RESEARCH PAPER

Ecological status, distribution and conservation management of largemouth bass (*Micropterus salmoides)* in Pantabangan Lake, Nueva Ecija, Philippines: Implications to community-based management

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Abstract

Pantabangan Lake, renowned for its pristine waters and diverse native fish species, faces a pressing challenge with the invasion of largemouth bass (*Micropterus salmoides*), locally known as *Tawis*. Introduced in 1907, largemouth bass now dominates the ecosystem, altering its dynamics. The largemouth bass, a carnivorous species known for hunting in groups, lacks natural predators in Pantabangan Lake. However, if it consumes the barbels of catfish, both species perish. Consequently, human anglers stand as the primary means of largemouth bass population control. With their prevalence in nine out of ten boats compared to blackchin tilapia's presence in only four, largemouth bass exhibit greater aggression and widespread distribution throughout the lake. Catch weights typically peak at ¼ kilogram, with lengths ranging from 22.86 to 55.88 centimeters, indicating maturity. However, larger specimens above 50 centimeters are increasingly scarce. While the 30 surveyed respondents demonstrate awareness of largemouth bass presence and utilize them to some extent, further monitoring is essential to assess negative impacts on native fish populations. Management strategies should focus on mitigating ecological consequences, understanding environmental factors influencing largemouth bass behavior, growth, and distribution, and implementing measures to preserve Pantabangan Lake's biodiversity.

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Introduction

Pantabangan Lake is one of the largest reservoirs in Southeast Asia and one of the cleanest lakes in the Philippines (Santos, 2012). The Pantabangan Dam is a multi-purpose dam on the Pampanga River in Pantabangan, Nueva Ecija. Pantabangan Lake's reservoir enables flood control while also providing water for irrigation and hydroelectric power generation. The dam's construction started in 1971 and was completed in 1974 (Serrano, 2020). In addition to serving as Central Luzon's water supply, this area supports several fishermen. However, the dam, which was once a haven for local fish like dalag, biya, and hito, is now overrun by alien species. One of the alien species that reside in Pantabangan Lake is the largemouth bass or locally called as *Tawis*.

According to Fisheries and Oceans Canada 2021, largemouth bass *(Micropterus salmoides)* came from Centrarchidae (sunfishes) family in the order of Perciformes (perch-like fishes). They are enormous, elongated, streamlined sunfish with giant mouths. Largemouth bass has a dark olive green back and light green sides that fade to white underneath. Along the sides, a strip with dark mottling is present, and the top of the lip reaches past the eye. This species is native to the fresh waters of eastern-central North America. The most adaptable specie of all bass is the largemouth bass. Although they are ferocious predators that quickly take artificial bait, they are extremely alert to danger and only spend a small portion of each day feeding. Largemouth bass begins to eat fish when they are about 2 inches long. Its ability to consume more oversized prey items is constrained since they swallow live fish and other aquatic life whole rather than chewing off chunks. The greater the bass, the larger the prey that will be chosen. Typically, giant bass will not feed substantially on little fish. It is not easy to fully classify their feeding behaviors. Fulfilling their appetite is one of the reasons bass feed. The other is a reflex action toward anything that moves. "If food is present, eat it" is the bass's motto. When in the urge to eat, the bass will typically lurk and wait until an unaware quarry passes, or it may simply glide closer to its target, open its large mouth, and inhale forcefully. With a sudden indrawn of water circulation, largemouth bass swiftly drags the victim into its mouth. The attraction of sound or vibrations in the water may be a food source for largemouth bass. Even the slightest vibrations created by other fish or prey pushing aside water as they move through or onto it can be detected by them. They fully benefit from periods or locations of dim light because of their exceptionally sharp vision (Johnke, 1995; Davis and Lock, 1997).

According to the Philippine Game Fishing Foundation report of 2022, the largemouth bass (Florida strain) was introduced to the Philippines by Mr. Alvin Seale of California in 1907, primarily for its utility as both a food source and a recreational game fish. Subsequent to this initial introduction, Seale re-introduced largemouth bass to Philippine waters in 1915 and 1958, with stocking efforts notably occurring in Trinidad Lake located in the northern province of Benguet and Caliraya Lake in Laguna. Specifically concerning the Pantabangan Reservoir, it is documented that the former governor, Honorable Eduardo Nonato Joson, who held office as governor of Nueva Ecija during 1995-1998 (as cited in Roque, 2013), oversaw the release of bass stocks into the reservoir between 1995 and 2000. Following these introductions, largemouth bass populations have successfully established, bred, and proliferated within these aquatic environments. Furthermore, in addition to the three lakes mentioned, instances of largemouth bass being released into selected ponds and rivers within their vicinity have also been documented.

The researchers' study may be grounds for further research as specific studies have yet to be studied. This may serve as the initial study on the record of the status of the largemouth bass, also known as Tawis, in Pantabangan Dam. The information and data to be collected may significantly help future related research.

Material and methods

Research design

The researcher used the descriptive design that allows the researcher to get data from the respondents' subjective viewpoints. This data is then accurately and adequately interpreted, sometimes with little or no help from statistical tools. The qualitative approach is used to comprehend people's attitudes, interactions, behaviors, and beliefs, producing data that is not numerical (Pathak *et al.*, 2013). The researcher used the descriptive method using a qualitative approach in collecting the data from the respondents and information about the present condition since the qualitative approach investigates the why and how. The descriptive qualitative method analyzes the awareness and perception of the residents in Pantabangan about the largemouth bass and determines the prevalence of the invasive alien species within Pantabangan Lake. In addition, the researcher used frequency of occurrence to determine the occurrence of largemouth bass in a catch sample in Pantabangan Lake.

Research locale

The study was conducted in Pantabangan Lake, Nueva Ecija, an artificial reservoir in the Philippines and considered one of Southeast Asia's largest artificial reservoirs (Fig. 1). The area around the lake is relatively tranquil, with a lovely outlook. Viewing the magnificent scene of the lake surrounded by the Sierra Madre mountains allows you to experience peace. Fishes like carp, tilapia, snake murrel, and largemouth bass thrive in this lake to survive. Pantabangan is famous for sport fishing and is dubbed the hotspot of bass fishing in Asia (Hilotin, 2013). The researcher selected 30 respondents of fishermen and Pantabangan residents and used survey questionnaire, Likert scale and do catch sample to collect the data for this study.

Research instrument

The researchers used a survey questionnaire to collect the data for this study, which contains questions or statements regarding the study. The researcher also used the Likert scale for this study to gain insight and the resident's and fishermen's awareness and perceptions of the largemouth bass.
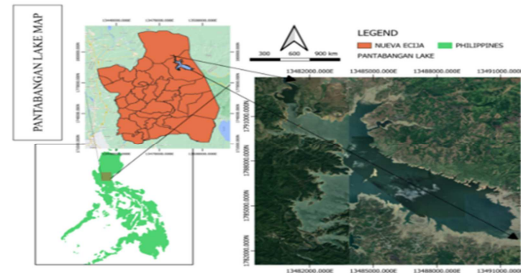
Fig. 1. Map of Pantabangan Lake, Pantabangan, Nueva Ecija, Philippines

Procedure of the study

The researchers asked permission from the target respondent before data gathering. The researcher surveyed questionnaires to gather the data needed for this study. The survey questionnaire comprises questions related to this study's objectives.

Data analysis

The researcher used discourse analysis to analyze the gathered data from the survey questionnaire. The data that has been collected are analyzed to conclude all the findings and the gathered data.

Results and discussion

Ecological status and distribution of largemouth bass (Micropteurs salmoides) in Pantabangan Lake

The highest largemouth bass catch was observed in boat 2, with eight individuals (Table 1). Boats 1, 3, 4, 5, 6, 8, 9, and 10 also reported catching largemouth bass in smaller quantities ranging from 1 to 4 individuals. Boat 2 had the highest catch of blackchin tilapia, with 346 individuals. Boat 3 reported the second-highest catch of black chin tilapia, with 56 individuals. Boats 5 and 6 also caught some black chin tilapia, albeit in smaller quantities. Boat 7, on the other hand, primarily caught goby and shrimp, and the fisherman mentioned leaving the fish trap all night. This suggests that goby and shrimp might have specific feeding behaviors or habitat preferences that make them more prone to being caught in fish traps left overnight. Boat 2 has the highest catch across multiple species; including largemouth bass, black chin tilapia, and shrimp. This could be attributed to the longer fishing duration of 6 hours and 45 minutes and the location near the mountain and in the middle of the lake.

Table 1. Frequency of occurrence

Boat	Largemouth Bass (*Micropterus salmoides*)	Black chin tilapia (*Sarotherodon melanotheron*)	Goby (*Glossogobius giuris*)	Shrimp (*Macrobrachium rosenbergii*)	Fishing duration	Fishing gear
1	3	0	0	0	30 minutes	Fishing rod with artificial lure
2	8	346	0	1	6 hours 45 minutes	Fishing net
3	3	56	1	1	4 hours	Fishing net
4	4	0	0	0	2 hours	Fishing rod with artificial lure
5	2	16	0	0	3 hours	Fishing net
6	2	4	1	0	2 hours	Fishing rod with artificial lure
7	0	0	1	1	-	Net fishing (pukot)
8	1	0	0	0	30 minutes	Fishing rod with artificial lure
9	1	0	0	0	45 minutes	Fishing rod with artificial lure
10	3	0	0	0	1 hour	Fishing rod with artificial lure

According to International Pacific Halibut Commission, fishing effort is the amount of fishing done, commonly expressed in gear type and frequency or duration of operations (e.g., 'hook sets,' 'trawl hours," searching hours'). In contrast, the fishing site is a location in a body of water where fish gather, and fishing is frequently successful.

The combination of fishing effort and the fishing site provided favorable conditions for attracting diverse fish species. The results indicate that the catch composition, fishing duration, and fishing locations varied among the observed boats in Pantabangan Lake. The differences in catch composition suggest variations in the habitat preferences and feeding behaviors of the targeted fish species (Purcell *et al.*, 2018). Boats that fished for longer durations, such as boat 2 (6 hours and 45 minutes), had higher catch frequencies for both species. This implies that spending more time fishing increases the likelihood of catching larger numbers of fish. Additionally, boats that caught the highest number of blackchin tilapia (boat 2) also had a relatively high occurrence of largemouth bass, indicating that certain fishing strategies or environmental conditions might have influenced the abundance of both species in that specific location (Brooker *et al.*, 2020).

The fishing locations near the mountain and in the middle of the lake (Boats 2, 4, 5, 6) seem to offer better opportunities for catching a variety of fish species, as compared to fishing near the shore (Boats 1, 8, 9, 10). This could be due to differences in habitat complexity, water depth, and availability of food resources (Sueiro *et al.*, 2010).

The last column of the Table 1 shows the different fishing gears used in the catch sample. Two types of fishing gear are used in the catch sample: the fishing rod with an artificial lure and the net fishing. The fishing rod with artificial lure is the most common fishing gear used in the catch sample. Fishing rods with artificial lures are commonly used in angling, which allows for targeted fishing and selective catch. Anglers using fishing rods with artificial lures have the flexibility to choose their bait based on the specific fish species they are targeting (Hitchcock, 2018). Fishing nets are effective at capturing a wide range of fish species indiscriminately. The larger mesh size of the nets may have made it easier for black chin tilapia, known as a shoaling species, to be caught in more significant numbers compared to largemouth bass, which tends to be more solitary. The targeted fish species' size and behavior often influence fishing nets' selectivity (Hubert *et al.*, 2012). The choice of fishing gear can significantly impact the catch composition and abundance of different fish species. According to the National Academies of Sciences, Engineering, and Medicine, fishing rods with artificial lures allow for targeted

fishing, giving anglers the ability to tailor their approach to specific fish species. In contrast, fishing nets are more likely to capture a broader range of fish species, but with less selectivity.

The fishing locations of the catch sample are categorized into three main areas: near the shore, the mountain, and the middle of the lake. Boats 1, 8, 9, and 10 were fishing near the shore (Fig. 2). Boats 2, 4, 5, 6, and 7 reported fishing near the mountain and in the middle of the lake. Boat 3 specifically mentioned fishing in the middle of the lake.

Fig. 2. Catch sample location map

Table 2. Frequency of largemouth bass and blackchin tilapia

Boat	Largemouth bass (*Micropterus salmoides*)	Blackchin tilapia (*Sarotherodon melanotheron*)
1	3	0
2	8	346
3	3	56
4	4	0
5	2	16
6	2	4
7	0	0
8	1	0
9	1	0
10	3	0

Analyzing the occurrence of largemouth bass and black chin tilapia, it is observed that the highest frequency of the two species is recorded in boat 2, the largemouth bass with 8 occurrences while the blackchin tilapia is 346 occurrences (Table 2). From the data, it is evident that largemouth bass and blackchin tilapia exhibit different patterns of occurrence within the lake. We can differentiate largemouth bass and black chin tilapia based on their frequency of occurrence in the sampled boats. Largemouth bass is present in a higher number of boats (9 out of 10 boats) compared to black chin

tilapia (3 out of 10 boats). This indicates that largemouth bass has a wider distribution across the sampled boats in Pantabangan Lake. The higher frequency of largemouth bass occurrences in the sampled boats suggests that largemouth bass may be more easily seen or caught in Pantabangan Lake compared to black chin tilapia. Several reasons can be accounted for these results such as the habitat preferences in which the largemouth bass may have a broader range of suitable habitats within Pantabangan Lake, allowing them to inhabit a wider area and be encountered more frequently (Sanders, 2023). The second one is the feeding behavior in which the largemouth bass may exhibit feeding behaviors that make them more susceptible to angling. They are often targeted by anglers due to their aggressive feeding habits, which can increase the chances of encountering them during fishing activities (Olander, 2021). The third is the fishing techniques employed by the sampled boats might have been more effective in targeting largemouth bass compared to black chin tilapia (Altrogge, 2019). Lastly, species interactions in which the presence of black chin tilapia in fewer boats could be influenced by interactions with largemouth bass. Largemouth bass is known to be voracious predators and may outcompete black chin tilapia for resources, limiting the distribution and occurrence of black chin tilapia in certain areas or under specific conditions (Booth, 2023). The higher frequency of black chin tilapia occurrences in the boats where it was present suggests that black chin tilapia may have a higher local abundance or concentration in those specific areas or habitats. This could be influenced by factors such as habitat preferences, availability of food resources, or reproductive patterns (Beras, 2005).

The catch samples in Boat 10 include larger fish, with weights ranging from 1 kg to 3.5 kg and lengths from 38.1 cm to 55.88 cm. These larger sizes could indicate the presence of older or more mature individuals. As shown in the standard weight for the length of the largemouth bass, some fish exceeded the standard weight while some of them did not meet the standard weight that is based on the length. This indicates that

there is an unstable developmental stage of largemouth bass in Pantabangan Lake. The classification of all caught largemouth bass as adults suggestthat the fishing activity targets mature individuals. It may also suggest that mature largemouth bass can be easily caught by the fishermen in specific locations where they are caught. This result could also be due to fishing regulations, fishing techniques employed, or the specific fishing locations chosen by the fishermen. The weights and lengths of the largemouth bass vary among the different boats, indicating potential variations in the size distribution of the species within the lake (Braun and Walser, 2011).

Familiarity, awareness, and perceived effect of the community around Pantabangan Lake on the largemouth bass

The three respondents who answered yes stated that they were familiar with and their idea is that invasive alien species multiply rapidly, which this response indicates that the species must be able to adapt to the new environment quickly to be invasive (Table 3). It must immediately multiply, and it must be detrimental to local wildlife, property, or the economy (Evers and West, 2022); introduced species in which this response determine that an unintentional release and individuals are the most common ways that they are introduced to an area (US Department of Commerce, 2019), lastly, fish with sharp teeth one indicates that an invasive alien species is a fish with sharp teeth that can cut or scrape your skin.

Table 3. Familiarity with the term invasive alien species

1. Have you already heard the term "invasive alien species"?	Yes	No
Total	3 (10%)	27 (90%)

The grand mean is 3.14, which is verbally interpreted as *familiar* means that the respondents, who are the fishermen and residents of Pantabangan, are familiar with the presence of the largemouth bass (Table 4). Although some respondents are more familiar with the term "introduced species" than "invasive alien

species," some said that the largemouth bass is an introduced species from America. This statement indicates that the respondents are familiar with the largemouth bass.

The data above responded to a question asking about the frequency of fishing in Pantabangan Lake (Table 5). A. Never: 17% of the respondent stated that they never fish in Pantabangan Lake because they are females they are just selling the fish that their husband or son caught; B. Rarely (once a year or less): 13% of the respondent stated that they fish in Pantabangan Lake once a year or less because some of their acquaintances invite them to go fishing with them; C. Occasionally (2-5 times a year): 17% of the respondent mentioned that they fish in Pantabangan Lake between 2 to 5 times a year because fishing is not their primary work, they do this to earn extra money; D. Frequently (more than five times a year): 7% of individuals indicated that they fish in Pantabangan Lake more than five times a year, and there were 46% responses of the respondents who fish every day they said that they do this to earn extra money and when someone invites them to go fishing.

Jigging and "lambat" (fish net) have the same number and highest of votes total of 13 persons, while casting has a total of 5 votes, the "pana" or spearfishing has two votes, while trolling does not have any votes. Lambat and pana are not among the choices, and these two answers are considered as others, yet the lambat technique is a popular type of fishing gear in Pantabangan Lake (Table 6).

The most commonly mentioned average size of largemouth bass caught in Pantabangan Lake is ¼ kg, followed by ½ kg. There were smaller mentions of ¾ kg, 1 kg, and 2 kg. Additionally, some respondents stated they do not know the average size of the largemouth bass they catch (Table 7).

Some individuals provided behavioral changes in largemouth bass, such as largemouth bass became greedier, which this response suggests that the largemouth bass has a heightened desire for food,

potentially indicating a change in their feeding behavior, aggressive in which could refer to their territorial behavior, response to lures or live bait or interactions with other fish species, largemouth bass also eat artificial bait in which this response indicates that largemouth bass has started consuming artificial bait, which may be a notable change in their feeding preferences; lastly, they become aggressive when it is their season in which this observation suggests that largemouth bass display increased aggression during their breeding or spawning season, which is a natural behavior associated with reproductive activities (Table 8).

These responses collectively provide insights into the perceived changes in the behavior of largemouth bass in Pantabangan Lake, highlighting shifts in feeding habits and aggression levels. Also, the researchers asked the respondents to provide some other information regarding the behavior of largemouth basses, and the respondents provided some behavior of largemouth bass, such as the hunting behavior in which the largemouth bass is said to form a shoal or group when hunting their prey. This behavior indicates a cooperative hunting strategy where they work together to capture their food, spawning behavior in which it is stated that largemouth bass lay their eggs everywhere when they cannot handle them anymore; this information highlights their reproductive behavior and the conditions that trigger egg-laying. Lastly, the predatory behavior of largemouth bass in which it is described as it jumps into the water to chase its prey, and this behavior showcases their agility and predatory nature.

Most respondents (19 individuals) indicated that they had caught largemouth bass in Pantabangan Lake during the summer (Table 9). This suggests that the summer months are favored or more productive for catching largemouth bass, according to the respondents' experiences.

Most respondents (22 individuals) have caught largemouth bass in Pantabangan Lake during the early morning, before sunrise (Table 10). This

suggests that early morning hours are preferred or more productive for catching largemouth bass, according to the respondents' experiences.

Most respondents (20 individuals) reported observing changes in the distribution of largemouth bass in Pantabangan Lake (Table 11). This suggests that there have been noticeable shifts or variations in the areas where largemouth bass are found within the lake. For individuals who responded yes, they were also asked about what are the changes that they have observed in the distribution of largemouth bass. These individuals provided some information, such as the number of largemouth bass increased; this suggests that the fish are being found in more areas or more significant numbers within the lake; largemouth basses can catch everywhere, which this response indicates that the largemouth bass is well distributed everywhere in Pantabangan Lake, in which you can catch it in every part of the lake.

Some individuals said that the largemouth bass begins to spawn in warmer or summer, some also provided perceived behaviors of largemouth bass during the spawning season, such as the largemouth bass becoming aggressive and greedy eaters during the spawning season; this suggests they actively seek and consume food more voraciously during this time (Table 12). One observation indicates an increase in the catch rate of largemouth bass during the spawning season, and this suggests that the largemouth bass is much more aggressive during their spawning season. In the morning and before sunset, they are aggressive and will eat anything. This indicates that largemouth bass show increased aggression and feeding behavior during specific times, particularly in the morning and before sunset.

Respondents who answered yes to this question were asked about the negative impacts of largemouth bass on the other fish species in Pantabangan Lake (Table 13). The respondents stated that the number of other species is decreasing because the largemouth bass eats them, harming the ecosystem of Pantabangan Lake.

Table 4. Familiarity of the community on largemouth bass

Statement	WM	VI
1. Tawis is an invasive alien species.	1.90	Somewhat Familiar
2. Tawis is a voracious feeder.	3.57	Very Familiar
3. Tawis grow up to 15 inches with an average weight of around 5 kilos.	3.10	Familiar
4. Tawis has a largemouth, where the upper part of its jaw, when closed, extends beyond the back of its eye.	3.47	Very Familiar
5. The first and second dorsal (back) fins of tawis are separated by a noticeable deep dip.	3.17	Familiar
6. Tawis are dark green on the top half of their bodies, with dark patches along the sides, and generally white on the lower and underside, with the coloration fading from the top down.	3.67	Very Familiar
Grand mean	3.14	Familiar

Table 5. Frequency of fishing in Pantabangan Lake

1. How often do you fish in Pantabangan Lake?	A. Never	B. Rarely (once a year or less)	C. Occasionally (2-5 times a year)	D. Frequently (more than 5 times a year)	Others Everyday
Total	5(17%)	4(13%)	5 (17%)	2(7%)	14(46%)

Table 6. Fishing techniques used to catch largemouth bass

1. What fishing techniques do you use to catch largemouth bass in Pantabangan Lake?	A. Casting	B. Trolling	C. Jigging	D. Spear	D. Fishing Net	D.Others No idea
Total	5	0	13	2	13	6

Table 7. Average size of largemouth bass caught in Pantabangan Lake

1. What is the average size of largemouth bass that you catch in Pantabangan Lake?	¼ kg	½ kg	¾ kg	1 kg	2 kg	No Idea
Total	8(27%)	7(23%)	2(7%)	5(17%)	2(7%)	6(20%)

Table 8. Observation of the respondents in the changes of the behavior of largemouth bass in Pantabangan Lake

1. Have you noticed any changes in the behavior of largemouth bass in Pantabangan Lake over the past few years?	A. Yes	B. No	C. Not sure
Total	14(47%)	9(30%)	7(23%)

Table 9. Seasons where largemouth bass are caught

1. What season of the year have you caught largemouth bass in Pantabangan Lake?	A. Wet (Rainy) season	B. Dry (Summer) season	No Idea
Total	0(0%)	19(63%)	11(37%)

Table 10. Time of the day when largemouth bass are caught

1. What time of day have you caught largemouth bass in Pantabangan Lake?	A. Early morning (before sunrise)	B. Morning (sunrise to noon)	C. Afternoon (noon to sunset)	D. Night-time (after sunset)	E. No Idea
Total	22(73%)	2(7%)	0(0%)	0(0%)	6(20%)

Table 11. Changes in the distribution of largemouth bass in Pantabangan Lake

1. Have you noticed any changes in the distribution of largemouth bass in Pantabangan Lake over the past few years?	A. Yes	B. No	C. Not sure
Total	20(67%)	6(20%)	4(13%)

It is primarily associated with their predatory behavior and competition with other fish species. Other fish species are mentioned to be scared of largemouth bass and they are hiding from the largemouth bass, this behavior suggests that the presence of largemouth bass has created a sense of vulnerability among the other fish species, causing them to alter their behavior to avoid predation indicating that largemouth bass hold a dominant position in the ecosystem of Pantabangan Lake. Additionally, it is suggested that largemouth bass display increased aggression when the moon is big and round (full moon).

The responses provided by those who answered "yes" to observing changes in the abundance or distribution of native fish species in Pantabangan Lake since the introduction of largemouth bass (Table 14). Respondents noted a decline in the population of native fish species, specifically "biya". This suggests that the introduction of largemouth bass may have harmed the native fish populations, decreasing their numbers. Some fishermen were mentioned to be using electrofishing to catch fish. It was suggested that electrofishing might contribute to the decrease in biya and possibly other native fish species. The response of the respondents about the abundance of native fish such as biya in Pantabangan Lake decreased when the largemouth bass was introduced into the lake; the researcher concluded that there is a negative impact on other fish species, especially the biya (goby) in which the largemouth bass are out-competing the other fish species that reside there before it was introduced.

For respondents who answered "yes" to the question about changes in fishing experience or catch rates for native fish species since the introduction of largemouth bass in Pantabangan Lake, respondents observed a decrease in the population of other fish species, especially goby (Table 15). This decline could compete with largemouth bass also some respondents mentioned that catching native fish has become more challenging since the introduction of largemouth bass. Native fish species have become elusive,

indicating a response to the presence of largemouth bass. Based on the responses above, the largemouth does harm other species since the largemouth bass will eat any fish that can fit in their mouth, so there is a reason why other fish species are scared of them, especially if that fish species is small.

Table 16 summarizes the suggestions provided by respondents to improve the largemouth bass fishing experience in Pantabangan Lake, such as avoiding catching small largemouth bass; this indicates that some fishermen do not care about the size of the fish they catch as long as they catch some fish to sell it. Suppress the use of electrofishing; this response indicates that some fishermen use electrofishing as their fishing technique. According to the Game and Wildlife Conservation Trust, this technique can potentially harm fish (physically and physiologically) and, in severe cases, kill them. Moreover, electrofishing near spawning areas might be harmful to embryos (Snyder,2003). Discourage the use of pukot or fine-holed nets for fishing; which this statement indicates that using fish nets with fine holes can adversely affect small fish, which, even the hatchling of the fish species, will prevent them from growing. One of the fishermen who suggested this stated, *"Some fishermen should avoid using pukot because this technique can catch all of the fishes even if it is just a hatchling, and this technique may be the cause why we cannot catch a tawis with 2 kilos above."*. Control the fishing pressure on tawis (largemouth bass) to allow population growth in which this indicates that largemouth bass is famous in Pantabangan Lake. According to an article entitled "Bass Fishing: Largemouth Bass," on a website named Discover Boating, in addition to being the most popular game fish in the United States, largemouth bass fishing competitions have grown in popularity recently. Due to their strong fighting abilities when caught with light spinning gear, largemouth bass is a very well-liked sport fish. Increase the population of tawis (largemouth bass), which indicates that some respondents do not consider the largemouth bass a pest in Pantabangan Lake.

Table 12. Largemouth bass spawning in Pantabangan Lake

1. Have you observed largemouth bass spawning in Pantabangan Lake?	A. Yes	B. No	C. Not sure
Total	15(50%)	11(37%)	4(13%)

Table 13. Largemouth bass interacting with other fishes

1. Have you observed largemouth bass interacting with other fish species in Pantabangan Lake?	A. Yes	B. No
Total	16(53%)	14(47%)

Table 14. Changes in the abundance or distribution of native fish species in Pantabangan Lake since the introduction of largemouth bass

1. Have you observed changes in the abundance or distribution of native fish species in Pantabangan Lake since the introduction of largemouth bass?	A. Yes	B. No	C. Not sure
Total	19(63%)	3(10%)	8(27%)

Table 15. Changes in the fishing experience or catch rates for native fish species since the introduction of largemouth bass in Pantabangan Lake

1. Have you noticed any changes in the fishing experience or catch rates for native fish species since the introduction of largemouth bass in Pantabangan Lake?	A. Yes	B. No	C. Not sure
Total	17(57%)	5(17%)	8(27%)

Table 16. Suggestions to improve largemouth bass fishing experience in Pantabangan Lake

What do you think should be done to improve the largemouth bass fishing experience in Pantabangan Lake? (Please describe)
1. Avoid catching small largemouth bass
2. Suppress the use of electrofishing
3. Discourage the use of pukot or fine-holed nets for fishing
4. Control the fishing pressure on tawis (largemouth bass) to allow population growth
5. Increase the population of tawis (largemouth bass)

Table 17 indicates that all respondents stated they had not heard of any efforts to manage or control the population of largemouth bass in Pantabangan Lake. This result indicates that none of the respondents were aware of any efforts to manage or control the population of largemouth bass in Pantabangan Lake. This finding suggests a potential lack of active initiatives or communication regarding the management of this fish species.

Table 17. Efforts to manage or control largemouth bass population in Pantabangan Lake

1. Have you heard about any efforts to manage or control the population of largemouth bass in Pantabangan Lake? If yes, please describe the efforts.
- No efforts reported

The respondents who answered yes suggested some management strategies, such as making a cage for them; this suggestion indicates that making a cage for the largemouth bass can prevent the increased distribution of this species (Table 18). Separate the tawis from the native fish and give them some limited prey/food, which indicates that separating the largemouth from other species can prevent the other or native species from decreasing their population. The fisherman who suggested this said, *"Control it so that the tawis will not be the only fish species who will reside in the Pantabangan Lake in the future."*

Table 18. Responses regarding the management of largemouth bass in Pantabangan Lake and the suggested management strategies

Response	Management strategies
No	None
Yes	Make a cage for them
	Separate the tawis from the native fish and give them limited prey/food

Table 19. Willingness to participate in future surveys or research on largemouth bass

1. Would you be willing to participate in future surveys or research on largemouth bass in Pantabangan Lake?	A. Yes	B. No
Total	30 (100%)	0 (0%)

Table 20. Perceived ecological and economic effects of largemouth bass

Statement	WM	VI
1. Tawis serves as a food and dishes.	3.83	Strongly Agree
2. Tawis reduces the number of native species, such as hito, biya and dalag.	3.33	Strongly Agree
3. You can earn money by selling tawis.	3.80	Strongly Agree
4. Tawis is a pest that resides in Pantabangan Lake.	2.43	Disagree
5. Tawis are popular in sports fishing.	3.77	Strongly Agree
6. The teeth of tawis can scrape/cut your thumb.	3.03	Familiar
7. Invasive species such as tawis can cause the extinction of native fish.	2.97	Neither agree nor Disagree
Grand mean	3.31	Strongly Agree

Most respondents answered "No" to the question, indicating that they believe largemouth bass should not be managed or controlled in the lake. Their reasons for this stance include the economic benefits of largemouth bass fishing and the species' popularity among tourists. This suggests a significant reliance on largemouth bass as a valuable resource for livelihood and recreation.

On the other hand, a few respondents answered "Yes" and proposed specific management strategies. One suggested strategy is the implementation of cages to control the distribution and population of largemouth bass. This approach limits the species' expansion and potentially prevents negative environmental impacts associated with their presence.

Another suggested strategy is the separation of largemouth bass, specifically the tawis, from native fish species and providing them with limited prey or food resources. This strategy seeks to maintain a balanced ecosystem by preventing largemouth bass from dominating the lake and negatively affecting the populations of other fish species.

The data above responded to a question asking if they are willing to participate in future surveys or research on largemouth bass in Pantabangan Lake: A. Yes: 100% of individuals stated they are eager to participate in future surveys or research on largemouth bass in Pantabangan Lake since they said that if it is for the research study, they are willing to provide data for the researchers (Table 19). There is some other additional information that the respondents provide regarding largemouth bass. The respondents said that there are two types of tawis (largemouth bass) mentioned, namely the green tawis and yellow *tawis*. The green tawis is described as strong-hearted and braver than the yellow tawis. It is mentioned that when yellow tawis are caught, they die quickly, and sometimes their eye spits. The respondents were asked about the survival time of the largemouth bass when removed from the water. Some of their responses said that it takes 2 minutes when they are taken out of water; this response indicates that largemouth bass is highly sensitive to being out of their natural aquatic environment and have a limited ability to survive in such conditions, 5 minutes in which it implies that the largemouth bass have a relatively short survival time and need to be returned to water promptly to increase their chances of survival, 30 minutes in which this response suggests a specific duration in which the largemouth bass may be able to survive before experiencing severe distress or potentially perishing. Lastly, 1 hour in which it indicates that largemouth bass can survive for approximately 1 hour when removed from the water, this response suggests a longer timeframe compared to the previous answers. According to Outdoor Geeky (2021), largemouth bass can live up to 20 minutes out of the water, indicating that some of the respondents' information is correct while others are not.

Table 20 presents the perceived ecological and economic effects of largemouth bass (tawis) in Pantabangan Lake, as rated by the respondents. The responses provide insights into the community's

perception of the species and its impact on various aspects, including food, biodiversity, economy, and fishing.

The respondents strongly agree that largemouth bass is valued as a food source and is commonly consumed as a dish. This perception aligns with the cultural and culinary significance of tawis in the local community. Most respondents strongly agree that largemouth bass contributes to a decrease in native fish species such as hito, biya, and dalag. This perception suggests concerns about the ecological impact of largemouth bass on the native fish community. Respondents strongly agree that selling largemouth bass (tawis) provides an opportunity for economic gain. This perception reflects the economic importance of tawis fishing, which supports the livelihoods of local fishermen. The respondents generally disagree that largemouth bass (tawis) is a pest in Pantabangan Lake. This perception indicates that the community does not view tawis as a harmful or destructive species. Respondents strongly agree that largemouth bass (tawis) is famous in sports fishing and attracts foreign anglers to catch them. This perception highlights the recreational value and appeal of tawis as a sport fish. The respondents are familiar with largemouth bass (tawis) having teeth that can potentially scrape or cut the skin. This familiarity indicates an awareness of specific physical characteristics of the species. The respondents neither agree nor disagree that invasive species such as largemouth bass (tawis) can lead to the extinction of native fish. This perception suggests a lack of consensus or knowledge regarding the potential ecological impact of tawis on native fish populations.

The general assessment, indicated by the grand mean of 3.31, shows that the respondents strongly agree with the statement that largemouth bass (tawis) has perceived effects in Pantabangan Lake. This indicates a consensus among the respondents that tawis has significant implications for the area's food, economy, and fishing activities.

Conclusion

Largemouth bass is a carnivorous type of fish species that hunts its prey in a group; they do not have any predators in Pantabangan Lake; however, the catfish's barbels or whiskers can kill largemouth bass if the largemouth bass eats it, but the catfish will also die. Therefore, the researcher concluded that the only predator of the largemouth bass is the people who catch it, so maintaining the sports fishing event in Pantabangan Lake is a good idea to control the largemouth bass population. The frequency of occurrence of the largemouth bass is almost present in 9 boats while the blackchin tilapia are only present in 4 boats; therefore, the researcher concludes that the largemouth bass is more aggressive than the black chin tilapia, and you can find largemouth bass everywhere around Pantabangan Lake. ¼ kilo, or approximately 250 grams is the most catch weight in Pantabangan Lake. At the same time, 22.86 cm is the shortest catch length of the largemouth bass while the longest catch length is 55.88 cm, and all of the largemouth basses that have been caught are considered to be adult; therefore, largemouth bass starts at 22.86 cm to become aggressive tough their capabilities and experience are different from each other since 22.86 cm is too small for a 55.88 cm- the stage of development of the largemouth bass seems stunned because 50cm above seems rare to find nowadays because the standard length that has been caught in the catch sample is 22.86-25.7 cm. The 30 respondents provide enough data to the researcher about the largemouth bass; therefore, they are aware of the presence of the largemouth bass, and their perception helps them to use the largemouth bass to an extent. Need for further monitoring in observing the negative impacts of largemouth bass on native fish populations. Creating management strategies to mitigate the potential ecological consequences of the interaction between largemouth bass and other fish species. Assessment of the environmental parameters or factors that affect the behavior, growth, and distribution of largemouth bass. Provide recommendations for managing and mitigating the impacts of largemouth bass on the biodiversity of Pantabangan Lake.

Recommendation(s)

Based on the findings of the study, and the conclusion drawn, furthered prospective with the study are hereby recommended:

1. Given the absence of natural predators for largemouth bass in Pantabangan Lake and the role of human angling as the primary means of population control, it is recommended to continue and promote sustainable sports fishing events. This could help manage largemouth bass populations while also supporting recreational activities and local economies. Implementing catch limits and size restrictions during these events can aid in maintaining a balanced ecosystem.

2. There is a need for ongoing monitoring and research to better understand the ecological impacts of largemouth bass on native fish populations in Pantabangan Lake. This includes assessing changes in species composition, abundance, and distribution over time. By gathering comprehensive data, informed management decisions can be made to mitigate negative impacts and preserve biodiversity.

In response to the potential ecological consequences of largemouth bass proliferation, it is crucial to develop and implement comprehensive management strategies. These strategies should focus on mitigating negative impacts on native fish species, such as through habitat restoration efforts and the implementation of selective removal programs. Additionally, incorporating environmental parameters and factors affecting largemouth bass behavior, growth, and distribution into management plans can help inform targeted interventions aimed at maintaining ecosystem balance and promoting biodiversity conservation in Pantabangan Lake.

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