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Fish catch assessment of the nine fish species at Ligawasan marsh, North Cotabato, Philippines

Pia Amabelle M. Flores[1,*], Rowell P. Nitafan[2], John Rey F. Agustin[4], and Jonald L. Pimentel[3]

1 *College of Agriculture, University of Southern Mindanao, 9407, Kabacan, Cotabato, Philippines*
2 *College of Arts and Social Sciences, University of Southern Mindanao, 9407, Kabacan, Cotabato, Philippines*
3 *College of Science and Mathematics, University of Southern Mindanao, 9407, Kabacan, Cotabato, Philippines*
4 *University of Southern Mindanao, Kidapawan City Campus, Kidapawan City, Kabacan, Cotabato, Philippines*

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*Corresponding Author: *Pia Amabelle M. Flores* – pamflores@usm.edu.ph

Abstract

Farmers' nine important fishes were assessed to determine relative abundance from data of fish catch landings and catch per unit effort (CPUE) in Ligawasan marsh from January to March 2022. The study gathered data from total fish catch landings, gear selectivity, catch per unit effort (CPUE) and length-weight relationship from fish catch landings. Results of the study showed that mudfish (*Channa striata*), tilapia (*Oreochromis niloticus*), and common carp (*Cyprinus carpio*) were the abundant species in the marsh. Gear selectivity was observed in some species. Length-weight relationship was compared to a similar wetland data. Shorter range for length were found in Ligawasan marsh fish species except for gourami (*Trichopterus trichogaster*) compared in the report from the study in Agusan marsh. The present study can provide baseline data on relative abundance of fish resources present in the marsh which can be used as reference to develop policy on sustainable management based in Ligawasan marsh, North Cotabato, Philippines.

Introduction

Ligawasan marsh is a wetland located in Mindanao which surpasses three provinces-South Cotabato, Maguindanao, and North Cotabato, Philippines. This wetland is included in the list of protected areas under the 1992 National Integrated Protected Area System (NIPAS) Act or Republic Act 7586. With this law, Ligawasan marsh has been declared as game reserve and bird sanctuary. However, other aspects pertaining to fishery resources management have not yet been fully maximized. In contrast to marine scenario wherein Marine Protected Area (MPA) system was already established to provide measures and systematic approach in coastal resource management (Alcala, 1988), the conservation system in freshwater environment has not yet been fully elucidated. There is a need to substantiate the ecological and social scheme in the area to develop an effective conservation approach. Hence, assessment of the fishery resources in the area was conducted in this study.

The previous study conducted by the DENR (2004) showed that the majority of settlers in Ligawasan marsh depended on farming, livestock or poultry production, and fishing as major livelihood sources. Fishing serves as primary source of income and sustenance. It becomes an alternative livelihood source when farming is not feasible when water levels rise, and the marshland communities are submerged. This also holds the integral role of fishing in the community as a common means in providing source of livelihood for each family. Moreover, DENR identified 33 species of freshwater fishes from Ligawasan marsh (DENR, 2004). However, fish stock assessments in the area was not explored and studies

have been limited to ecological descriptions and sociodemographic factors. Therefore, there is a need for stock assessment to provide quantitative data since fish stocks in this wetland are vulnerable to exploitation pressure due to the open access system. This assessment updates the local government units (LGU) and other agencies on the fishery resources in the area and helps explore ecologically-sound policies addressing the modern-day needs of the marshland communities. In this way, the data from this study can be an indicator if the existing municipal policies have been effectively implemented.

To evaluate the relative abundance of the species present in the marsh, fish stock assessment was conducted using catch per unit effort (CPUE). The most common index of relative abundance was calculated through CPUE data from fish stock samples (Fabrizio & Richards, 1996; Hubert 1996; Maunder et al., 2006; Ney, 1999). CPUE measures the proportion of the population that is vulnerable to fishery, considering gear selectivity, size, age of fish, horizontal and vertical distribution of fish, and fishing practice. For this study, factors considered were the types of fishing gear used, number of hours spent fishing as part of the fishermen's practice, and weight and length of the fish.

The goal of the present study is to assess fish stock on the relative abundance of nine important fishes caught at Ligawasan marsh based on fish catch data. Four of the species are native to Ligawasan marsh included mudfish (*Channa striata*), climbing perch (*Anabas testudineus*), native catfish (*Clarias macrocephalus*) and giant mottled eel (*Anguilla marmorata*). The cyprinid species-common carp (*Cyprinus carpio*), rohu carp, (*Labeo rohita*), silver carp (*Hypothalmichthys molitrix*), and other fish such as snakeskin gourami (*Trichogaster pectoralis*) and tilapia (*Tilapia niloticus*) are all introduced to Ligawasan marsh. Fish stock assessment can provide valuable information for fishery resource management. In the future, the results serve as baseline for the development of policies preventing the risk of overexploitation of resources. The data can be used by fishery managers to estimate fish population in a certain fishing ground. The information from fish stock assessment can be used as basis for maximum sustainable yield which determines regulatory actions such as closed season or other measures compliant to RA 8550 (Fisheries Code of the Philippines) and RA 10654 (Law on Illegal, Unreported and Unregulated fishing activities in the Philippines).

Methodology

Study area

The fish landing site was situated at Bagoinged, Pikit in the province of North Cotabato, Philippines (Figure 1) at 6'60'' North, 124'42" East. There are five prominent fish landing sites in North Cotabato that obtain fish from Ligawasan marsh. The fish landing site in Bagoinged, Pikit has the highest percentage of fish landed in the area, thus was selected the site for this study.

Using the Ramsar Convention definition of wetlands as a basis, the Ligawasan marsh is classified into three major wetland habitats: the marsh habitats, artificial habitats, and open water habitats. In the case of Ligawasan marsh, specifically the Bagoinged, Pikit, the habitat is characterized by running open water habitat. The still open water habitat is also present where floaters such as *Pistia stratioites* (water lettuce) and *Eichhornia crassipes* (common water hyacinth) are found. These areas are used by local human communities for fishing and transportation.

Figure 1. The location of sampling site at Bagoinged, Pikit which covers an area of Ligawasan marsh.

Preliminary survey

A preliminary survey was conducted last December 2021 prior to the fish stock assessment to gather information on the species most commonly caught in the area and to identify the landing site with the highest fish catch. The activity included an ocular inspection of the landing sites. This information served as a basis for selecting species to be assessed during the nine-week period.

Data on the socio demographic profile of the fisherfolk community at Bagoinged, Pikit were recorded. A sample size of 80 respondents were selected. The survey questionnaires covered socio-demographic information such as family size, number of years in fishing, and age at which respondents started fishing. Descriptive statistics such as counts, averages percentages, tables and graphs were used to describe and summarize the results of the survey.

Selection of species for data collection

The data gathering was limited to the nine most abundant fish species caught and landed at the fish landing site. These species include: (1) mudfish (*Channa striata*), (2) gourami (*Trichopodus tricopetrus*), (3) climbing perch (*Anabas testudineus*), (4) native catfish (*Clarias macrocephalus*), (5) giant mottled eel (*Anguilla marmorata*), (6) rohu carp (*Labeo rohita*), (7) silver carp (*Hypophthalmichthys molitrix*), (8) common carp (*Cyprinus carpio*), and, (9) tilapia (*Oreochromis niloticus*).

Sampling method

The collection of data was conducted from January to March 2022, corresponding to the first quarter of fishing activities in the Ligawasan marsh area. Sampling was done weekly, except when weather conditions are unfavorable or during periods of fishing restrictions. Data gathering took place during high and low water levels depending on the week covered.

Ten random fish samples per species were selected for measurement each week. Length was measured by a meterstick, and weight was recorded by weighing scale. Fishing and related activities from the time of arrival to the fishing ground to the actual catching

of fish, hauling, dispersal in landing sites and other related activities for 8-12 hours daily were recorded. Total catch was estimated by volume of catch (weight) and recorded according to respective fishing gears used. Small fish and other by-catch not included in the study were discarded. Only the nine fish species identified were included in the inventory. Fish catch landing was presented as relative abundance of fishes caught in the study whereas CPUE is the efficiency of the gears used in fishing by fisherfolks in the marsh. The following are the three fishing gears used by fishermen in Bagoinged, Pikit.

A. Gill net

The gill net or *pukot* (Figure 2A-B) is named after its catching principle, where fish are usually caught by "gilling", or when fish are caught in the mesh of the net by their gills. Fish captured by gill nets are most likely to catch fish during feeding or migratory movements. Fish may avoid the gill net if they notice the gear, so catches are normally best in areas with turbid water. The gill net in Ligawasan marsh is commonly constructed at 240 x 182 cm with 8 cm mesh size. Gill nets that are observed in Ligawasan are made from nylon (polyamide) and typically operated as a stationary gear anchored to the bottom. Gillnets are operated from smallest non-mechanized fishing boats to motorized fishing boats.

B. Improvised Fish Trap

The traps used by fishermen in Ligawasan have the same features described by FAO-technical paper (Bjordal et al., 2020) however it is constructed at bigger sizes to capture more fish (Figure 3A-B). The traps are normally not baited, instead it catches the fish by leading them into the trap device, and eventually into the fish compartment designed to hold the trapped fish and preventing it to escape. The fish traps are constructed with inner side walls made of nets assembled into mesh sizes forming V-shaped that entrap fish. The fish trap is constructed at 200 cm x 80 cm (length x width), the opening of which is measured at 15 cm and the mesh sizes are ideally at 3 cm. The improvised fish trap or *bubo* is constructed with bamboo to hold the nets together and the nets are made of synthetic twines (polyvinyl). These are submerged in designated areas in the marsh.

C. Fish pot

The improvised fish trap and fish pot are similarly called as "*bubo*" or "*buo*". The fish pot in this study (Figure 4A-B) represents a smaller version of the improvised fish trap described previously. The design of fish trap in this area is constructed using bamboo and sticks at 120 cm x 76 cm (length x width). The body is wrapped with synthetic nets with mesh size measuring 6 cm. The design makes use of a V-shaped funnel opening which leads the fishes into the inner compartment and trapped therein.

Of these species, seven species are native to Ligawasan marsh including mudfish, gourami, climbing perch, native catfish, rohu carp and silver carp. Two species are introduced, namely common carp and tilapia. Common carp is also considered as invasive (Pinto et al., 2005; Maiztegui et al., 2019).

Analysis of data

In this study, CPUE is presented as number of fish per amount of fishing time. A separate CPUE is computed according to fishing gear used. Catch was recorded by weight (kg) in terms of total gross catch per species and per species according to type of fishing gear used. The study used nominal fishing effort as elucidated in the study of Ogle (2018) with modifications, wherein CPUE was calculated by dividing the catch of fishing trip by fishing effort (number of fishing hours multiplied to number of fishing boat during the fishing trip). The number of fishing hours corresponds to the whole duration of fishing including the entrapment time for both fish trap and fish pot.

$$\text{Catch per unit effort} = \frac{\text{mass of fish caught (kg)}}{\text{fishing effort}}$$

Length and weight were also recorded. These are then compared to another study on marsh fishery resources particularly in Agusan marsh (Jumawan and Seronay, 2017).

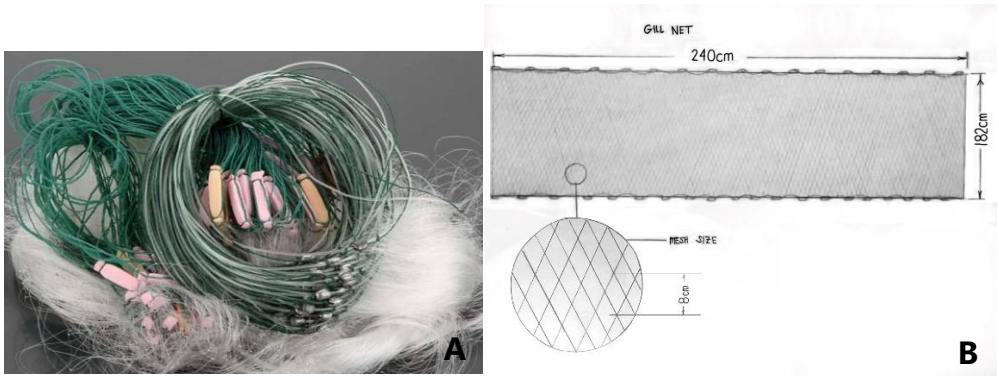

Figure 2A-B. The gill net used by fishermen at Bagoinged, Pikit.

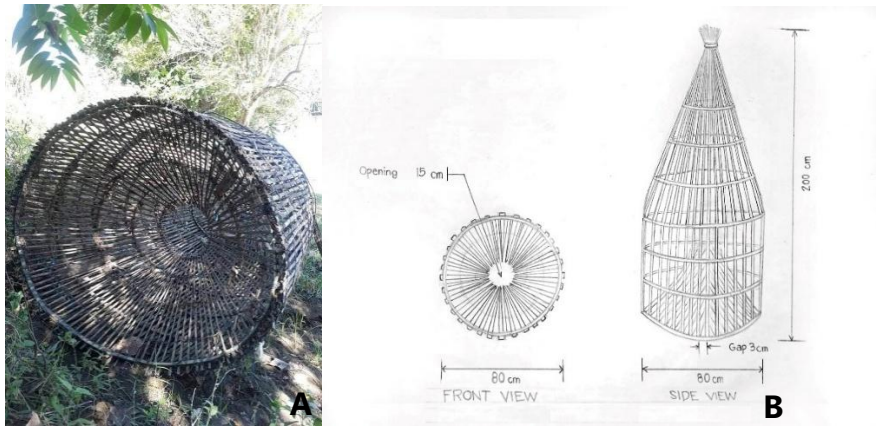

Figure 3A-B. The fish improvesied fish trap used in fishing at Bagoinged, Pikit.

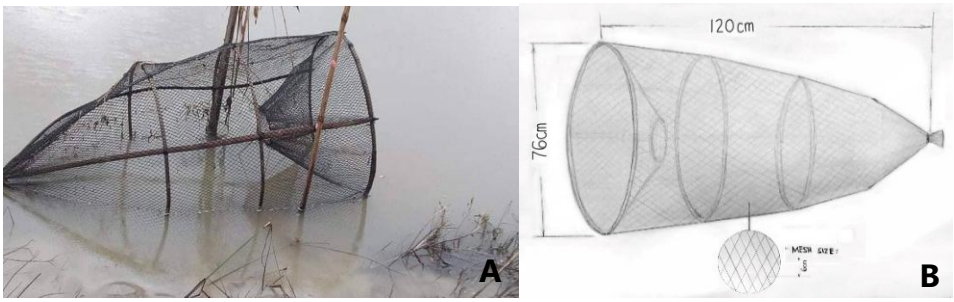

Figure 4A-B. The fish pot used by fishermen at Bagoinged, Pikit.

Results

The study gathered data on fish catch landing for a nine-week observation. Species observed included mudfish, tilapia, rohu carp, common carp, giant mottled eel, climbing perch, silver carp, native catfish, and snakeskin gourami. The sociodemographic aspect was also investigated to provide valuable inputs in the resource management and sustainable development of Ligawasan marsh communities.

Sociodemographic profile

Data from sociodemographic survey indicated that majority of fishermen (51.25%) belong to ages above 46 years old. Majority of fishermen (78%) had been fishing for 6-10 years. In addition, married status made up the majority (91%) of fishermen in the area. These individuals mostly engaged in fishing belong to families with more than 7 members. The size of family members of fishermen could be one factor that led to high frequency of fishing activities in this wetland community since fish becomes the primary source of food in the area.

In the previous study conducted by DENR last 2004, the households engaged in fishing comprised of 44.5%. A slightly higher percentage were found to rely on farming (46.2%) for subsistence. Fishing became the second major livelihood source, since farming is not feasible when water levels rise, and marshland communities are submerged. The study of Bautista et al. (1999) showed that 81.5% considered fishing as major source of livelihood in Ligawasan marsh. However, the number of fishermen declined from 1999 to 2022. Men are predominantly involved in fishing, while women are actively involved in post-harvest activities. Majority of post-harvest products include dried and smoked fish.

Fishing constitutes the source of living and sustenance of families at Bagoinged, Pikit. It has become a way of life for majority (80%) of the respondents. The community has also adapted fishing strategies to cope with heavy rainfall. The use of fish traps has advantages during rainy weather, as more fish are likely to be trapped in the device.

Fish catch landings

The highest percentage of catch (22%) was observed in mudfish followed by Nile tilapia (20%), common carp (19%) and rohu carp (14%) as seen in Table 1. Other fish species were recorded at less than 10%. The snakeskin gourami has the least catch recorded.

Table 1. Fish catch landing (kg) at Bagoinged, Pikit, North Cotabato at 9-week survey.

Fish	Number of weeks									Total	%
	1	2	3	4	5	6	7	8	9		
Mudfish	396.0	383.0	163.0	144.0	155.0	147.0	173.0	177.0	132.0	1,868.7	22
Nile Tilapia	250.5	293.3	146.6	91.4	192.7	245.0	258.0	164.0	93.7	1,735.3	20
Common carp	195.0	185.0	160.0	143.0	188.0	190.0	210.0	198.0	192.0	1,661.0	19
Rohu carp	149.5	139.5	142.1	106.9	1,18.0	131.0	131.0	131.0	140.0	1,188.0	14
Climbing perch	77.7	66.8	107.1	94.7	126.4	88.6	97.7	36.1	43.2	738.3	9
Native catfish	43.1	45.7	50.3	53.2	64.7	40.1	38.3	43.9	52.0	431.3	5
Silver carp	67.4	40.3	45.7	27.8	33.0	39.8	52.8	29.6	13.4	349.8	4
Giant mottled eel	44.7	61.1	47.6	34.9	33.4	37.6	19.5	47.2	34.7	360.7	4
Snakeskin gourami	25.6	23.3	20.6	18.1	19.3	24.7	27.4	35.7	33.4	228.1	3
Total	1224	1,215	862	696	911	919	979	826	702	8,333.1	

Mudfish presents the highest number of fish landings during the first two-weeks of observation, but the catch slightly declined in the succeeding 3-9 weeks. Consistent catch was observed for carp species throughout the observation period. Native catfish and snakeskin gourami showed consistently low catch rates. Climbing perch showed declining catch during weeks 8-9.

Gear selectivity

One of the factors affecting CPUE is the type of fishing gear used by fishermen. Gear selectivity was notably observed from the three fishing gears used by fishermen in Bago-inged, Pikit. Thompson and Ben-Yami (1984) considered selectivity as the capacity of any method of gear type to capture certain fractions or sections of the fish population whether grouped by species, age, size or behavior and to exclude others. The type of fishing gear affected both the target species and quantity of catch, with species caught varying according to the type of fishing gear used.

A. Gill net

Gill nets are primarily used to target a wide range of species such as mudfish, climbing perch, rohu carp, native catfish, snakeskin gourami, Nile tilapia and silver carp (Figure 5). The range of catch per week was recorded in native catfish (40- 70 kg), snakeskin gourami (18.1-35.7 kg), silver carp (13.4- 67.4 kg), and climbing perch (6.3- 36.1 kg). Highest catch was observed in tilapia ranging from 91.4 to 293.3 kg. It was also noted as one of the most abundant species caught at the site followed by rohu carp (120- 160 kg) using the gill net. In terms of total catch per species over the 9-week fish landing data, gillnet can catch as much as 1,735 kg of mudfish, 1,265 kg rohu carp, 654.7 kg mudfish, 470 kg native catfish, 349.8 kg silver carp, 234.5 kg climbing perch, and 228.1 kg snakeskin gourami.

B. Improvised Fish Trap

On the other hand, improvised fish traps captured mudfish, native catfish, and common carp (Figure 6). Data showed that this design of fish trap was effective for catching common carp. This is the only fishing gear capable of capturing this species, and common carp was recorded as one of the highest catch landings during the 9-week observation. In contrast, both fish pot and gill net were effective in catching mudfish and native catfish in the area. In terms of total fish catch, the improvised fish trap accumulated 1,659 kg of common carp, 1,214 kg of mudfish, and 431.3 kg of native catfish. Improvised fish trap is expected to catch more common carp than native catfish and mudfish.

C. Fish pot

The fish pot is used for catching giant mottled eel, rohu carp, and native catfish (Figure 7). Both the fish trap and gill net are used in catching native catfish, and rohu carp. Giant mottled eel caught using fish trap was recorded at 33.4 kg- 47.6 kg, rohu carp at 106 kg-149.5 kg and native catfish at 40.1 kg- 64.7 kg in the 9-week fish catch observation. In terms of total catch, rohu carp accumulated 1,188 kg, 431.3 kg native catfish, and 360.7 kg giant mottled eel. If a fish trap was used, the highest number of fish caught was recorded for rohu carp, and the least was for giant mottled eel.

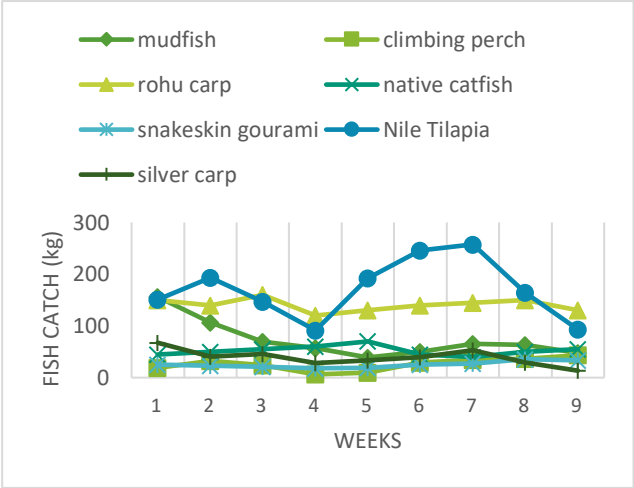

Figure 5. Fish catch landing of fishes caught in Ligawasan marsh using gill net.

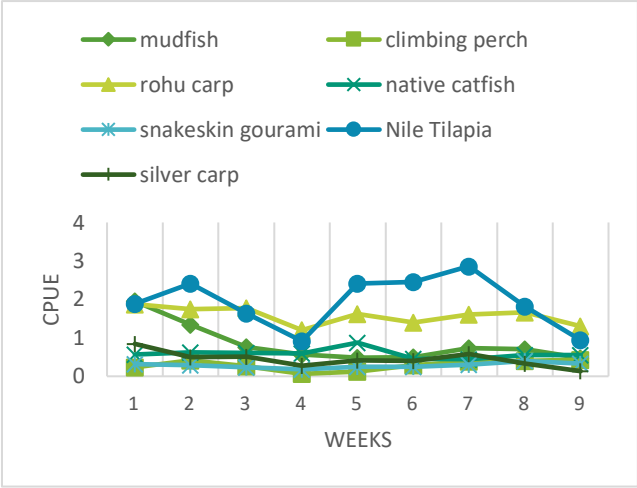

Figure 8. CPUE of fishes caught using gill net.

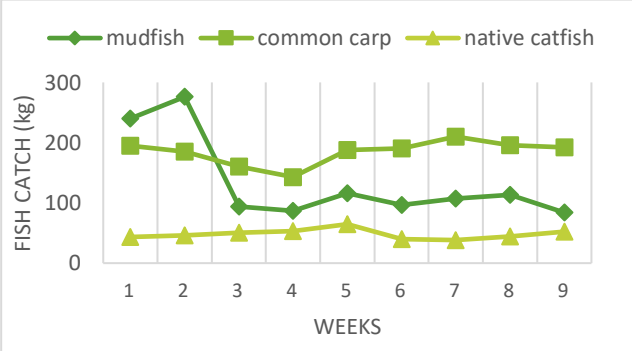

Figure 6. Fish catch landing of fishes caught in Ligawasan Marsh using improvised fish trap.

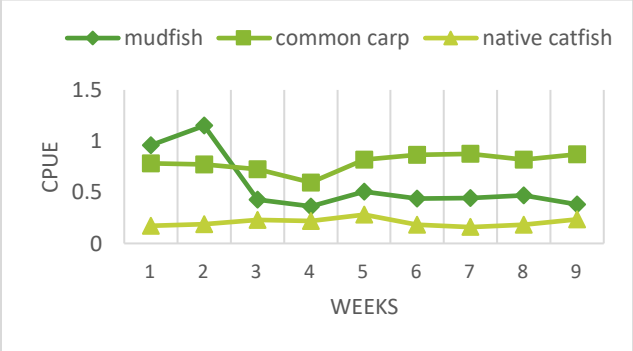

Figure 9. CPUE of fishes caught using improvised fish trap.

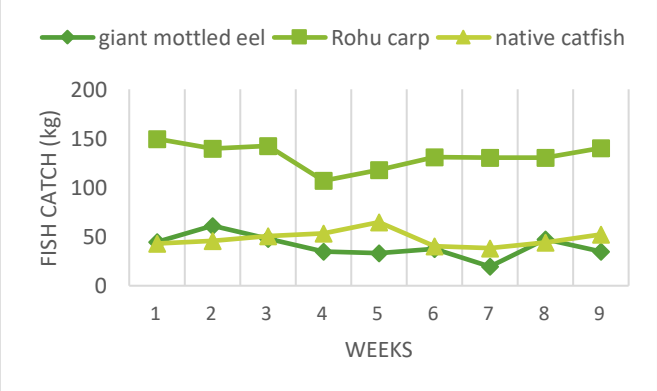

Figure 7. Fish catch landing of fishes caught in Ligawasan Marsh using fish pot.

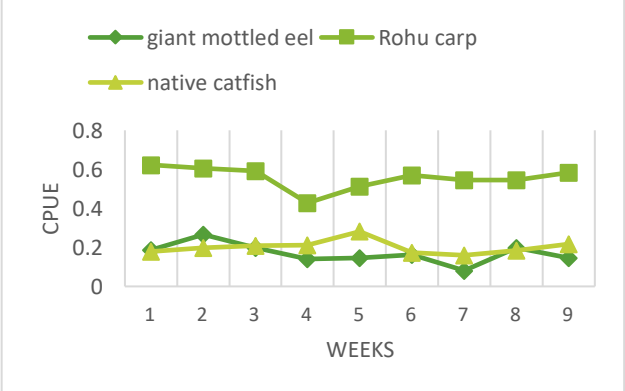

Figure 10. CPUE of fishes caught using fish pot.

Catch Per Unit Effort (CPUE)

In this study, CPUE was calculated from the catch according to each type of fishing gear used (Figure 8-10). Since type of fishing gears influenced the catchability of fishes in Ligawasan, gear selectivity was considered as a factor in CPUE. The number of fishing hours varies for each week using gill net on daily basis, fishermen spent around 6-10 hours fishing, from traveling to the fishing grounds to disposal of catch at fish landing sites. By practice, the fishermen in Ligawasan allow 24 hour-entrapment time before harvesting.

A. Gill net

Comparing Figure 5 and Figure 8, CPUE and total catch using gill nets showed a similar trend. It means that regardless of fishing effort, relative abundance of fish caught in Ligawasan was already evident in the fish catch landing data. It can be implied that the CPUE of gill nets and the total fish catch by gill nets were directly proportional. CPUE of fishes caught using gill net recorded values for Nile tilapia at 0.91-2.86, rohu carp at 1.2-1.87, mudfish at 0.47- 1.95, native catfish at 0.44-0.87, silver carp at 0.13- 0.84, climbing perch at 0.06-0.43, and snakeskin gourami at 0.18-0.39. The highest CPUE average using gill net was recorded in Nile tilapia and least with snakeskin gourami.

B. Improvised Fish Trap

The improvised fish trap CPUE recorded lower values for native catfish (0.16- 0.28) and higher values for mudfish (0.36- 1.15) and common carp (0.59- 0.87). The average CPUE using improvised fish trap was highest for common carp (0.79) and least for mudfish (0.57). Comparing Figure 6 and Figure 9, it showed that similar trends could be detected in mudfish, native catfish and common carp. Fishing effort influenced abundance of fish catch.

C. Fish pot

Both fish catch trends (Figure 7) and the trend observed in CPUE of fishes caught using fish pot (Figure 10) showed similar trends. Longer trapping time could have influenced higher probability of catching more fishes into the fishing gear. Figure 10 showed fish pot had lower CPUE data for giant mottled eel (0.08-0.27), native catfish (0.16-0.28), but higher CPUE for rohu carp (0.43-0.62). Average CPUE using fish pot was highest for rohu carp (0.55) and least for giant mottled eel (0.17).

Fish length-weight

Length of fish samples, including the minimum and maximum ranges from the catch, as well as average length were presented in Table 2, Figure 11. For this study, total length was measured which correspond to the length from the tip of the snout to the tip of the caudal fin.

No evident increase in size was recorded as the sampling progressed. Ranges of fish length were recorded for each species as shown in Table 2. For instance, the total length of giant mottled eel ranged from 89 to 92 cm, rohu carp ranged from 37.5 to 42 cm, the native catfish length ranged from 35.5 to 39.5 cm, common carp ranged from 30.5 to 36.5 cm, mudfish ranged from 26 to 37.5 cm, silver carp ranged from 20 to 22.5 cm, Nile tilapia ranged from 17 to 21.5cm, snakeskin gourami fish ranged from 15 to 18 cm, and climbing perch length ranged from 12.5 to 17cm.

Table 2. Length (cm) of fishes caught in Ligawasan marsh (n=10).

Week	Giant mottled eel	Rohu carp	Native catfish	Common carp	Mudfish	Silver carp	Nile tilapia	Snakeskin gourami	Climbing perch
1	90.5	38.5	35.5	32.0	30.5	20.0	17.0	16.0	15.0
2	89.0	42.0	37.5	30.5	33.0	21.0	17.0	15.0	14.5
3	92.0	41.0	38.5	32.0	26.5	20.0	17.0	15.0	14.5
4	89.0	40.0	38.5	31.5	26.0	22.0	20.0	15.5	12.5
5	90.0	39.5	36.5	34.0	27.0	22.0	21.5	15.5	14.0
6	92.0	38.5	39.0	36.0	32.0	22.5	21.0	15.5	15.0
7	92.0	38.0	39.5	36.5	30.0	23.0	20.5	15.5	17.0
8	92.0	39.5	38.5	33.5	35.5	22.0	19.5	18,0	14.0
9	91.0	37.5	39.0	33.4	37.5	22.5	18.0	18.0	14.0
Min	89.0	37.5	35.5	30.5	26.0	20.0	17.0	15.0	12.5
Max	92.0	42.0	39.0	36.5	37.5	22.5	21.5	18.0	17.0
Ave	90.8	39.4	38.1	33.3	30.9	21.7	19.1	16.0	14.5

Discussion

The study assessed the relative abundance in terms of fish catch data and CPUE of the nine commercial fishes found in Ligawasan marsh observed from fish landing sites at Bagoinged, Pikit. Wilberg et al. (2009) stated that catchability is an important parameter in many stock assessment models because it relates the index of abundance to stock size. The study also provided sociodemographic profile of the community to reflect the importance of fishery resources to wetland community thus sustainable management of resources should be implemented.

Socio-demographic profile

The socio-demographic profile of the community showed that the local population depended on fishing for sustenance and livelihood. Fishing is artisanal in nature. The population of fishermen is considered as aging, with the highest percentage of fishermen in ages 46 years old and above. This could explain the manner of fishing in the area that is considered traditional, using passive fishing gears such as "bubo", such fishing gears been used for decades. Although, these types of fishing gears are considered as ecologically friendly, which can be related to the fishermen's role to conserve wetland resources against exploitation. However, mesh sizes of the fishing gears are not compliant with the standard mesh size stated in the Fisheries Code. The standard mesh size according to the Fisheries Code is not to exceed 3 cm, as compared to 1.5 cm mesh size observed in the nettings of fishing gears used by the fishermen in this study. This can be attributed to the higher percentage of married fishermen with large family size. This policy might have been overlooked, as the pressure to catch fish for daily subsistence becomes imminent.

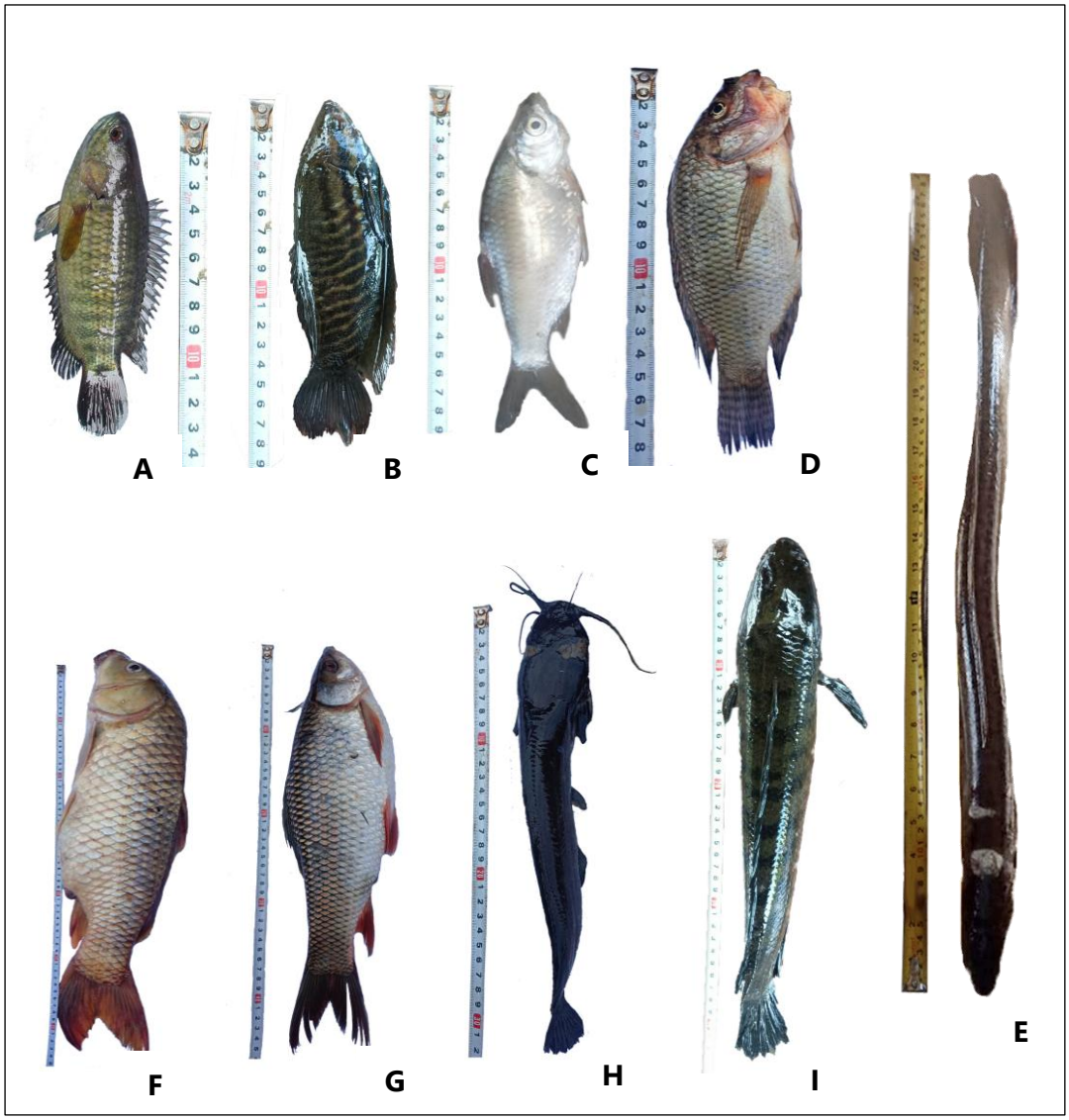

Figure 11. Fishes caught in Ligawasan marsh from fish catch landing site at Bagoinged, Pikit: (A) climbing perch; (B) snakeskin gourami; (C) silver carp; (D) Nile tilapia; (E) giant mottled eel; (F) common carp; (G) rohu carp; (H) native catfish; (I) mudfish.

Fish catch landings

In terms of relative abundance, the results showed that cyprinids are highly abundant in Ligawasan Marsh. A baseline study in Ligawasan marsh has recorded at least 33 species of freshwater fishes (DENR, 2004). The fishes recorded in this report include: bigeye trevally, broadband sleeper, catfish, climbing perch, common carp, dusky sleeper, giant gourami, giant mottled eel, glass perchlet, guppy, half-beak, Indo- pacific tarpon, java carp, Mozambique tilapia, mudfish, mudskipper, mullet, native catfish, olive flathead, Otomebora mullet, rohu carp, silver carp, snakeskin gourami, spotted barb, silver carp, tank goby, tapiroid grunter, three-spotted gourami, and walking catfish. DENR (2004) recorded the cyprinids as the dominant group which also agrees with the findings of the present study. There was no prior fish stock assessment conducted last 2004 from the DENR study and was limited only to qualitative description of the ecological and socioeconomic data. Since then, the most important fishery species from the marshes are dominated by introduced cyprinids, gouramys, cichlids, and the introduced catfish species. Cyprinids include common carp, rohu carp, and silver carp. The same species were found to be abundant in the present study. The native

fishes are brought to the fish landing sites for sale. In the case of the present study, native catfish which is native to Ligawasan marsh was also found being sold at the landing site.

The Fisheries Situationer (2022) reported inland municipal fisheries production at 205.54 thousand metric tons. In this context, production in Ligawasan marsh can be considered low, despite the abundant catch observed. However, a previous study by Small Grant Program (2012) estimated daily catch at approximately 10-30 tons. The present study estimates daily catch at 0.1-0.17 tons which is evidently lower compared to the data gathered ten years ago.

Gear selectivity

Passive gears are in general commonly practiced in Ligawasan marsh fishing grounds, particularly "*bubo*" and "*pukot*". Gill nets are categorized under passive gears because these are stationary when used. These types of gears are commonly observed in small scale-fishing and are employed for artisanal fisheries because they require less effort and lower cost in the construction. Fishermen in Bagoinged, Pikit are engaged artisanal fishing.

From the data gathered, it can be stated that gear selectivity influenced the fish catch profile at Ligawasan marsh, particularly on fish catch landed at Bagoinged, Pikit. For instance, tilapia, climbing perch, silver carp, and snakehead gourami were only caught using gill net. Fish pot is the only fishing gear used to catch common carp, and fish trap is exclusively used to catch giant mottled eel. But this is not true for all cases of wetlands. In North and South Dakota, both gill nets and fish traps were used to catch common carp as observed in the study of Clark et al. (1991). Overall, from the data gathered, it can be stated that tilapia and common carp, despite its high gear selectivity, have high catchability compared to other fish caught in Ligawasan marsh.

The high relative abundance of tilapia in the area or its dominance can be accounted for its tolerance for a wide range of salinity, temperature and critical conditions. They are 'hardy' species with a high resistance to harsh environmental conditions, thus, they are considered basic food source in rural communities adjacent to freshwater sources. Given its characteristics, high turn-out is somewhat expected for tilapia catching rate however, it is unlikely for common carp.

Considering catch as a common index of relative abundance, it can be noted that common carp is relatively abundant in Ligawasan marsh, with a catch percentage similar with tilapia but with a large difference compared to other fishes such as native catfish, eel, gourami and other cyprinid species. But then, it can be noted that common carp is regarded as invasive species in wetlands (Pinto et al., 2005; Maiztegui et al., 2019). If the population of the common carp continues to grow at this rate, an intervention will be necessary to increase the abundance of other species. Conallin et al. (2012) cited that environmental water affluent can be managed to lessen population dynamics of common carp, to allow native fishes to thrive in the wetland. This may be challenging in the case of Ligawasan due to the regular occurrence of flooding, thus other interventions should be explored.

Low gear selectivity was observed in species such as mudfish, rohu carp and native catfish. According to the practice of fishermen in Ligawasan, rohu carp are caught using gill nets and fish traps while mudfish are caught using gill nets and fish pots. The use of two different fishing gears for these species could account for the high catching rates observed for rohu carp and mudfish species in the area. In addition, fish pot can catch more mudfish than gill net. Fish traps tend to catch more rohu carp than gill nets. A strikingly high catching rate was observed in the first weeks of observation in mudfish species, but this declined in

the following weeks. As compared to rohu carp, which was observed to have consistent high catching rate for the whole 9-week observation period.

Gill nets, fish pots and fish traps can be used to catch native catfish. Despite the use of these three fishing gears, fish catch for native catfish still exhibited incremental percentage compared to other fish species. This suggests that even though all three types of fishing gears were already used to catch this species, it still accounted for only 5% of the total catch, indicating low abundance of this fish in the area. Further assumptions may indicate that low abundance of native catfish was affected by exploitative competition with other fish in Ligawasan, or that its stocks are declining due to overfishing. From this study, it is implied that higher gear selectivity does not always reflect lesser catchability of a particular species. Also, low gear selectivity does not necessarily indicate high relative abundance.

Catch per unit effort

From the data gathered, respondents indicated that fishing effort was affected by water levels and flooding in Ligawasan marsh. Generally, the fishing effort is affected by flooding thus less catch was observed at some weeks wherein flooding or water level rise was encountered. The highest CPUE was observed in common carp (13-21.8), while lowest CPUE was observed in snakeskin gourami (1.6 -3.97).

Furthermore, higher CPUEs were observed in mudfish, common carp, rohu carp and tilapia as opposed to native catfish, gourami, silver carp, climbing perch and giant mottled eel. The variation incurred in fish pot CPUE can imply that even though fishing effort was increased, fish catch remains low. Hence, there is an indication that relative abundance has evidently declined for giant mottled eel and native catfish, except for rohu carp wherein high CPUE was observed.

Length-weight relationship

FishBase website recorded the average size of giant mottled eel at 26.3 cm with a maximum length for male species at 70 cm and female species at 200 cm. Comparing the data from the study, giant mottled eel (89-92 cm) from Ligawasan marsh exceeds the average and maximum length for male species. However, the study was not able to observe the reproductive organ of the species which is a limitation of the study.

He et al. (2021) recorded rohu as a fast-growing species reaching a length of 35-45 cm. However, the length recorded in the present study was shorter compared in the study of Sarkar et al. (2017) wherein the size of *Labeo rohita* ranged from 18-24 cm in Kulia beel, a wetland adjacent to the river of West Bengal, India. In another study, Kaur et al. (2018) recorded rohu carp length at 67.6 cm–51.3 cm at Harike wetland, Punjab, India.

The length of native catfish in this study were recorded at 35.5- 39.0 cm which was shorter compared to the maximum length recorded by Fishbase.org at 120 cm. On the other hand, the length of native catfish in Agusan Marsh was comparable at 25.5-41.0 cm (Jumawan and Seronay, 2017). It can be noted that both wetlands recorded almost similar fish length for native catfish thus the wetlans structure and can be a factor for this size limitation.

Common carp can grow up to 93 cm as observed in the study of Abassi et al. (2017) at Zayandehrud dam, Isfahan, Iran. The study of Jumawan and Seronay (2017) recorded a length up to 51 cm for common carp. Fishbase.org reported common carp length at 34.8 cm at maturity, with a common length at 31 cm, but can grow up to 120 cm. This could mean that common carps found in Ligawasan may not have reached its maturity length but not yet its

maximum length. There is also a possibility that common carp caught in Ligawasan have not yet reached its maximum size at this time of the year.

According to Fishbase.org, the maximum length for mudfish is recorded at 100 cm with common length of 61 cm. The length recorded in this study (25-37.5 cm) were shorter and also shorter compared to the range recorded in Agusan Marsh (23-61 cm) in the study of Jumawan and Seronay (2017). A substantial study on the nutrient composition at Ligawasan Marsh could also be considered to further explain these findings as well as the migratory behavior of fishes in the area.

Fishbase recorded the maturity length of silver carp at 51.7 cm with a maximum length at 120 cm. The common length of silver carp was recorded at 18 cm (Abassi et al., 2017). The data from the present study showed a shorter length for silver carp at 23 cm, but longer than the common length mentioned. This suggests that the silver carp in Ligawasan marsh have not yet reached their maximum sizes.

Nile tilapia length in this study are comparable with common sizes observed at harvestable sizes in ponds, although it is slightly increased above average as observation progressed in the latter weeks. The length of tilapia in wetland have not been widely discussed in literatures, which mostly focuses on their invasive nature, thus explaining their proliferation in almost all bodies of water.

According to Fishbase.org, snakeskin gourami can grow to a maximum size of 25 cm, but is commonly observed at 15 cm. The same length was observed in this study (15-18 cm). Welcomme (1988) reported several countries with adverse ecological impact caused by the introduction of this species. The species is naturally occurring in Mekong basin (Kottelat, 2001) and introduced widely in the southeast Asian region (Paepke, 2009).

Climbing perch length were recorded at 12.5–17 cm which is slightly longer compared to the study of Kumary and Raj (2016), where length registered a minimum of 7-10 cm at Kuttanad wetland in Kerala state, India.

This study compares the results with the study of Jumawan and Seronay (2017) relating to the length-weight relationship of fishery resource in Agusan marsh. Although these studies are not interconnected, both are located in Mindanao, making this a relevant comparison of wetlands situated near the Ligawasan. A comparison of the length, weight, linear regression and status of similar species can be shown in the two studies (Table 3).

From the data gathered, comparing two wetland ecosystems, Ligawasan marsh has a lower length-weight range for most species compared to that in Agusan marsh, except for snakeskin gourami (*Trichogaster trichopterus*). It can be noted that minimum lengths recorded in Ligawasan was higher compared to Agusan marsh, but the maximum lengths were greater in Agusan marsh. This difference may be due to the wider variety of fishing gears used by fishermen in Agusan Marsh, which could have affected the catchability rate in the wetland. Fishermen in Agusan Marsh tends to use more types of fishing gears such as cast nets, scissor nets, fish trap, fyke net, and multiple hook and lines (Jumawan and Seronay, 2017). Given that in Agusan marsh, different types of fishing gears were used to catch similar fishes and recorded higher length and weight, there is a possibility that extractive factors in Ligawasan marsh could be limiting the growth of these species to reach its maximum size. This is highly evident in species like mudfish, tilapia, and common carp species. However, considering that fishermen in Ligawasan only used passive fishing gears, another factor may be influencing the growth of fish to a certain length, in this area. It is possible that fish pots

and fish traps are located near the breeding grounds blocking the migration routes obstructing the growth of adult fishes that have not yet reached the maximum size. Otherwise, there is a nutritional factor in Ligawasan marsh that does not permit growth beyond the cited range.

The status of species is similar in two wetland sites except for mudfish that is native to Ligawasan but an introduced species in Agusan Marsh. The dominance of introduced species was noted to pose many dangers to the aquatic habitat. Compared to native fishes, introduced species tend to have higher reproductive rates (Townsend & Pettigrew, 1996; Sakai et al., 2001; Mills et al. 2004) and one reason could be early maturity at a shorter size range. Tilapia for instance can reproduce as early as three month-time.

Table 3. A comparison between Agusan Marsh (Jumawan & Seronay, 2017) and Ligawasan Marsh (this study) fishery resources on total weight and body weights.

Family and Species		Total length (cm)	Body weight (g)	Status
Anabantidae				
Anabas testudineus				
	Ligawasan	12.5- 15	36.1- 77.7	Native
	Agusan	9.6- 17	15.50- 77.6	Native
Channidae				
Channa striata				
	Ligawasan	26- 37.5	131.5- 396	Native
	Agusan	23- 61	50- 1500	Introduced
Cyprinidae				
Clarias macrocephalus				
	Ligawasan	35.5- 39.5	40.1- 52	Native
	Agusan	25.5- 41	115- 500	Native
Cichlidae				
Oreochromis niloticus				
	Ligawasan	17- 21.5	93.7- 293.3	Introduced
	Agusan	11.5- 47	25- 2000	Introduced
Osphronemidae				
Trichogaster trichopterus				
	Ligawasan	15.5- 18.0	18.1- 35.7	Introduced
	Agusan	4.9- 11.5	1.7- 21.5	Introduced

Conclusion

From this study it can be inferred that fishery resources in Ligawasan Marsh were considered abundant. In terms of total fish catch in 9- week observation period, fish landing in Bagoinged, Pikit recorded approximately 8 tons of fish catch from 9 fish species. Ligawasan Marsh resources can produce up to 8 metric tons of fish in 9 weeks period. However, data on length-weight relationship revealed that smaller fish are being caught compared to maximum sizes of these species. Although, a comparison of similar study of a wetland in close proximity, such as Agusan marsh, showed higher length-weight range than Ligawasan marsh

except for snakeskin gourami. Gear selectivity was also evident in Ligawasan marsh. Giant mottled eel was only caught using fish pot, while common carp was only caught using improvised fish trap. Climbing persh, snakeskin gourami, Nile tilapia and silver carp were only caught by gill net. Both gill nets and improvised fish traps were effective in catching mudfish in the area, while both gill nets and fish pots were used to catch rohu carp. The low gear selectivity of mudfish and rohu carp may have contributed to its relative abundance in fish catch. However, all three fishing gears were able to catch native catfish and yet low fish catch data were still recorded. Thus, it can imply low relative abundance of native catfish. In contrast to Nile tilapia which is caught only by using gillnet and common carp caught only by using improvised fish trap yet high fish catch data were recorded. This also implies that these areas of Ligawasan marsh are most abundant in Nile tilapia and common carp. Further research is needed to determine the rate of recruitment in Ligawasan marsh to compare the rate of reproduction. If both recruitment and reproduction are determined, then the rate of dwindling stock can be assessed. With this data, the information on how to regulate fishing, or on how to implement closed season to allow time of propagation of a particular species.

Recommendation

There is a need to determine the sustainable level of fish catch specifically the native fishes. The land use policy of the municipalities bordering the wetland has significant influence on the fishing resources. Fish policy development is needed in Ligawasan Marsh. Although there are existing policies prohibiting catch of young freshwater fish, these are not properly enforced as evidenced by the data gathered in fish stock assessment. If fish caught contains smaller sizes than those commonly observed in wetlands in the Philippines (i.e. Agusan Marsh), then a more specific municipal ordinance should be carried out in the community. The low abundance of native catfish in the area, despite low gear selectivity, suggests a need for proper management of fishery resources. The socio-political structure in Ligawasan Marsh must have a concrete system in place on how policies can be implemented in the community. LGUs play a crucial component in promoting or spearheading policy development in the community, and a strong linkage to the LGU unit of the municipality should be established to facilitate the implementation of new policies in the Ligawasan community.

The study focused on the fish catch landing in the data collection excluding data from breeding grounds. Although it is highly recommended to identify breeding grounds in the marsh in the future studies. For this study, results suggest that the species most likely to be captured depends on gear selectivity. Results showed giant mottled eel tend to be caught only using fish pot. Snakeskin gourami, tilapia and silver carp are caught using gill net. Interestingly, native catfish is the easiest to catch regardless of the different gears used.

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No potential conflict of interest was declared by the authors.

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