Proceedings of a workshop at the Institute of Forest Conservation, University of the Philippines.

Donia EA, Pautong AT, Pechon RR, Cecilio MA, Andales KM, Mallare TAB, Pendaliday UD Jr, Marabulas RC. 2023. The fisheries of Liguasan Marsh, North Cotabato, Mindanao, Philippines. Phil J Fish. 30(1): in press. https://doi.org/10.31398/tpjf/30.1.2021C0011

Dudgeon D. 2019. Invasive carp. Curr Biol. 29(8):R279–R280.

Estal-Mercado R. 2018. A freshwater fish inventory of Daniog River, Lanuza, Surigao del Sur, Philippines. Sci Int (Lahore). 30(1):141–145.

Fabay RV, Alejos MS, Fabay JV. 2021. Gut content analysis of freshwater fishes from Liguasan Marsh, Maguindanao. Uttar Pradesh J Zool. 42(2):227–232.

Froese R, Pauly D, editors. 2019. FishBase. World Wide Web electronic publication. FishBase. World Wide Web electronic publication. http://www.fishbase.org.

Froese R, Pauly D, editors. 2023. FishBase. World Wide Web electronic publication. http://www.fishbase.org.

Ganzon MM, Demayo CG. 2022. Fish diversity in selected small lakes in Mindanao, Philippines. AACL Bioflux. 15(2):796–810.

Genovia J, Barquilla M, Baludo M. 2023. Reproductive biology of *Rasbora philippina* at Lake Wood for basis management. J Environ Sci Sustain Dev. 6(1):149–166. doi:10.7454/jessd.v6i1.1112.

Hart R, Calver M, Dickman C. 2002. The index of relative importance: an alternative approach to reducing bias in descriptive studies of animal diets. Wildl Res. 29(5):415–421. doi:10.1071/WR02009.

Hyslop EJ. 1980. Stomach contents analysis—a review of methods and their application. J Fish Biol. 17(4):411–429.

Jenkins M. 2003. Prospects for biodiversity. Science. 302(5649):1175–1177.

Jenkins RE, Burkhead NM. 1994. Freshwater fishes of Virginia. Bethesda (MD): American Fisheries Society.

Kamimura Y. 2022. Evaluating the food and feeding habits of fish. J Aquac Eng Aquac Res. 8(1):1–9.

Kefi AS, Mumba CD, Mupenda N, Kujila GM, Chilongo R. 2016. Sex-dependent condition factor and index of preponderance of *Oreochromis andersonii* (Castelnau, 1861) fed with artificial feed in fertilized ponds. Int J Fauna Biol Stud. 3(5):130–136.

Kottelat M, Witte K-E. 1999. Two new species of Aphyosemion from Gabon, with a discussion of taxonomic problems in the genus (Cyprinodontiformes: Aplocheilidae). Ichthyol Explor Freshwaters. 10(2):139–148.

Liao H, Pierce C, Larscheid J. 2001. Empirical assessment of indices of prey importance in the diets of predacious fish. Trans Am Fish Soc. 130(4):583–591. https://doi.org/10.1577/1548-8659(2001)130<0583:EAOIOP>2.0.CO;2

Mangi A, Memon Z. 2017. Analysis of gut contents of common carp (*Cyprinus carpio*) in District Larkana, Sindh, Pakistan. J Entomol Zool Stud. 5(6): 2631-2634. https://www.entomoljournal.com/archives/2017/vol5issue6/PartAJ/5-6-154-542.pdf

Manko PV. 2016. Stomach content analysis in freshwater fish feeding ecology. Prešov (Slovakia): University of Prešov.

Mendoza M, Legaspi K, Acojido M, Cabais A, Guzman J, Favila A, Lazo S, Rivera J, Briones J, Papa RD. 2015. Dietary habits and distribution of some fish species in the Pansipit River–Lake Taal connection, Luzon Island, Philippines. J Environ Sci Manag. 18(2):1–9. doi:10.47125/jesam/2015_2/01.

Muchlisin ZA, Rinaldi F, Fadli N, Adlim M, Siti-Azizah MN. 2015. Food preference and diet overlap of two endemic and threatened freshwater fishes, depik (*Rasbora tawarensis*) and kawan (*Poropuntius tawarensis*) in Lake Laut Tawar, Indonesia. Aceh J Anim Sci. 8(1):40–49. https://www.researchgate.net/publication/279486132_Food_preference_and_diet_overlap_of_two_endemic_and_threatened_freshwater_fishes_depik_Rasbora_tawarensis_and_kawan_Poropuntius_tawarensis_in_Lake_Laut_Tawar_Indonesia

Mugiya Y. 1992. Tilapia culture in Africa. Aquac Mag. 18(3):79–85.

Nath SR, Beraki T, Abraha A, Kiflom A, Yonas B. 2015. Gut content analysis of Indian mackerel (*Rastrelliger kanagurta*). J Aquac Mar Biol. 3(5):268–272.

Paglinawan RJ, Paylangco R, Paylangco JC, Along A, Almadin FJ. 2022. Association of size structure, diet composition, endo-parasites of snakehead fish (*Channa striata*, Bloch), in Lake Mainit, Caraga Region, Philippines. Southeast Philipp J Res Dev. 27(2):Article 2. https://doi.org/10.53899/spjrd.v27i2.135

Pratt WE. 1916. Philippine lakes. Philipp J Sci. 11(3):223–237.

Rao PG, Simhachalam G. 2018. Food and feeding habits of freshwater fish *Labeo bata* (Hamilton, 1822) from the River Godavari. Int J Pharm Biol Sci. 8(2):403–408.

Ridho MR, Setiawan A, Sarno S, Suthari N, Mulyani Y, Avesena M. 2022. Food habit and feeding habit of the silver rasbora (*Rasbora argyrotaenia* Blkr) in waters of Sungai Dua Village, downstream of Komering River, South Sumatra. IOP Conf Ser Earth Environ Sci. 995:012057. https://doi.org/10.1088/1755-1315/995/1/012057

Sagar MV, Rekha JR, Ambarish G. 2019. Stomach content analysis techniques in fishes. In: Recent advances in fishery biology techniques for biodiversity evaluation and conservation. Kochi (India): ICAR-Central Marine Fisheries Research Institute. p. 104–115.

Saikia SK. 2015. Food and feeding of fishes: what do we need to know? Transylv Rev Syst Ecol Res. 17(2):71–84.

Supersales JB, Zafaralla MT, Sacala JM, Nabasca JS. 2014. Water quality and fish fauna in Lakewood Lake, Zamboanga del Sur, Philippines. Int J Ecosyst Ecol Sci. 4(3):433–442.

Tang WQ, Ng PKL. 1998. The status and distribution of freshwater fishes of Indo-Burma. In: Proceedings of the Second International Conference on Indo-Pacific Fishes. Bangkok (Thailand). p. 199–201.

Van der Ploeg J, Vermeersch L, Rodriguez D, Balbas M, Van Weerd M. 2017. Establishing freshwater protected areas to protect biodiversity and improve food security in the Philippines. In: Marine protected areas: interactions with livelihoods and food security. Rome (Italy): FAO. p. 31–42.

Wagaw S, Mengistou S, Getahun A. 2022. Diet composition and feeding habits of *Oreochromis niloticus* (Linnaeus, 1758) in Lake Shala, Ethiopia. Fish Aquat Sci. 25(1):20–30. https://doi.org/10.47853/FAS.2022.e3t