



FISH ASSEMBLAGES AS INDICATORS OF PEAT SWAMP HEALTH: EVALUATING FISH DIVERSITY IN THE SUNGAI KARANG FOREST RESERVE, SELANGOR, MALAYSIA

Rohasliney Hashim* and Muhammad Norshahidi Alias

*Department of Environmental Management, Faculty of Forestry and Environment,
Universiti Putra Malaysia, Malaysia*

Peat swamp forests are among the most distinctive and threatened freshwater ecosystems in Southeast Asia, providing critical habitats for endemic and endangered aquatic species. This study evaluated fish assemblages as indicators of peat swamp health in the Sungai Karang Forest Reserve, Selangor, Malaysia. Sampling was conducted over a month, from August 23, 2020, to September 24, 2020, across five habitat-diverse sites, utilizing two complementary capture methods, such as fish traps and scoop nets, to maximize species detection. A total of 423 individual fish representing 13 species, six families, and five orders were recorded. The Osphronemidae family was the most diverse, comprising over half of the total assemblage, with notable presence of *Betta livida* and *Betta hipposideros*, both classified as endangered by the IUCN. Catch per unit effort (CPUE) assessments revealed that *Betta livida* was the most captured species using fish traps and scoop nets combined, indicating its abundance. *Pristolepis fasciata* and *Betta bellica* also showed high capture rates, along with notable catches of *Helostoma temminckii*, *Trichopodus trichopterus*. Biodiversity was assessed using three ecological indices. The Shannon-Wiener diversity index yielded a value of 2.36, indicating moderate to high species diversity, while the Berger-Parker dominance index of 0.14 reflected low dominance by any single species. Notably, scoop nets proved more effective than fish traps in terms of capture volume and species range, accounting for 75.7% of the total individuals collected. Significant differences in catch composition between the two gear types were statistically supported ($F = 56.573$, $p < 0.05$), highlighting the influence of sampling methods on biodiversity assessments. The Sungai Karang Forest Reserve has a diverse freshwater fish community, highlighting its ecological importance. The presence of endangered species emphasizes the need to protect peat swamp habitats from threats like habitat alteration, runoff, and ecotourism. Ongoing biodiversity monitoring, habitat conservation, and community efforts are crucial to preserve Malaysia's peat swamp ecosystems.

Keywords: peat swamps, fish, diversity, indicator, diversity index, CPUE

***Corresponding Author:** rohasliney@upm.edu.my



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Rohasliney Hashim and M. N. Alias

*Department of Environmental Management, Faculty of Forestry and Environment,
Universiti Putra Malaysia, Malaysia*

INTRODUCTION

Peat swamp forests are a unique freshwater habitat characterized by highly acidic, dark water. This stunning wetland ecosystem is formed from the accumulation of organic matter that has been composed over thousands of years under saturated conditions, resulting in carbon-rich soil (Fahmi Ahmad & Samat, 2015). These forests host a diverse range of flora and fauna, including endangered species found in Malaysia, which may face extinction in the future (Kamal et al., 2022; Sule et al., 2016; Thornton et al., 2016). Among the fascinating species that inhabit this environment is the Golden Arowana (*Sceloropagus formosus*) (Fahmi-Ahmad et al., 2024). Furthermore, peat swamp forests can play a crucial role in supplying water for domestic activities in the surrounding area and have become popular tourist attractions due to their economic potential (Sule et al., 2018).

In Selangor, the vast peat swamp forest is in the northwestern region of the state. Historically, the South-East Pahang peat swamp forest was the largest, followed by the North-South Peat Swamp Forest (NSPSF) (Jabatan Perhutanan Negeri Selangor, 2012). The NSPSF spans 81304 hectares and encompasses four Forest Reserves: Raja Musa Forest Reserve (36,938 hectares), Bukit Belata Extension Forest Reserve (1,635 hectares), Sungai Dusun Forest Reserve (2,201 hectares), and Sungai Karang Forest Reserve (36,654 hectares) (Global Environment Centre, 2014). Recognized as the largest remaining peat swamp forest along the west coast of Peninsular Malaysia, the North-Western Peat Swamp Forest plays a vital role in conserving flora and fauna, managing water resources effectively, and storing carbon (Sule et al., 2018). This region supports a rich diversity of fish, with various studies recording 92 fish species, some of which are classified as endangered (Shuhada et al., 2025). Consequently, peat swamp forests are vital assets for our country, providing crucial habitats for endangered species. Conserving these species is paramount, as they hold future value and contribute to the ecological diversity of the peat swamp ecosystem.

The primary issue observed at the Sungai Karang Forest Reserve in Kuala Selangor is the limited influence of human development on the peat swamp forest ecosystem. Local agricultural activities and nearby housing have the potential to impact this ecosystem negatively. Many peat swamp forests have already suffered degradation due to illegal logging, forest fires, and agricultural conversion (Shuhada et al., 2025). Additionally, the reserve's popularity for ecotourism and agriculture contributes to pollution in the area. Uncontrolled development poses a risk to fish populations, as the peat swamp is crucial for the survival of unique freshwater species. Habitat loss



and human disturbance are critical threats to Malaysia's freshwater fish, leading to the extinction of endemic species. According to Sule et al. (2018), human exploitation for agriculture poses a threat to peat swamp forests. Local communities frequently enter the reserve to harvest *Licuala* palm leaves, used in Malaysian cuisine for wrapping and cooking rice dishes. They also rely on other forest resources for their livelihoods, which further disturbs the aquatic ecosystem, mainly affecting fish in temporary water bodies. A forest fire poses a significant threat to peat swamps, potentially degrading the habitats within the ecosystem. Additionally, the status of fish assemblages in Sungai Karang Forest Reserve remains poorly understood, particularly regarding endangered species in the area. Therefore, this study aims to identify fish assemblages and assess fish diversity using diversity indices as indicators of the health of the peat swamp ecosystem.

METHODOLOGY

Study Area

The study was conducted in the Sungai Karang Forest Reserve in Selangor, Malaysia. This research focused on different habitat characteristics and locations. The Sungai Karang Forest Reserve is surrounded by a residential area. Additionally, Sungai Karang has become an eco-tourism destination for those who wish to enjoy outdoor activities like traversing the peat swamp forest and kayaking. Furthermore, residents utilize water from the nearby river as a source of water for their daily activities, such as drinking and agricultural needs.

Sampling periods

The data used in this study were primarily collected from August 23, 2020, to September 24, 2020. Sampling was conducted 7 days a week for a month.

Fish collection

In total, five sampling points were identified based on varying habitat characteristics and their locations around the Sungai Karang Forest Reserve. These diverse habitat types (i.e., blackwater pools, flooded forest floor, peat channels, leaf litter beds, swamp margins) were selected to fulfil the study's goal of assessing fish diversity at these points. The chosen locations were evaluated for safety, ensuring minimal risk from wild animals, including monkeys and snakes.

The five selected sampling sites were located within the forest. Fish were captured using two techniques: fish traps and scoop nets. Each day, the positions for the fish traps and scoop nets were randomly determined. Fish traps were strategically placed in water areas with a minimum depth of 1 meter, while shallower areas with depths under 1 meter were used for scoop net sampling. Additionally, fish were collected from areas beneath submerged, emergent, and floating vegetation. Fish traps were deployed overnight and monitored twice—once in the morning and again in the late evening. Concurrently, scoop net sampling took place from morning through late afternoon. The sample size for this study was 280 samples/forest reserve ($n=5$ sampling sites $\times$ 2 fish gears $\times$ 7 days $\times$ 4 weeks = 280)



Fish samples obtained with both fishing gears were identified and measured. Measurements included length (in cm) and weight (in g), using a digital scale along with a ruler or measuring tape. Each species caught was identified at the species level whenever possible. All fish were released back into their natural habitat.

Data analysis

The diversity of the fish populations was assessed using several indices, including the Shannon-Wiener, Simpson, and Berger-Parker indices. To compare diversity across sampling sites, a one-way ANOVA was conducted. Additionally, t-tests were used to determine differences in fish populations caught with the two fishing gears.

Fish population evaluation was conducted using the Catch per Unit Effort (CPUE) metric. In this context, CPUE is measured as area per day, providing a standardized way to assess fishing efficiency and productivity.

RESULTS AND DISCUSSION

Fish composition and status

An extensive survey captured 423 fish from 13 species across five orders and six families, providing valuable insights into the region's aquatic biodiversity. Notably, *Betta livida*, made up an impressive 14.18% of the total catch.

The Osphronemidae family stood out as the most diverse, showcasing a remarkable variety of species, including *Sphaerichthys osphromenoides* (Biji Durian), *Belontia hasselti* (Kepar), *Trichopodus trichopterus* (Sepat), *Anabas testudineus* (Puyu), *Betta bellica* (Pelaga Hijau), *Betta hipposideros* (Betta Kuda Besi), and *Betta livida* (Betta Cemburu) (Table 1).

The Osphronemidae family is particularly fascinating due to their unique adaptation to freshwater habitats. They possess a specialized air-breathing organ called the labyrinth, which allows them to thrive in low-oxygen environments, such as peat swamp forests. This adaptation not only improves their survival in stagnant waters, as noted by Moyle and Cech (2000), but also highlights their remarkable resilience in various aquatic ecosystems, including fast-moving streams.

Betta livida is recognized as an endangered species by the International Union for Conservation of Nature (IUCN). Its population decline is primarily due to overexploitation for the ornamental fish trade. Significantly, *Betta livida* has the highest catch volume among species captured with scoop nets, suggesting that the Sungai Karang Forest Reserve provides an ideal habitat for this endangered species. The gathered data illustrated that the Sungai Karang Forest Reserve is crucial for ecosystem conservation, as demonstrated by the presence of endangered species.

Table 10. Fish assemblages and status in Sungai Karang Forest Reserve, Selangor, Malaysia, were studied using two gears (fish traps and scoop nets) over a 1-month period.



Order	Family	Local name	Scientific name	Status*	Percentage (%)	
Actinopterygii	Pristolepididae	Patong	<i>Pristolepis fasciata</i>	NO	14 %	
	Channidae	Bujuk	<i>Channa lucius</i>	NO	7 %	
Anabantiformes	Osphronemidae	Biji Durian	<i>Sphaerichthys osphromenoides</i>	NO	3 %	
		Kepar	<i>Belontia hasselti</i>	NO	13 %	
		Sepat	<i>Trichopodus trichopterus</i>	NO	12 %	
		Puyu	<i>Anabas testudineus</i>	NO	8 %	
		Pelaga Hijau	<i>Betta bellica</i>	NO	9 %	
		Betta Kuda Besi	<i>Betta hipposideros</i>	EN	3 %	
		Betta Cemburu	<i>Betta livida</i>	EN	14 %	
		Cyprinidae	Seluang	<i>Rasbora kalochroma</i>	NO	4 %
		Siluriformes	Clariidae	Keli limbat	<i>Clarias nieuhofii</i>	NO
	Perciformes	Helostomatidae	Temakang	<i>Heleostoma temminckii</i>	NO	10 %
Channidae		Ruanjuk	<i>Channa bankanensis</i>	NO	2 %	

*Status is based on the IUCN Red List of Threatened Species. 2019; NO, not threatened; EN, endangered.

Fish captured using fish traps totalled 103 individuals, while scoop nets recorded 320 individuals. There are significant differences between fish caught with fish traps and those caught with scoop nets. The results showed that fish were caught using different gears ($f = 56.573$, $df = 1$, $p < .05$). The most common species caught with traps was *Belontia hasselti*, accounting for 50% of the total catch due to the specific characteristics of the sampling areas, which had higher water depths and better habitat conditions (Table 2). The least captured species with traps was *Pristolepis fasciata* (Patong), making up only 1.34% of the total. In contrast, the most frequently caught species with the scoop net was *Betta livida*, which accounted for 18.75% of the total catch, while *Belontia hasselti* was the least captured, accounting for 1.25%. An active sampling tool, such as a well-designed scoop net, proved effective for collecting fish, capturing more individuals than other methods. Its robust structure and fine mesh facilitated quick manoeuvrability in the water, making it possible to catch even the hardest-to-find fish.

Based on data derived from catch per unit effort (CPUE) assessments, *Betta livida* (Betta cemburu) emerged as the most frequently captured species when using fish traps and scoop nets combined. This indicates its significant presence and likely abundance in the studied aquatic environments. Following closely behind in terms of capture rates were *Pristolepis fasciata* (Patong) and *Betta bellica* (Pelaga Hijau), highlighting their prevalence. Additionally, the study found notable catches of *Heleostoma temminckii* (Temakang) and *Trichopodus trichopterus* (Sepat). The trends



illustrated in Figure 1 reflect not only the effectiveness of the fishing methods employed but also the relative population densities of these species within the ecosystem.

In the Sungai Karang Forest Reserve, a biodiversity assessment highlights an aquatic ecosystem with a Shannon-Wiener diversity index of 2.36, indicating moderate to high fish diversity. The value suggested that the ecosystem supports a relatively diverse community of species. This suggests a moderate variety of species contributing to ecological balance. Although not exceptionally high, values above two typically indicate a healthy ecosystem with good species richness and evenness. From a conservation perspective, this level of diversity indicates the habitat is still functioning ecologically and may be a priority for protection.

Additionally, the Berger-Parker index is 0.14, indicating low dominance by any species and reinforcing the balanced distribution among species. However, the study's one-month duration may limit the comprehensiveness of its findings regarding biodiversity in the reserve.

CONCLUSIONS/RECOMMENDATIONS

In conclusion, this study's findings highlight the ecological significance of the Sungai Karang Forest Reserve as a habitat for freshwater fish within a peat swamp ecosystem. The moderate to high diversity, as indicated by a Shannon-Wiener index of 2.36, combined with a low Berger-Parker dominance index of 0.14, reflects a relatively balanced fish community structure with minimal species dominance. The capture of 13 species across five orders, including endangered taxa such as *Betta livida* and *Betta hipposideros*, highlights the conservation importance of this habitat. The dominance of the Osphronemidae family and the efficacy of complementary sampling techniques provided robust insights into species composition and habitat use. Given the increasing anthropogenic pressures and the ecological fragility of peat swamp habitats, these findings support prioritizing long-term monitoring and targeted conservation strategies to safeguard the biodiversity of freshwater systems in Malaysia.

Table 11. Comparison of fish captured using fish traps and scoop nets for a one-month sampling in the Sungai Karang Forest Reserve, Selangor, Malaysia

Gear	Order	Family	Scientific name	Number of Individuals (%)
Fish traps	Actinopterygii	Pristolepididae	<i>Pristolepis fasciata</i>	2 %
		Channidae	<i>Channa lucius</i>	8 %
	Anabantiformes	Osphronemidae	<i>Belontia hasselti</i>	50 %
			<i>Trichopodus trichopterus</i>	15 %
		Anabantidae	<i>Anabas testudineus</i>	16 %
	Perciformes	Helostomatidae	<i>Heleostoma temminckii</i>	5 %
	Siluriformes	Clariidae	<i>Clarias nieuhofii</i>	4 %
Total number of individuals				103
Scoop net	Actinopterygii	Pristolepididae	<i>Pristolepis fasciata</i>	18 %



Anabantiformes	Anabantidae	<i>Anabas testudineus</i>	6 %
		<i>Betta Bellica</i>	11 %
		<i>Betta hipposideros</i>	4 %
		<i>Betta Livida</i>	19 %
	Osphronemidae	<i>Sphaerichthys osphromenoides</i>	4 %
		<i>Belontia hasselti</i>	1 %
		<i>Trichopodus trichopterus</i>	12 %
	Channidae	<i>Channa lucius</i>	7 %
Cypriniformes	Cyprinidae	<i>Rasbora kalochroma</i>	5 %
Perciformes	Channidae	<i>Channa bankanensis</i>	2%
	Helostomatidae	<i>Heleostoma temminckii</i>	11 %
Total number of individuals			320



Figure 18. Composition of fish caught in Sungai Karang Forest Reserve using fish traps and scoop nets

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