Sustainable Fisheries Management Program for Lake Mainit

PHASE II:
Comprehensive Resource Assessment
FINAL REPORT

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NMCIREMP

Lake Mainit Development Alliance

Sustainable Fisheries Management Program for Lake Mainit

Phase II. Comprehensive Resource Assessment

Final Report

Prepared by

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Executive Summary

Lake Mainit is an important shared resource of Agusan Norte and Surigao del Norte, distinguished as the deepest (219.35 meters) and fourth largest (17,060 ha) lake in the Philippines, with a shoreline of 62.1 km long and a watershed area of 87,072 ha. Twenty-eight river tributaries contribute to the water volume of Lake Mainit, which is drained by a single outlet – the 29 km Kalinawan River that flows into Butuan Bay.

Earlier studies conducted in 1980-81 by Pauly, et al. (1990) and in 1997-98 by Galicia & Lopez (2000) showed that Lake Mainit supports a high diversity of aquatic fauna and a thriving freshwater fishery. On the other hand, the lake and river fisheries are rapidly being depleted due to unsustainable or destructive fishing practices, too many fishers, highly diversified fishing technology, and lack of enforcement of fisheries and environmental policies. Income from fishing is no longer sustainable in many areas, and lakeshore communities fear that rare and endemic fishes in the lake will be lost due to overfishing.

Lake Mainit has rich aquatic resources that can be developed to optimize economic benefits to surrounding communities, however, fisheries management interventions are necessary in order to conserve the lake resources, protect remaining biodiversity and sustain incomes of fishers. The last comprehensive assessment was done more than 25 years ago (Pauly et al. in 1980-81), and effective planning depends on reliable and updated information to guide decision-making and the formulation of a holistic and integrated framework for sustainable fisheries management.

The *Sustainable Fisheries Management Program for Lake Mainit* is a project implemented by the Mindanao State University at Naawan through the MSUN Foundation, Inc. in three phases over a period of three years that started in July 2007. The long-term goals of the project are to establish a comprehensive fisheries management program to sustain its fishery resources, promote equitable access and utilization, and improve quality of life of lakeshore communities through enhanced economic well-being. Among the specific objectives of the project are to a) updated data on aquatic biodiversity of Lake Mainit, b)generate a comprehensive profile on status of the lake and riverine fisheries , c) provide an updated socio-economic profile of fisherfolk around the lake, and d) identify & evaluate existing intervention programs and institutional arrangements prevailing in Lake Mainit.

This report presents the results of the Comprehensive Resource Assessment (Phase II) and incorporates the Inception Report prepared under the Rapid Resource Appraisal (Phase I). The SFM Program for Lake Mainit is funded by the International Fund for Agriculture Development-Northern Mindanao Community Initiatives in Resource Management Project (IFAD-NMCIREMP) of the Department of Agrarian Reform (Caraga Region), Lake Mainit Development Alliance (LMDA), and the Philippine Council for Aquatic and Marine Research and Development (PCAMRD-DOST). The report covers the subcomponents of Aquatic Biodiversity and Fisheries Assessment, Population Biology and Stock Dynamics, and Socio-Economics and Intervention Programs. Highlights of the results had been presented to the Lake Mainit LGUs at the SFM Planning and Validation Workshop on October 22, 2008. Comments and suggestions from the validation workshop had been incorporated in the final report.

Aquatic Biodiversity and Fisheries

Rapid resource appraisal conducted between August and October 2007 and the comprehensive resource assessment conducted from November 2007 to September 2008 report that 41 species of finfish, 5 crustaceans, 10 mollusks and 15 aquatic plants, occur in Lake Mainit and its outlet Kalinawan River. The number of finfish species presently found in the lake exceeds the 37 species reported by Pauly et al. (1990), however, 13 species listed in earlier are not reported in the present study. More than 65% of the fish are migratory between the lake and Butuan Bay through Kalinawan River. Some species have virtually disappeared while populations of previously abundant species (such as the giant mottled eel *Anguilla marmorata*) have significantly dwindled. Results show that a species changeover has occurred, possibly a result of overfishing, exotic species introductions, and declining water quality of the lake. Invertebrate fauna (mollusks and crustaceans) are not very diverse compared to marine communities. The most common mollusk are the snails called locally as *Ige, kuhol* and *suso,* while the most common crustaceans are the freshwater shrimps *ulang* and *isik.*

Very diverse aquatic vegetation occurs in most shallow parts of the lake, dominated by *Vallisneria* sp. (*lusay),* and *Hydrilla vertilicillata* (*dugman*), forming extensive underwater vegetation. The dominant emergent plant in the lake is the *paguse* (*Nelumbo nucifera*), while the river is dominated by the floating plants represented by *Echornia crassipes* (water lilies). The floating water lily or hyacinth occurs most abundantly along the river entrance at Jabonga and drifts along Kalinawan River. Piling up of these plants along the narrow portions of the river often caused water backflow, contributing to higher water levels during *guob* or flood season.

Fisheries assessment was conducted through monthly monitoring of fish catch and effort by local enumerators or research partners in the six LGUs. Recorded fish catch from six municipalities between August 2007 and September 2008 amounted to 274.15 tons. Extrapolating our estimates based on 14 monitoring months and 28 monitored landing areas yields an estimated annual fisheries production of 620.0 tons, which is only about 4.1% of the 1980-81 yield (15,108 t) reported by Pauly et al. (1990). *Pijanga* made up 51.4% of the total catch from the lake while *Lampohon* comprised 38.9% of the total fish catch from Kalinawan River. Local research partners noted that a large portion of the pijanga catch is exported to other areas, such as Butuan City, which explains why only a small amount is retained and sold in local markets around the lake.

Lake Mainit and Kalinawan river are two distinct ecosystems with differences in fishery resources. Two species of goby, the *pijanga* (*Glossogobius giuris*) and *bugwan* (*Hypseleotris agilis*)*,* are important native species of the lake, and still occurs but in much reduced abundance than around late 1990s (Galicia and Lopez, 2000). The introduced *tilapia* is also abundant in the Lake, together with other common fishes such as *carpa, hayuan,* and *luyab.* The most productive fishing gear in both the lake and river is the *pukot* (gillnet), while *baling* (beach seine) remains efficient particularly in the municipality of Mainit, Surigao del Norte where this gear still operates. Average catch rates of major gears range from 8.3 kg/unit/day (*bungsod*) to as much as 70 kg/unit/day (*pukot palutaw*), although the latter value is based on only a single observation. A type of encircling gillnet locally called *surit* also lands abundant catches in Tubay, Agusan del Norte along Kalinawan River. Total recorded

fish catch for the period 2007-2008 was highest in Kitcharao and Mainit where a large number of fishers was also monitored. Average catch (kg) per fisher, however, is highest in Jabonga as a result of fewer fishers, followed by Mainit and Tubay. It can be noted that the large average catch per fishing effort (CPUE) in Mainit is contributed by catches from *baling,* which is already a banned gear in other municipalities around the lake. Present annual catch of *pijanga* (142.5 t) is about 63% of the 1997-98 production reported by Galicia and Lopez (2000), indicating dwindling of goby stock in less than 10 years.

Population Biology of Lake Mainit Fishes

Lake Mainit has a very diverse fish community - classified into three different groups, namely, true freshwater fishes (lake and riverine), amphidromous fishes and catadromous fishes. Detailed biological analysis was conducted on only two major fishes in the lake, namely, *pijanga* (*Glossogobius giuris*) and *bugwan (Hypseleotris agilis)*, which were also studied by Galicia and Lopez (2000). Monthly collection of fish samples was made from catches of *pukot* and *baling.* All individuals were measured for total length and body weight, and dissected to determine sex and gonadal maturity.

The *bugwan* sampled between August and November had a size range of 5.1-18.0 cm, which is smaller than the size range of 4.0-18.5mm studied by Galicia and Lopez (2000). Specimens of *pijanga* had a size range 5.0-24.1 mm, again smaller than reported size range of 2.5 to 30.5 mm by Galicia and Lopez (2000). The present results indicate that both *bugwan* and *pijanga* are generally smaller now than in the 1990s. Large proportion of mature or spawning individuals of *bugwan* were observed between November and February, while in *pijanga* occurred between January and April. Results of gonadal maturity agree with those of Galicia & Lopez's (2000) that spawning in both species occurs throughout the year, but defined peaks were observed during which spawning would be more pronounced. Sex ratios in both species favor the females, while length-weight relationships indicate that both gobies exhibit a positive allometric growth (i.e. increase in weight is faster than length).

Results of length-frequency analysis by *FiSAT* obtained the following parameters on population dynamics for *H. agilis*: asymptotic length, $L\infty$ = 19.16 cm; Growth rate, K = 0.27; Total mortality, Z = 1.55; Natural mortality, M = 0.87; Fishing mortality, F = 0.66 and Exploitation Rate, Exploitation rate, E = 0.43. For *G. giuris* the following parameters were obtained: L_∞ = 25.73cm; K = 0.27; Z = 1.62; M = 0.82; F = 0.80; E = 0.50. Recruitment pattern is bimodal for both gobies. Length-weight parameters and feeding habits were also studied for seven other commercially important species of finfish, all showing allometric growth. Major commercial fishes from Lake Mainit can be classified as carnivores, omnivores, and detritivores. Carnivorous fishes from Lake Mainit include the mudfish (*C. striata*), the golden tank goby (*G. celebius*), the white goby (*G. giuris*), and the Mainit eleotrid (*H. agilis*). Omnivorous fishes include the walking catfish (*Clarias batrachus*) and the Nile tilapia (*O. niloticus*), while detritivorous fishes are represented by the common carp (*C. carpio*).

Socio-Economics and Intervention Programs

The municipalities along Lake Mainit and Kalinawan River are classified as fourth (Mainit, Jabonga, and Santiago) to fifth class (Alegria, Kitcharao, and Tubay) economies based on the LGU's average annual income in the last three calendar years. Fisherfolk communities around Lake

Mainit and environs have diversified livelihoods, clearly a response to depleted incomes from fishing. For full time fishers, fishing in Lake Mainit and Kalinawan River is the main source of income (85%), followed by farming (12%). Other minor income-generating activities are operating a sari-sari store, engaging in small-scale mining and many others. For part time fishers, farming is the main source of income supplemented by fishing and other livelihood options especially in Jabonga and Santiago.

A survey of the fishing effort across six municipalities around Lake Mainit (Mainit, Alegria, Kitcharao and Jabonga) and along Kalinawan River (Santiago and Tubay) showed that some 1,754 fishers and 1,546 fishing boats are involved in Lake Mainit fisheries. Majority of the fishing boats are non-motorized *bancas* or *bandong* except in Tubay where motorized exceeded the non-motorized boats. Kitcharao and Tubay has the most number of the fishers, however, most of Tubay fishermen actually fish in Butuan Bay more than in Kalinawan River. A total of 36 kinds of fishing gear are being used by fishermen in Lake Mainit and along Kalinawan River, with Mainit and Jabonga having the most diversified fishing activities. The most commonly used gears are various modifications of hook-and-line or *pasol/bingwit,* gillnet (*pukot*), fish traps (*timing*), spear (*pana*) and the modified cast net or *laya*.

The volume of catch landed daily around Lake Mainit varies widely among fishing gears, from as low as 1.5-5.0 kg/day or trip to as high as 150 kg/day landed by *baling,* although such a large catch is quite rare. Fish traps such as *timing* and *bantak* are popular in Lake Mainit because of their simple operation and relatively higher volume of catch. Catch of *timin*g reaches up to 100 kg during *guob* although normally the catch ranges from less than 5kg to 20 kg. Majority of the catch is sold in local markets around the lake, except for large catches of carps and *pijanga* which are sold in the cities of Butuan, Surigao, and Cabadbaran, and as far as Iligan City and Marawi City.

Incomes derived from fishing varied among fishers in Lake Mainit and Kalinawan River depending on the type and number of gears they operate and on the fishing season. Average daily income per fisher ranges from P223 during the lean months to as much as P1,537 during the peak season. Certain gears have meager incomes during the lean fishing season, such as *bingwit, taan,* and *pukot.* Gears such as *baling, pana, laya, bungsod,* and *timing* seem to be quite profitable, earning moderate daily incomes even during lean months, and potentially large incomes during peak seasons when they experience "jackpot" catches.

The pattern of expenditures of a fishing household around Lake Mainit comprise of four basic components, namely: food (rice, viand and groceries), educational expenses (fare, allowance, and tuition), payment for basic amenities (medicine, water and light/electricity) and other miscellaneous expenses. The biggest chunk goes to food, comprising 57-69% of the daily budget of a family. Results show that the average household around Lake Mainit needs Php228-353 to cover their basic daily requirements. Monthly household expenses range from Php8,270 (Alegria) to about Php12,829 (Jabonga). Education is regarded as important expense item by most fisherfolk, spending from Php990 to Php2,230 on tuition, daily fare and allowance. Results indicate that monthly incomes of the average fisher during lean months of about Php6,700 is not enough to meet monthly expenses in most cases. On the other hand, most fishers spend a substantial sum on miscellaneous expenses such as cigarettes, cellphone load, gambling bets for card and number games, and 'snacks' that include alcoholic drink

Fishers around Lake Mainit recognize that their daily income from fishing can hardly meet the basic family expenditures, thus, many of them and their family members are engaged in other forms of income-generating activities to supplement income from fishing. These activities range from farming, livestock raising, driving motorcycle (*habal-habal*), fish vending, providing labor services and many other alternative sources of income. A popular economic activity in certain lakeshore communities of Alegria and along the riverbanks of Kalinawan River in Santiago is gold panning or mining for nickel, copper and other minerals.

Lake Mainit and its surrounding municipalities have attracted the attention of various programs and projects introduced to the communities. Intervention programs range from support for various livelihood options (such as livestock raising), credit facilities for financial assistance, health care, infrastructure, and environmental programs such as tree planting.

The residents of lakeshore communities around Lake Mainit identified several issues and concerns in connection with fisheries-based livelihood, living conditions and socio-political situation around the lake. The most common concerns include declining fish catch and poor income, resource use conflicts, degrading quality of lake water, and poor or ineffective management or governance. The role of LMDA as an alliance of local government units is recognized as crucial to the successful implementation of all resource and environmental management programs for Lake Mainit and its associated river systems. Integrating fisheries management to the Lake Mainit development agenda is an important step in implementing a holistic, sustainable resource management program for the present and future generations of fishers.

Lake Mainit is a highly productive wetland ecosystem which has, naturally, attracted the attention of many government agencies and non-government organizations (NGOs) alike. Local communities around the Lake are also politically active, with more than 50 people's organizations (PO's) and local organizations involved in various livelihood and resource management initiatives. At least 21 international organizations, 12 national line agencies and 3 academic institutions have come to Lake Mainit for a variety of social, economic and research interventions. The intervention programs are categorized arbitrarily into the following: livelihood options, credit facilities for financial assistance, health care, infrastructure, and environmental programs.

Management Implications and Recommendations

Results of the fisheries resource assessment project have indicated that fish production from the lake has been rapidly declining over the last two decades, and that most fishers earn marginal incomes barely enough to meet basic daily needs such as food, education of children, and health. Lake Mainit experiences the typical syndrome of a threatened fisheries: biodiversity loss, high fishing pressure, use of unsustainable fishing gears and methods, declining fish catch and catch-per-unit-effort, decreasing size of fish caught, and marginal or meager fisher incomes.

Among the recommended measures to sustain the lake's fisheries are: a) establishment of closed season and protected areas to protect spawning of goby; b) Regulate fishing effort through regular (annual) fisherfolk, boat, and gear registration; c) complete ban of *baling* in the municipality of Mainit; and d) establishment of land-based income-generating activities to alleviate fishers' income and reduce pressure on the lake's fishery resources.

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  - Hon. Aristotle E. Montante – Kitcharao, Agusan del Norte
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- Ms. Flordela Galo of Kitcharao, Agusan del Norte
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INTRODUCTION

Project Background

Lake Mainit is the fourth largest lake in the Philippines with a surface area of 17,060 hectares, a shoreline 62.1 km long, and a watershed area of 87,072 hectares (LMDA, 2005). Twenty-eight river tributaries flow into the lake from surrounding upland areas, while only one outlet river, the 29-km long Kalinawan River, drains into Butuan Bay through Jabonga, Agusan del Norte. Lake Mainit is a shared resource of the provinces of Agusan del Norte and Surigao del Norte in Northeastern Mindanao, bordered by eight municipalities that comprise the Lake Mainit Watershed (Fig. 1).

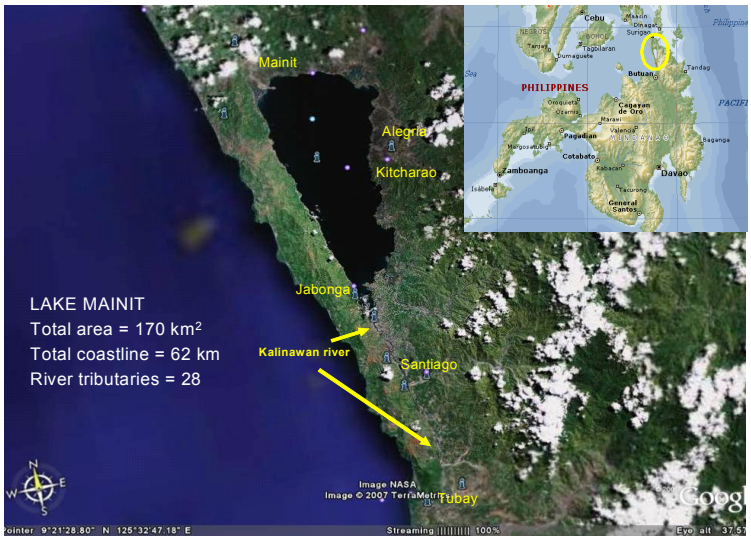

Figure 1. *Map showing the location of Lake Mainit in northeastern Mindanao.*

An ecological study of the lake (Tumanda, et al. 2004) has shown Lake Mainit to be oligotrophic with high transparency, sufficient nutrient supply to support high productivity, and well-oxygenated freshwater of excellent quality to supply domestic uses (EMB, 2003). In fact, its excellent water quality has earned its reputation as one of the cleanest lakes in the Philippines. The study also confirmed Lake Mainit to be the deepest lake in the country, with a mean depth of 128 m and a maximum depth of 223m (Fig. 2).

Lake Mainit supports a high diversity of aquatic fauna and a thriving freshwater fishery (Fig. 3), particularly of commercially important gobies and Nile tilapia (Galicia and Lopez, 2000). On the other hand, Lake Mainit also faces threats of overfishing and habitat degradation due to pollution from agriculture and mining and destructive fishing practices (LMDA, 2005). Fine-meshed nets, electric fishing, and the use of chemicals or poisons have reduced the aquatic biodiversity of the lake and Kalinawan River (Fig. 4).

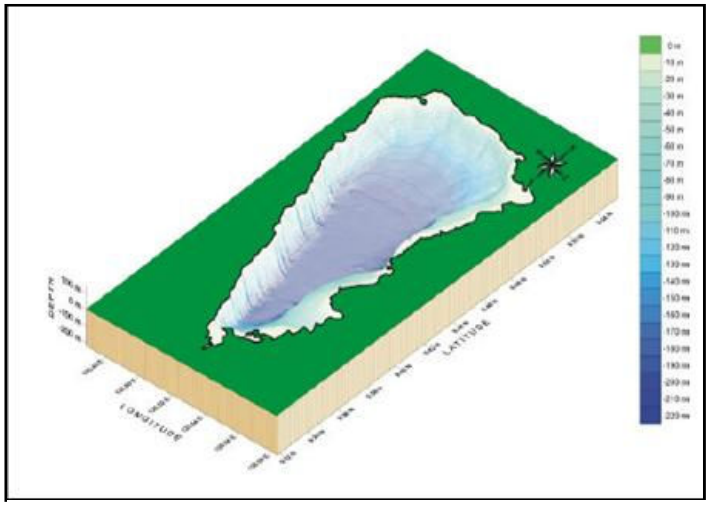

Figure 2. *Bathymetric map of Lake Mainit in northern Mindanao (Tumanda et al., 2004).*

Unsustainable aquaculture practices, such as introduction of exotic species into the lake, have also threatened a number of rare and endemic species of fish. The threat to the biodiversity of the lake and other freshwater ecosystems in Mindanao becomes even more critical with the promotion of new aquaculture projects, such as *Pangasius* culture, by the Bureau of Fisheries and Aquatic Resources, the Department of Trade and Industry, and private feed corporations.

Rationale for a Sustainable Fisheries Management Program

Lake Mainit has rich aquatic resources that can de developed to optimize the economic benefits to surrounding communities. A Lake Mainit NGO-PO Forum conducted in July 2005 had recognized that most NGO projects in the area are focused on agriculture and agro-forestry, with scant attention to management of lake fishery and other aquatic resources. The need to address the diverse management issues concerning the resource ecology of Lake Mainit was also given preferential attention. The last comprehensive assessment was done more than 25 years ago in 1980-81 (Pauly et al. 1990) which placed the annual total fisheries production of the lake at more than 15,000 tons. After more than two decades baselines have either shifted or changed, and species composition may have been altered.

***Figure 3**. Lake Mainit supports a thriving but vulnerable freshwater fishery.*

***Figure 4**. A view of the placid Kalinawan River flowing from Lake Mainit into Butuan Bay.*

The imperative to conduct a comprehensive assessment of the lake and riverine resources to produce an updated profile on diversity and production is governed by the strong desire of the Lake Mainit Development Alliance (LMDA) to invest in a sustainable fisheries management program for the lake and Kalinawan River. The results of this assessment will provide the scientific basis for formulating a comprehensive fisheries management plan for Lake Mainit that shall, in turn, be integrated into the Lake Mainit Development Agenda.

Project Objectives

The project ultimately aims to establish a comprehensive fisheries management program to sustain the fishery resources of Lake Mainit, promote equitable access and utilization, and improve quality of life of lakeshore communities through enhanced economic well-being. To achieve these long-term goals, the project aims to satisfy the following specific objectives:

1. To generate a comprehensive profile describing the status of the lake and riverine fisheries;
2. To provide an updated checklist of the aquatic biodiversity;
3. To provide an updated socio-economic profile of the municipalities bordering the lake;
4. To identify and evaluate the existing intervention programs in the area;
5. To determine critical related issues and problems and recommend alternative measures; and
6. To integrate these information into a holistic, implementable program in sustainable fisheries management.

Review of Existing Literature

Freshwater resources such as lakes, rivers, streams, reservoirs, ponds, marshes and swamps are scattered over the major islands in the Philippines. These inland waters are home to a number of native as well as introduced freshwater fish species (Conlu, 1986). Freshwater resources account for about 41% of the 22,000 living species of fish estimated by Cohen (1970 cited by Moyle and Cech, 1982). With such rich resource attributes, the freshwater habitats of the Philippines are considered economically important but threatened fishery systems.

A limnological survey of Lake Mainit was conducted in 1971 by Lewis (1973) who published the first bathymetric map of Lake Mainit, although Woltereck (1941 as cited by Lewis, 1973) provided the earliest record of depth measurement at one site of the lake at 167m. Limited data on the physical properties of the lake were published by Gracia (1981) and Balayut (1983).

There is very limited information on the fisheries of Lake Mainit; most studies were conducted more than 50 years ago (Manacop,1937; Gracia, et al. 1962). Pauly et al. (1990) reported that the annual catch of Lake Mainit in 1980-81 from major gears amounted to 15,108 tons. Accordingly, migratory fish that traversed Kalinawan River comprised most of the catch, since annual catch from Jabonga, lying close to the river, alone was estimated at 12,900 tons. Galicia & Lopez (2000) estimated the annual catch of two indigenous gobies, *Pijanga* (*Glossogobius giuris*) and *Bugwan* (*Hypseleotris agilis*), in the municipality of Mainit at 225.857 tons landed by beach seine (*baling*) alone in 1997-98. Galicia and Lopez (2000) also studied the biology and population dynamics of the two gobies, and reported an estimate of asymptotic length (L_∞) of 29.03cm for *G. giuris* and 20.21cm for *H. agilis*. A study on diversity of molluscan fauna in the lake was conducted by Abrea (2003).

II. METHODOLOGY

The comprehensive fisheries resource assessment project is part of a three-year Sustainable Fisheries Management program for Lake Mainit. The fisheries assessment covers the four lakeshore municipalities of Mainit and Allegria in Surigao del Norte; Kitcharao and Jabonga in Agusan del Norte; and the municipalities of Santiago, and Tubay (Agusan del Norte) along Kalinawan River, covering a total of 31 lakeshore and riverside barangays. A Rapid Resource Assessment (Phase I) was conducted between July and October, 2007 while the Comprehensive Resource Assessment (Phase II) covers the period November 2007-October 2008 and has the following sub-components:

1) Aquatic Diversity and Assessment of Lake and Riverine Fisheries;
2) Population Biology and Stock Dynamics; and
3) Socio-Economic Profiling and Intervention Programs

2.1 Aquatic Diversity and Assessment of Lake and Riverine Fisheries

Data Collection

Monitoring of fish catch and effort from different sampling sites in six municipalities around the lake was made monthly from August 2007 to September 2008 with the assistance of local research partners (LRPs) assigned to each municipality. Relevant fisheries information from each fisher was recorded on standard data sheets for a minimum of 15 days each month, specifically on the following:

- Gear and boat type used and number of units
- Kinds of fish caught
- Volume or weight of fish (kg)
- Number of hours fishing (including travel time)
- Location of fishing ground/area

The species composition of landed catch was determined by gear type to show the diversity of fisheries resources in the lake and river, and of catches of various gear types. Maps showing the distribution of fishing gears and major fish and invertebrate resources were also generated and have been validated with fishers around the lake in a validation workshop on January 22, 2008. Voucher specimens of different plant species, fish, and invertebrates were collected during the survey. Rare species reportedly present in the area, but without voucher specimens, were also listed and noted. Photographs were taken of different species of flora and fauna, while different gear types were photographed, described, and their measurements obtained.

Analysis of Fisheries Data

Data gathered from daily monitoring of lake and riverine fisheries were analyzed to obtain estimates of important parameters that would describe the present state of fisheries in Lake Mainit, such as total fishing effort, total annual fish production, and catch rates or CPUE. Comparison of recorded catches and CPUE was made among types of fishing gear

and boat or vessels, and among municipalities. A map showing the area of operation of fishing gears was also generated to show the effort distribution within the lake.

Estimates of total annual catch of all species of finfish, crustaceans, and other invertebrates exploited by different gear types were determined from landed catch. In order to account for unrecorded catches from other landing areas within the lake and Kalinawan River, the total recorded catch was multiplied by a raising factor to obtain the total amount of landed catch, thus:

$$Total\ Catch\ Landed = Total\ Recorded\ Catch \times NT/nt$$

where N is the total number of landing areas in the lake, T is the total number of fishing days per month, n is the number of landing centers monitored and t is the number of sampling days per month.

Catch-per-unit-effort, also called catch rate, is a useful measure to describe the economic viability of a fishing operation and was calculated from data on landed catches. To avoid confusion, the term CPUE is used here to denote the amount of catch landed by a fisher from a single operation and is expressed as kg/fisher/day. The term catch rate is used to describe the efficiency of each gear type and is expressed as kg/gear unit/day. Another useful measure in comparing the catching efficiency of gears is by dividing the daily catch rate by the fishing duration (number of hours) of each gear or kg/gear unit/hour. CPUE values were compared among different monitoring sites, while catch rates were compared among gear types in order to show the differential efficiency of various gears. Catch rates allow one to evaluate the technological efficiency of different gear types involved in the fishery of Lake Mainit and its associated river ecosystem as a basis for management measures.

The species composition of landed catch was determined by gear type. This is to show the diversity of fisheries resources in the lake and river, and the relative proportion of catches of various gear types. A resource map showing the distribution of major fish and invertebrate resources was also generated.

2.2 Fish Population Biology and Stock Dynamics

Collection of Biological Parameters

Data on body length, weight, sexual maturity, and other biological parameters of major fishery resources were gathered each month. Detailed analysis was focused on two species of gobies, *Glossogobius giuris,* known as "Pijanga" and *Hypseleotris agilis,* known as "Bugwan", whose population dynamics and fishery were studied in the late 1990s by Galicia and Lopez (2000). Whenever possible, at least 100 individuals of each species were sampled from catches of gillnet (*pukot*) and beach seine (*baling*) in the lakeshore municipalities of Mainit, Alegria, Jabonga, and Kitcharao each month within a three-day period. Biological parameters such as size ranges, sex ratios, and maturity stages were determined from monthly data. Gonadal maturity was determined based on a modified 5-point classification scale (immature, maturing, mature, gravid (spawning) and spent (resting). Monthly biological data are important in the analysis of length-weight relationships and population dynamics of commercially important stocks that can help in formulating fisheries management measures.

Data Analysis

Correlations between growth in length and in weight of major species of fish was made using the exponential relationship (Pauly, 1984):

$$W = a\,L^b$$

where W is the total fresh weight (g) of each fish, L is the total length (cm), and a & b are calculated parameters of a linear regression *(a* is the intercept and *b* is the slope). Male to female ratios were also determined from monthly samples while sexual maturity was expressed as the proportion of mature to immature male and female specimens.

Monthly length-frequency data were used in the analysis of population dynamics of the two major species of goby, namely, *G. giuris* and *H. agilis,* performed using the online version (ver. 1.2.0.2) of a fisheries computer software called FiSAT or FAO-ICLARM Stock Assessment Tools (Gayanilo, *et al*., 1992). This software includes routines that obtain approximate values of growth, mortality, and recruitment parameters following popular fish stock assessment models (Pauly, 1984; Sparre and Venema, 1992). These parameters, in turn, are used as input to predictive models to determine the exploitation levels of major fish stocks in the lake.

2.3 Socio-Economic Profiling, Institutional Arrangements and Intervention Programs

A socio-economic profile of the fishing communities around Lake Mainit was obtained primarily based on output of a series of focus group discussions conducted under a Participatory Resource Appraisal (PRA) in the six municipalities surrounding Lake Mainit. Information from the FGDs was supplemented in Phase II with information from the provincial and municipal profiles, key informant interviews (KII), validation through walk-through or ocular surveys, and interviews of fishing households in 24 barangays around the lake and Kalinawan River. Data on municipal ordinances related to fisheries and environmental management were also obtained from municipal profiles and reports provided by LGU offices. A survey of intervention programs implemented by government, non-government and people's organizations and their impacts on the social and economic well-being of lakeshore communities was also made.

III. RESULTS AND DISCUSSION

3.1 Aquatic Diversity and Fisheries of Lake Mainit and Kalinawan River

3.1.1 Aquatic Biodiversity

Finfish Resources

A total of 41 species of finfish belonging to 21 families were identified in Lake Mainit and Kalinawan River based on collected samples during the survey (Table 1). This number exceeded the 37 species reported by Pauly et al. (1990), which indicates that more

species are now found in the lake. On the other hand, 13 species listed in Pauly et al. (1990) are not reported in the present study. Notably absent from the current list is the tarpon *Megalops cyprinoids* ("bulan-bulan"*),* the Hawaiian ten-pounder *Elops hawaiiensis*, and the spotted grunt *Pomadasys hasta*. Pauly et al. (1990) also listed five species of gourami whereas only one species is reported in the present study, although Lake Mainit fishers alleged that at least three kinds of gourami still occur in the lake albeit rarely encountered. At least four more fish species remain unidentified as no voucher specimens were collected (Table 1). This difference in species diversity across time could be attributed to a number of factors. Some species may have become locally extinct due to overfishing or the increased prominence of introduced or exotic species (such as tilapia, carp, and catfish). Conversely, the apparent increase in species diversity of fish in Lake Mainit could be due to the migratory nature of many species that follow different temporal patterns. It is also possible that some of these migratory species were not recorded in the various sources that Pauly et al. (1990) compiled.

Of the 41 species found in the Lake, at least 14 species (34%) are freshwater fish and the rest (66%) are noted to be marine fish that enter freshwater bodies seasonally, usually to spawn. Many of the marine species in the list are caught in Kalinawan River where the monitoring stations of Santiago and Tubay, Agusan del Norte are located. Many of these fishes have wide habitat ranges where they inhabit coastal lakes, rivers, estuaries, lagoons, and creeks. The marine species *Mugil cephalus* or mullet (family Mugilidae) also breeds in freshwater areas. Figure 5 shows pictures of common finfish resources found in Lake Mainit.

Majority of these fishes were caught at mature stages except for *Therapon jarbua* (family Theraponidae) where many juveniles or young stages were caught by various gears. Young stages of *T. jarbua* and young adults of *Valamugil cunnesius* are known to enter freshwater ecosystems (Conlu 1982). Small glassfish (*Ambassis spp.*), locally known as *ibis,* are either estuarine or freshwater. Fish families such as Clariidae, Lutjanidae, and Carangidae are represented in the catches from Kalinawan River. At least four freshwater species, namely, *Oreochromis nilotica* (Nile tilapia), *O. mossambica* (Mossambique tilapia), *Cyprinus carpio* (common carp), and *Clarias batrachus* (Thai catfish) are introduced fishes in the Lake that have successfully established their populations and are now part of the dominant groups. The list of fishes compiled by Pauly et al. (1990) from various sources indicated that at least 24 species were either marine or migratory, entering freshwater at certain times of the year or their life cycle.

The gobies *Glossogobius giuris,* locally called *pijanga* (or *pedianga*) and *Hypseleotris agilis* (*bugwan*) are the most popular species, reported to be the most abundantly caught fish in the 1980-81 assessment of Pauly et al. (1990) and the 1997-98 study of Galicia and Lopez (2000). These gobies are considered by fishers in Lake Mainit as native or indigenous, although Pauly et al. (1990) reported that they may be marine species entering the freshwater ecosystem of the lake. Not reported in past studies is another species of goby, *Glossogobius celebius,* that is caught from Lake Mainit at much lower abundance than the two more common gobies, but has a larger body size (Fig. 6).

Table 1: Diversity of finfish caught from Lake Mainit and Kalinawan River (August 2007 to September 2008).

Family	Species Name	Local Name	Common Name
1 Anabantidae	*Anabas testudineus*	Puyo; Bakang	Gourami
2 Anguillidae	*Anguilla marmorata*	Kasili	Eel
3 Carangidae	*Caranx sp 1*	Langub	Trevally
4 Carangidae	*Caranx sp 2*	Bogok	Caranx
5 Carangidae	*Ulua mentalis*	Samin-samin	Caranx
6 Centropomidae	*Lates calcarifer*	Laya	Giant sea perch
7 Chandidae	*Ambassis sp 1*	Ibis	Glassfish
8 Chandidae	*Ambassis sp 2*	Ibis	Glassfish
9 Chandidae	*Ambassis commersonii*	Ibis pangan	Glassfish
10 Channidae	*Channa striata*	Haluan	Chevron snakehead
11 Chanidae	*Chanos chanos*	Bangus	Milkfish
12 Cichlidae	*Oreochromis nilotica*	Tilapia	Nile Tilapia
13 Cichlidae	*Oreochromis mossambica*	Lipunan	Mosambique Tilapia
14 Clariidae	*Clarias batrachus*	Bangkok	Thai catfish
15 Clariidae	*Clarias sp*	Agok-ok; Pantat; Hito	Native catfish
16 Cyprinidae	*Cyprinus carpio*	Carpa	Common carp
17 Cyprinidae	*Puntius binotatus*	Gabot	Spotted barb
18 Engraulidae	*Engraulis sp*	Mole	Anchovy
19 Eleotridae	*Hypseleotris agilis*	Bugwan	Goby
20 Gerridae	*Gerres filamentosus*	Latab	Spotted mojarras
21 Gobiidae	*Glossogobius giuris*	Pijanga; Pedianga	White goby
22 Gobiidae	*Glossogobius celebius*	Pijanga; Pedianga	Goby
23 Gobiidae	*Glossogobius sp.*	Bul-a	Goby
24Gobiidae	*Ophiocara aporos*	Durod	Snakehead gudgeon
25 Hemiramphidae	*Hemiramphus sp*	Suloy-suloy	Halfbeak
26 Leiognathidae	*Leiognathus equulus*	Mawalay; Sap-sap	Common slipmouth
27 Leiognathidae	*Leiognathus sp*	Pot-pot	Slipmouth
28 Lutjanidae	*Lutjanus argentimaculatus*	Gingaw	Red snapper
29 Lutjanidae	*Lutjanus sebae*	Bilbigan	Emperor red snapper
30 Lutjanidae	*Lutjanus sp*	Aha-an	Snapper
31 Mugilidae	*Mugil cephalus*	Banak; Balanak	Flathead mullet
32 Mugilidae	*Valamugil cunnessius*	Gisaw	Long-arm mullet
33 Mugilidae	*Mugil sp*	Lampohon	Mullet
34 Mullidae	*Upeneus sp*	Bod-bod/salmoyete	Goatfish
35 Phallostethidae	*Neosthetus thessa*	Bolinao	Priapium fish
36 Scatophagidae	*Scatophagus argus*	Kikilo	Spotted scat
37 Siganidae	*Siganus punctatus*	Buras	Rabbit fish
38 Siganidae	*Siganus sp*	Danggit	Rabbit fish
39 Sillaginidae	*Sillago sihama*	Aso-os	Common whiting
40 Theraponidae	*Therapon jarbua*	Bugaong	Convex-lined therapon
41 Theraponidae	*Mesopristis cancellatus*	Pigok	Cross-barred grunt
Unidentified Finfish			
		Bakoko	Unidentified
		Bungusan	Unidentified
		Subok	Unidentified
		Anga; Bunog	Unidentified

Figure 3. Common finfish species of commercial value in Lake Mainit: A) *Glossogobius giuris* B) *Hypseleotris agilis* C) O*reochromis nilotica* D) *Cyprinus carpio* E) *Channa striata* F) *Valamugil cunnessius* G) *Anguilla sp.* H) *Neostethus thessa.*

The eel *Anguilla sp.* (*kasili*) used to be caught in great abundance in the 1970s, allegedly exceeding 100 kg per fishing operation but recent reports from fishers around the Lake suggest that this species has become a rare commodity. The rapid decline in the population of this high-valued finfish is largely attributed to the operation of a specialized bamboo trap called *palaksuhan* set across Kalinawan River during the migration runs of the eel toward Butuan Bay. Aside from its dwindling numbers, the average size of eel caught at present is also reportedly smaller than in past decades. A species of anchovy, locally called *bolinao,* is identified by recent taxonomic references as *Neostethus thessa* (FishBase 2007) and is caught in moderate abundance in the lake. Figure 7 shows the distribution of major kinds of fish around the lake, with the higher diversity found on the northeastern side (Mainit to Kitcharao).

Figure 6. Three species of freshwater goby found in Lake Mainit differ in their adult size: *G. giuris* has a Lmax = 30.5cm; *G. celebius* has Lmax = 33.5cm; and *H. agilis* has Lmax = 18.0cm.

Aquatic Invertebrates

At least ten major groups of aquatic invertebrates are found around Lake Mainit which are composed of bivalves, gastropods, crabs, and shrimps. The most common bivalve is of the genus *Corbicula* (Family Corbiculidae) locally called *kabibi* which probably consists of two or more species. Abrea (2003) identified *Corbicula manilensis* and four other unknown species along the littoral zone of Mainit and Kitcharao. These bivalves are commonly found along the littoral zones of Tagbuyawan, San Pablo, San Roque, Mainit, Jabongga, and as far as Habungon and La Paz along the midsection of Kalinawan River (Fig. 8). Also found in moderate abundance is the Taiwan shell, *Anodontia* (Cristaria) *woodiana* (Family Unionidae), an introduced species occurring along San Pablo, San Roque, Mainit, Jabongga, and La Paz.

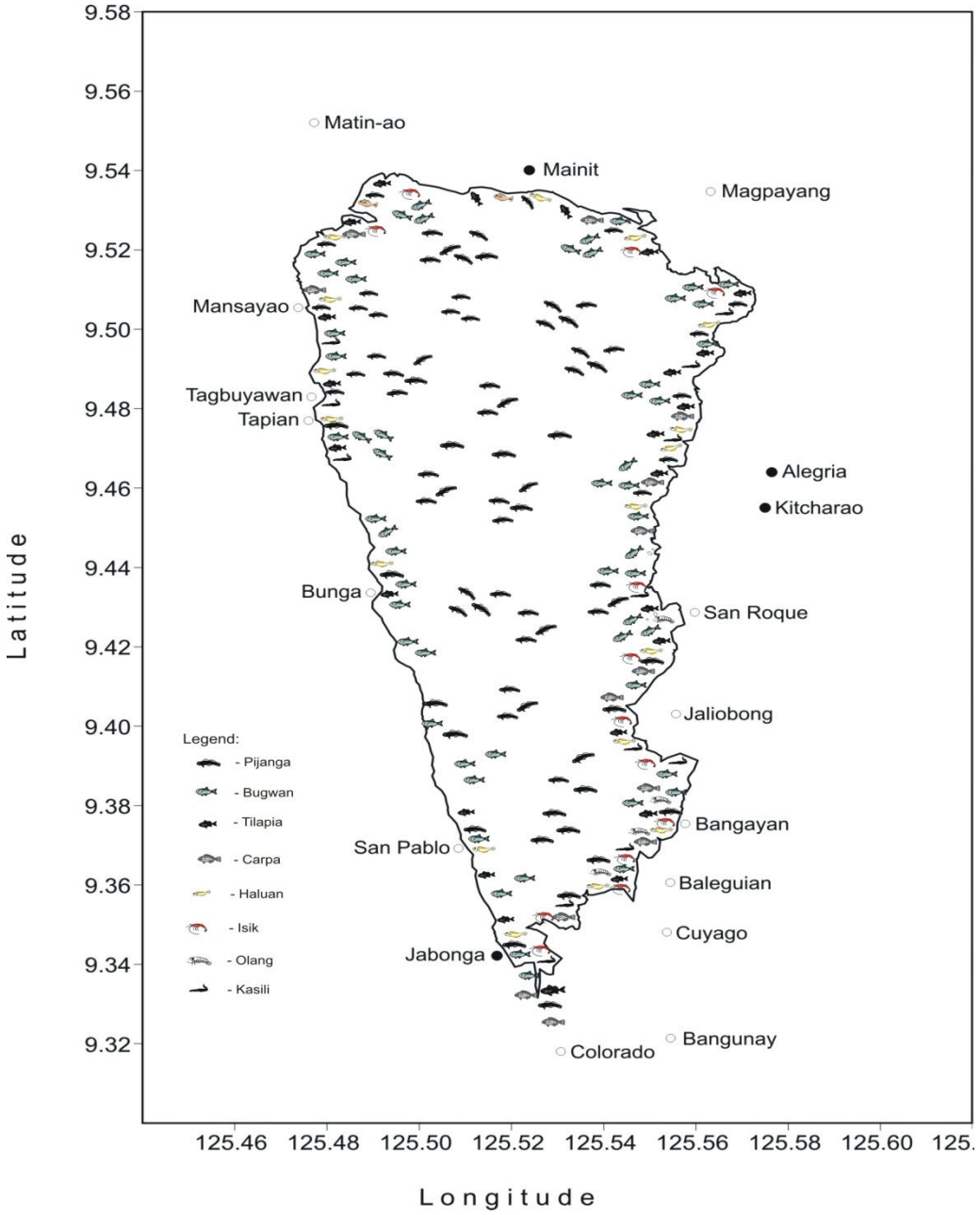

Figure 7. Resource map of Lake Mainit showing distribution of major fish and crustacean resources.

Aquatic plants

A total of fifteen (15) species of freshwater flora classified into six submersed, three emergent, and six floating plants were identified in Lake Mainit and Kalinawan River (Table 2; Fig. 9). Preliminary identification of collected voucher specimens was made based on Winterton & Shcer (2007) and a poster published by PCAMRD. All submersed plants form

extensive underwater meadows with the exception of *Ottelia alismoides*. A common aquatic plant in the lake, *Vallisneria* sp., locally called *lusay* and is similar to the marine eelgrass, is found growing along clear shoreline waters together with *Hydrilla verticillata*, *Najas graminea* and *Ceratophyllum* sp. Known locally as *dugman, Hydrilla* tends to grow quite extensively in monospecific mats with an average percent cover of 86%, particularly in the municipality of Jabonga along the mouth of Kalinawan river and north of Alegria toward the municipality of Mainit. *Hydrilla* has been reported to be a noxious plant in Washington Bay (Winterton & Shcer, 2007), its ability to form extensive mats making the bottom anoxic. Since *dugman* is a very fast growing plant it can compete for space with other plant species in the lake, and may reduce oxygen in relatively stagnant lake waters. In Lake Mainit, however, fishers claim that these *dugman* beds provide habitat for fish species and is considered an important fishing area for *tilapia*, *pijanga,* and invertebrates.

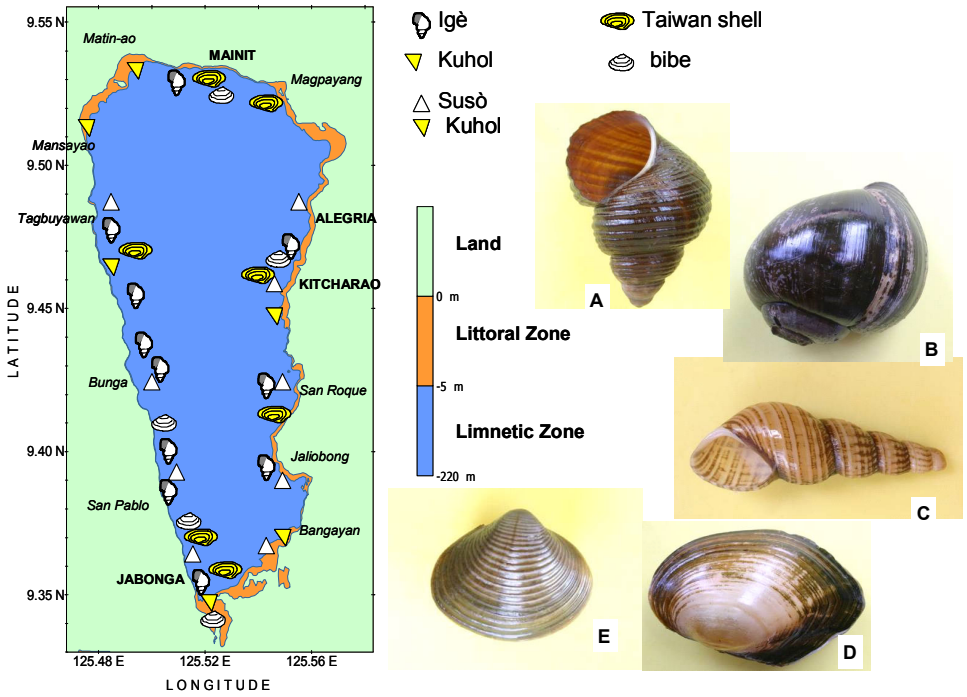

Figure 8. Distribution of mollusks in Lake Mainit. A. *Viviparia angularis* (*ige*) B. *Pomacea canaliculata (kuhol)* C. *Melania* sp (*suso*). D. *Anodontia woodiana* (Taiwan shell) and E. *Corbicula* sp. (*bibe*).

Among the emergent plants, *Nelumbo nucifera* locally known as *pagusè* occurs in wide patches with an estimated total area of 11.26 hectares within the lake (Fig. 10). The largest *pagusè* bed was recorded in Barangay Mayag (5.2 ha) of the municipality of Mainit, followed by Tagbayawan (2.7 ha) in Alegria. Several small patches (less than a hectare) of *pagusè* are observed in Jabonga and San Roque. Fruits of *pagusè* are harvested mostly by children and are eaten or sold in bundles for P0.50 each.

Table 2. List of aquatic plants occurring in Lake Mainit and its outlet Kalinawan River.

	Local Name	Common Name
Submersed Plants		
Ceratophyllum sp.	none	Coontail, hornwoot
Hydrilla verticillata	*Dugman*	Hydrilla
Najas graminea	none	Water nymph
Ottelia alismoides	none	Duck lettuce
Vallisneria sp.1	*Lusay*	Eel grass, tape grass
Vallisneria sp.2(rosette type)	*Lusay*	Eel grass
Unidentified species	none	
Floating & Emergent plants		
Azolla pinnata	none	Pond fern
Echornia crassipes	Water lily	Water hyacinth
Ipomea aquatica	*Tangkong*	Kangkong, water spinach,
Ludwigia adscendes	none	-
Nelumbo nucifera	*Paguse*	Sacred lotus, lotus lily
Neptunia oleracea	*Kupo-kupo, hibi-hibi*	Small-leaf sensitive plant, Neptunia
Nymphaea sp.1	Red lotus	Red lotus
Nymphaea sp.2	White Lotus	-
Pistia stratiotes	none	Water lettuce

The water lily or hyacinth (*Echornia crassipes*) is a floating plant common along the shoreline and all throughout Lake Mainit, and cover almost the whole stretch of the Kalinawan river bank. In some areas, bamboo poles are provided to collect the water hyacinths, turning them into fish shelter and fishing areas for the local community. During the flood season or "*guob"* (November to February) resulting from high rainfall, faster downstream current pushes dense growth of the plant into the Kalinawan River, making the river impassable. The piling up of this plant in the shallow parts of the river often causes backflow, thus, raising the water level of the lake significantly.

Usually found on the periphery of the dense water lily spread is the red stem kangkong, *Ipomea sp.* A number of floating plants such as the *Neptunia* sp. locally known as "*kupo-kupo*" or *"hibi-hibi"* occur in small patches along the upper part of Kalinawan river. Downstream of Kalinawan River the bottom is primarily sandy-muddy. Submerged plants are conspicuously absent, except for filamentous green algae which are used as baits for pole fishing of tilapia. Approximately 3 km from the river mouth, a small patch of duck lettuce, *Ottelia alismoides,* was noted growing on muddy substrates with cover ranging from 15% to 80%. Aquatic plants along the river bank of Kalinawan river (Fig. 11) comprise at least six species which were identified based on their local names, namely: *Tigbao, Ayaganay, Dawpang, Moti-moti, Tamok,* and *Makahiya.*

Figure 9. Aquatic plants of Lake Mainit and Kamiawan river: A) water nymph B) coontail or hornwoot C) duck lettuce D) eel grass or tape grass E) eel grass rosette type F) Hydrilla G) lotus lily or *paguse* H) red lotus I) water hyacinth J) water lettuce K) pond fern L) kangkong or water spinach M) Neptunia or small-leaf sensitive plant N) unidentified.

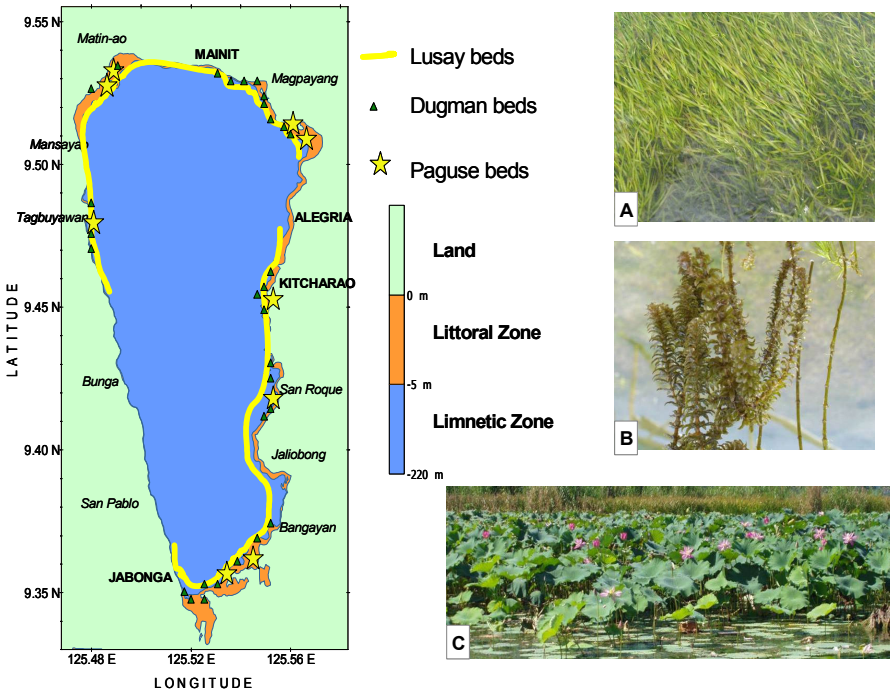

Figure 10. Distribution of major aquatic plants in Lake Mainit: A) *Vallisneria* sp or *lusay,* B) *Hydrilla verticillata* or *dugman,* and C) *Nelumbu nucifera* or *paguse*.

4.1.2 Profile of Lake and Riverine Fisheries

Fishing Gears

Figure 11. *Common riparian vegetation on the banks of Kalinawan River.*

A total of seven major fishing gear groups were documented as follows: seines, impounding nets, mobile impounding nets, gillnets, traps and pots, hook and line, and simple hand implements (Table 3). Figure 12 shows the distribution of the major fishing gears used in Lake Mainit and Kalinawan River (see Appendix 1 for detailed descriptions). These gears, with the exception of fish corrals, crab traps, fish traps, gillnets and hook and line, are active, *i.e.* those that capture fish and invertebrates by active pursuit or gear movement. Many gear types have several variants or modifications, leading to a higher number of gear types operating in the lake and Kalinawan River. Numerous modifications of the set gillnet are operated for specific target fish species, such as *pijanga*, carp, and tilapia.

Although banned in most municipalities, beach seine or "*baling"* is operated in the northern part of the lake, while "*boso"* or diving with compressor still occurs in the midsection of Lake Mainit, operated by fishers from Kitcharao.

Table 3. Types and distribution of fishing gears in Lake Mainit and Kalinawan river.

Gear types		Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
English Name	Local Name						
Seines							
Beach seine	*Baling, sinsin*	✓					✓
Impounding Nets							
Barrier net	*Panira/lambat*					✓	
Fish corral	*Bungsod*			✓	✓	✓	
Mobile Impounding Nets							
Cast net	*Laya, paapong*	✓	✓	✓	✓	✓	✓
Gill Nets							
Set gill net	*Pante-taan*						
2 cm mesh (goby)	*Pukot pang-pijanga*	✓	✓	✓	✓		
3.2 cm mesh (gourami)	*Pukot pang-gurami*					✓	
6 cm mesh (tilapia)	*Pukot pang-tilapia*	✓	✓	✓	✓	✓	
15 cm mesh (carp)	*Pukot pang-carpa*	✓	✓	✓	✓		
Drift gill net	*Paanod, pante-anod*						✓
Traps/Pots							
Fish/Crab trap	*Bantak*	✓		✓	✓		
Fish trap	*Timing, screen*	✓	✓	✓	✓	✓	
Modified river fish trap	*Palaksuhan*					✓	
Hook and Line							
Simple hook & line	*Bingwit/Pasol*			✓	✓		✓
Multiple handline	*Buldos, bundak*			✓			
Bottom set longline	*Taan, palangre*	✓	✓	✓	✓		
Hand Instruments							
Spear	*Pana*	✓	✓	✓	✓	✓	✓
Harpoon	*Sapang*			✓			
Scoop net	*Sarap*	✓		✓			

An inventory of fishing gears around Lake Mainit shows that there are 1,690 units belonging to 19 types involved in lake and river fisheries (Table 4). These are classified as seines, impounding nets, mobile impounding nets, gillnets, traps and pots, hook and line, and simple hand implements. Most of the gears, with the exception of fish corrals, crab and fish traps, gillnets and hook and line, are active, *i.e.* those that capture fish and invertebrates by active pursuit or gear movement.

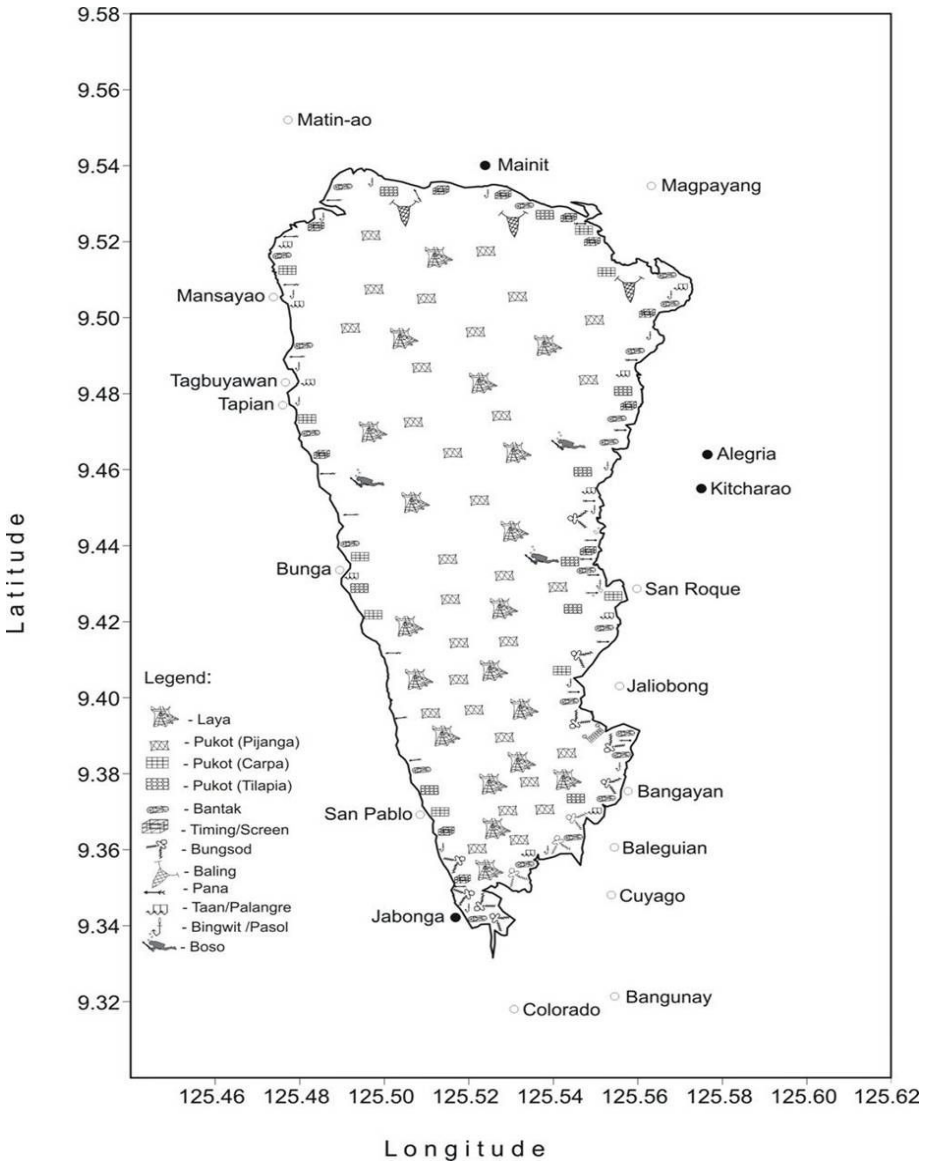

Figure 12. Map of fishing gear distribution in Lake Mainit.

Fish trap or *bantak* (Fig. 13), is the most dominant gear type used the lake, accounting for at least 74.3% in terms of number (Table 4). This trap is either made of plastic or bamboo cylinders, the latter wrapped by either wire or plastic mesh. Most of these traps are operated in Kitcharao and Jabonga, and one fisher can use from 100-400 units for every fishing operation. Other numerically important gears are the fish corral or "*bungsod*" (5.7%) and bamboo fish trap or "*timing*" (5.3%). Spear is commonly used by fishers in all stations, while at least one fisher use a special spear or harpoon called *sapang.* The bottom or midwater-set gillnet is also common in all stations except Tubay.

Landed Fish Catch

The total fish catch of the Lake and Kalinawan River recorded from August 2007 to September 2008 is estimated at 274.15 tons, based on landed fish catch data in 28 out of 32 major and minor landing areas around Lake Mainit. The lake fishery represented by stations Mainit, Alegria, Kitcharao and Jabonga accounted for 93.5% (256.32 tons) of the total catch, while the Kalinawan river represented by Santiago and Tubay contributed only 6.5% (17.82 tons) of total landed catch (Fig. 14-15). Extrapolating our estimates based on 14 monitoring months and 28 monitored landing areas yields an estimated 620.0 tons of fish caught for a one year period (see Appendix 2). Our present value is just about 4.1% of the total annual catch of 15,108 tons reported in 1980-81 by Pauly et al. (1990), clearly indicating that fish production from the Lake and Kalinawan River had severely depleted over a period of more than two decades.

Figure 13. *Most common fish trap in the lake locally called bantak.*

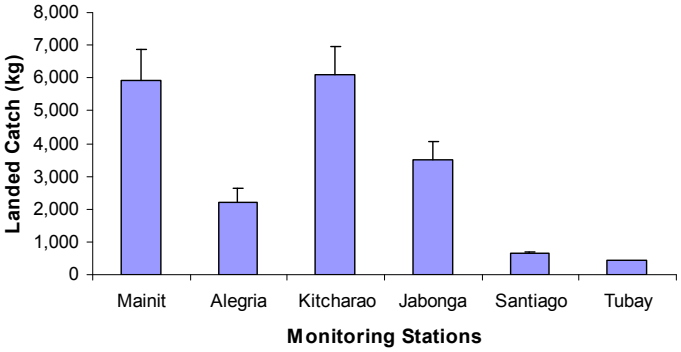

Figure 14. *Average monthly catch landed in six municipalities around Lake Mainit and Kalinawan River from August 2007 to September 2008. Error bars are standard errors of n=14 months.*

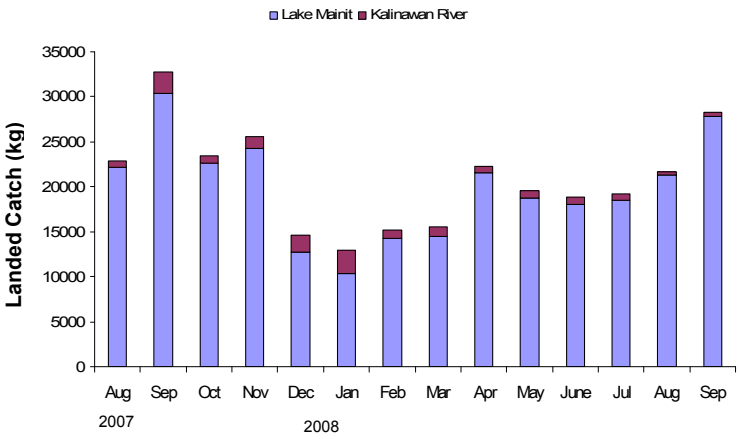

Figure 15. *Comparison of the monthly landed fish catch (kg) in the six municipalities around Lake Mainit and Kalinawan river.*

Among the monitored stations, Kitcharao contributed the highest fish catch accounting for 31.7% of total landed catch from the lake, followed by the municipalities of Mainit (30.3%), Jabonga (19.9%) and Alegria (11.6%). Kalinawan river represented by Santiago and Tubay had low fish catch contributing about 6.5% of total fish catch landed, however, Tubay had the most number of species recorded with 27 species caught by various gears. Figure 16 shows the monthly catch profile of the six monitoring sites (see Appendix 3-4 for landed catch data). Most of the species reported are marine species caught near the mouth of Kalinawan River draining into Butuan Bay. Landed catch in Kitcharao comprise 22 species, while the lowest number of 12 species comprise the landed catch in Alegria.

Based on recorded catches, the most abundantly caught fish in the six municipalities around Lake Mainit is the white goby *pijanga,* accounting for more than half the total landed catch between August 2007 and September 2008 (Fig. 17). This result seems to contradict common observations and local perception that *pijanga* is already a diminishing resource in the lake. Local research partners and fishers around Lake Mainit, however, have validated this result by noting that much of the *pijanga* catch is being exported to Butuan City and other neighboring towns. This would explain why *pijanga* is not commonly encountered in the local markets around the lake, but would reinforce the importance of this goby to the local economy of Lake Mainit.

Data from landed fish catch also showed that Lake Mainit and Kalinawan River have distinct fishery resource profiles (Fig. 17). *Pijanga* contributes more than half (51.4%) of the total fish catch from the lake followed by the *tilapia* (17.7%), *luyab* (10.5%) and *Carp* (5.5%). In Kalinawan river, the mullet locally known as *lampohon* is the dominant catch (38.9%) from the river, followed by tilapia (18.8%), *carpa* (13.8%) and *haluan* (13.2%).

Fishing Effort, CPUE and Gear Efficiency The estimated number of fishing boats operating in the lake and Kalinawan River range between 1,000 (based on LRP inventory) to more than 2,700 (based on FGD data), where at least 70% are non-motorized boats with or without outrigger.

The fishing gear with the largest contribution to fish production in all municipalities is the set gillnet (*pukot*) which accounted for 41% of landed catch from the lake and 33% from Kalinawan River (Fig. 18). *Baling* (20%) and *laya* (16%) also landed larger catches compared to other fishing gears in the Lake. Catches of *pana, bantak and timing* contribute only a small percentage to the total capture fisheries production from the lake. Another major gear with large recorded catches (30%) in Kalinawan River is drift gillnet, locally called *pante-anod.* This gear is operated only by fishers in Tubay near the mouth of Kalinawan River and its catch probably includes marine fishes from Butuan Bay.

Data on landed fish catch, fishing effort and CPUE are shown in Table 5. On an average day, Mainit has the most number of fishers (53 fishers/day), followed by Kitcharao (38 fishers/day) while Santiago has the fewest fishers (10). Estimated catch per unit effort (CPUE) is, however, highest in Jabonga (10.37 kg/fishers/day), followed by Kitcharao (7.08kg/fisher/day). The lowest CPUE so far recorded is 1.16 kg/fisher/day in Tubay. The average CPUE across landing sites and gear types is 5.47 kg/fisher/day.

Table 4. Estimated numbers of fishing gears used in Lake Mainit (2007-2008) based on ocular survey and interviews.

English Names	Local Names	Number of Units	Relative Abundance (%)
Seines			
Beach seine	*Baling*	8	0.47
Modified beach seine	*Sin-sin*	1	0.06
Impounding Nets			
Barrier net	*Panira/lambat*	1	0.06
Fish corral	*Bungsod*	96	5.68
Mobile Impounding Nets			
Cast net	*Laya, paapong*	56	3.31
Set Gill Nets (Mid/Bottom)			
Set gillnet modifications	*Pante or pukot taan*		
2 cm mesh (goby)	*Pukot pang-pijanga*	52	3.08
3.2 cm mesh (gourami)	*Pukot pang-gourami*	2	0.12
6 cm mesh (tilapia)	*Pukot pang-tilapia*	10	0.59
15 cm mesh (carp)	*Pukot pang-carpa*	21	1.24
Drift gill net	*Pukot or pante paanod*	4	0.24
Traps/Pots			
Crab trap	*Bantak*	1255	74.26
Fish trap	*Timing*	90	5.33
Modified river fish trap	*Palaksuhan*	2	0.12
Hook and Line			
Simple hook & line	*Bingwit/Pasol*	31	1.83
Multiple handline	*Buldos, bundak*	4	0.24
Bottom set longline	*Taan, palangre*	21	1.24
Hand Instruments			
Spear	*Pana*	28	1.66
Harpoon	*Sapang*	1	0.06
Scoop net	*Sarap*	3	0.18
Other Methods			
Compressor fishing	*Boso*	2	0.12
Electric fishing	*Kuryente*	2	0.12
Total		**1690**	**100.00**

Mean catch rates of 10 major gears in Lake Mainit and Kalinawan River are shown in Figure 19. These values range from 8.3 kg/unit/day (*bungsod*) to as much as 70 kg/unit/day (*pukot palutaw*), and are relatively higher values than those landed in many coastal marine fisheries in Mindanao. Estimates of high catch rates for gears such as *pukot palutaw, skylab* and *sapang,* however, were based on single observations and, thus, are not representative of average catch levels for these gears. Although *baling* landed the second largest overall catch within the assessment period its average daily catch per gear unit was quite small at 4.72 kg/unit/day. Catch rates of different gear types have not taken into account the crew size or number of fishers per operation. A comparison of catch-per-unit- effort across the six sites (Table 5) shows that fishers from Santiago and Tubay obtain very low CPUE values, and *hence*, daily income from fishing possibly a result of using less efficient fishing gears and fishing in the less productive system of Kalinawan River than inside Lake Mainit.

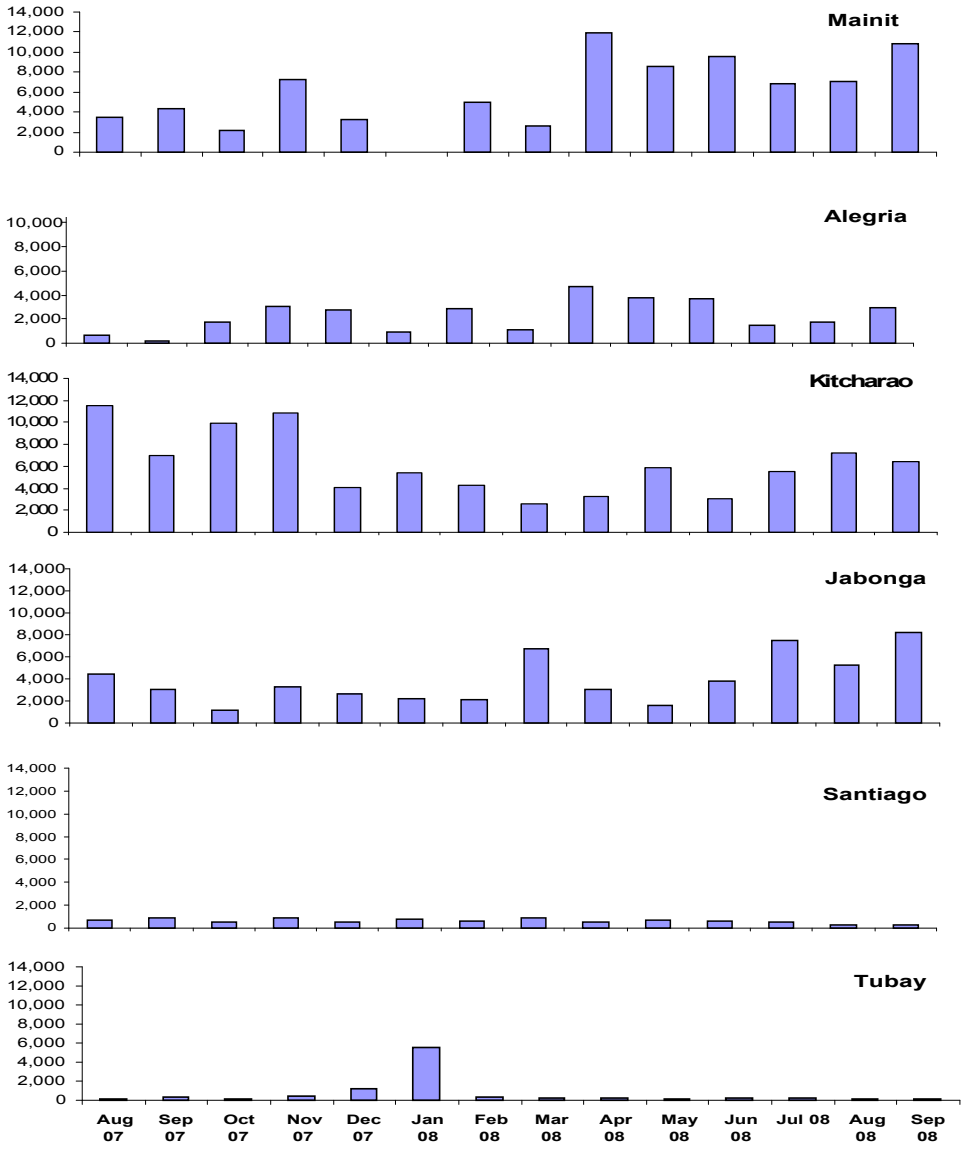

Figure 16. Monthly landed fish catch in six monitoring sites around Lake Mainit.

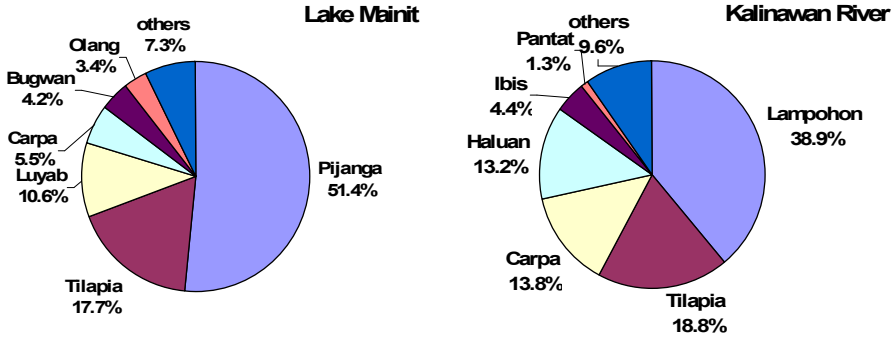

Figure 17. Relative abundance of the major finfish species in Lake Mainit and Kalinawan river from August 2007 to September 2008.

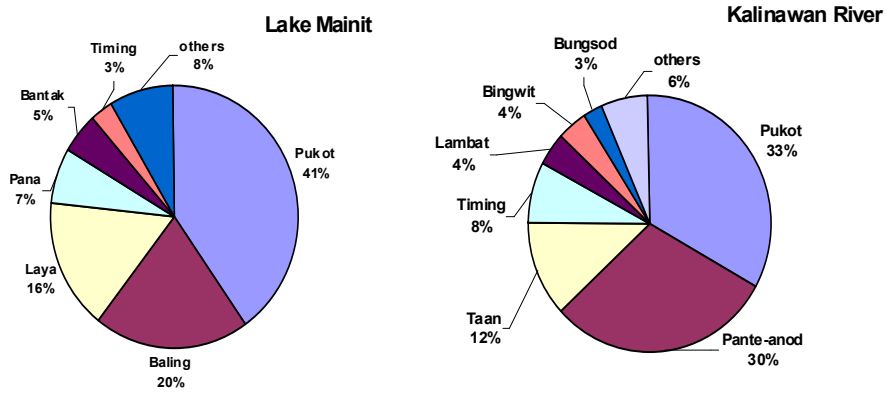

Figure 18. Relative contribution of major gear types in Lake Mainit and Kalinawan river fisheries.

Table 5. Summary profile on catch and fishing effort in Lake Mainit and Kalinawan river.

	Mean Landed Catch (kg) per month	Mean No. Fishers per month	Mean No. fishing days monitored per month	Mean No. Fishers per day	Mean Catch per Fisher per day (kg)
Mainit	6,334	909	17	53	6.97
Alegria	2,235	535	25	21	4.18
Kitcharao	6,193	875	23	38	7.08
Jabonga	3,958	382	17	22	10.37
Santiago	607	199	20	10	3.05
Tubay	383	333	16	21	1.16
Total	19,711	3,232	118	166	
Average	3,285	539	20	28	5.47

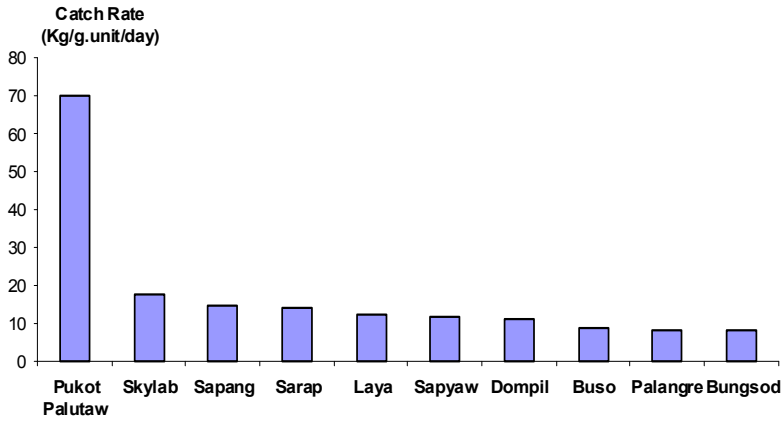

Figure 19. *Comparison of catch rates of ten top fishing gears in Lake Mainit and Kalinawan River.*

Table 6. Mean catch rates or efficiency of various fishing gears and methods used in Lake Mainit fishery.

	Fishing Gear or Method	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	Mean Catch Rate (kg/day)	Mean Catch per Hour (kg/hr)
1	Pukot Palutaw				35.00			35.00	4.38
2	Skylab	18.00						18.00	0.38
3	Sapang			14.68				14.68	3.67
4	Sarap	8.99		18.66				13.83	1.63
5	Laya	6.25		16.77	14.17			12.40	1.55
6	Sapyaw			12.05				12.05	3.44
7	Dompil	13.00			9.79			11.39	1.42
8	Buso			9.29				9.29	2.06
9	Palangre	14.67			6.30		4.30	8.42	2.81
10	Bungsod	1.63	5.19	16.26	12.38	5.97		8.29	0.12
11	Buldos	3.50			11.58			7.54	1.57
12	Timing/screen	12.54			7.33	1.85		7.24	0.80
13	Pukot palugdang	11.76	4.19	9.60	7.08	3.11		7.15	0.89
14	Timing	7.86	5.48	4.24				5.86	0.33
15	Taan1	9.53	3.00	3.25	8.85	3.49	2.05	5.03	0.50
16	Baling	5.60			3.85			4.72	1.18
17	Bantak	7.12	3.96	3.57	3.65	3.66		4.39	0.20
18	Lambat					4.30		4.30	1.07
19	Begjo/Pana				4.12			4.12	1.37
20	Pana	3.93	3.07	5.05	3.17	4.42	2.91	3.76	0.94
21	Palaksuhan					3.20		3.20	0.40
22	Taan2					3.02		3.02	0.30
23	Kuryente	3.00						3.00	1.00
24	Bingwit	4.00	2.66	2.43	3.00		1.47	2.71	0.42
25	Sin-sin						2.50	2.50	1.25
26	Darak				2.00			2.00	1.00
27	Pontak			2.00				2.00	0.20
28	Pasol						1.46	1.46	0.73
29	Pante-taan						1.16	1.16	0.33
30	Mosket						1.07	1.07	0.27
31	Pante-anod						1.06	1.06	0.53
32	Surit						46.00	46.00	30.67
	Grand Total	131.37	27.56	117.85	132.28	33.02	63.99	266.64	67.41

Another useful measure in comparing catching efficiency of fishing gears in Lake Mainit is to calculate the amount of catch per hour of fishing operation. The derived values in Table 6 indicate that some gears have large daily catches but longer duration of fishing results in lower catching efficiency on hourly basis. Values across gear types can help management decide on which gear would catch more fish with less effort and thus, reduce fishing costs.

3.2 Population Biology and Stock Dynamics

Detailed biological analysis was conducted on only two major fishes in Lake Mainit, namely, *pijanga* (*Glossogobius giuris*) and *bugwan (Hypseleotris agilis)*, which were also studied in 1997-98 by Galicia and Lopez (2000). These two species of goby are the most popular and abundant native fishes in the lake and their catches support the local economy. Changes in the population dynamics of these important species are of interest to fisheries management, and detailed information in their biology is critical to development of measures to sustain their fisheries. Some biological characteristics are also provided on six other commercially important species of fish in Lake Mainit.

3.2.1 Classification of Fishes of Lake Mainit

Lake Mainit has a very diverse fish community - classified into three different groups, namely, true freshwater fishes (lake and riverine), amphidromous fishes and catadromous fishes. The true freshwater fishes are confined either in the lake or river and include commercially important fishes such as catfish, mudfish, tilapia, common carp, endemic eleotrid and the white goby. Small lake fishes that are of low commercial importance include the climbing perch, spotted barb, priapium fish, freshwater halfbeak, and small freshwater cardinal fish known locally as "subok". Riverine fishes are those that inhabit any of the 28 tributary or watershed rivers, Kalinawan River, and the seasonal Pagusi Lake along the Kalinawan River.

The amphidromous fishes are euryhaline fishes (wide tolerance to salinity range) that migrate to Lake Mainit during periods of flooding and inundation (November to January) – a phenomenon of extreme water level rise that locals call *guob.* Amphidromous fishes include snappers, mullets, milkfish, scats, tarpons, ten pounders, and trevallies. These fishes are mostly caught by various kinds of traps along the Kalinawan River - a migration highway between Lake Mainit and the marine waters of Butuan Bay.

The catadromous fishes are represented by the giant mottled eel locally known as *kasili* and the tapiroid grunter locally known as *pigok*. These fishes grow in freshwater environments but migrate to marine waters during spawning. The giant mottled eel breeds in deep channels of the Indo-Pacific region particularly in southern Philippines, east of Indonesia, and west of New Guinea at depths reaching 400m (www.fishbase.org, version (04/2009). The tapiroid grunter breeds offshore near the mouth of Kalinawan River.

3.2.2 Biological Characteristics of Major Fish Stocks

Length-frequency data on the two species of gobies are available from August 2007 to August 2008, covering more than 12 months of biological data which are viable for detailed analysis of growth, mortality, recruitment and other parameters needed to describe the population dynamics of these important fish species. Detailed analysis of length-frequency and biological data was made to obtain these parameter estimates using the computer software package FiSAT (ver. 1.2.0.2).

The common goby *Hypseleotris agilis* Herre. The common eleotrid locally known as *bugwan* (*Hypseleotris agilis* Herre) is a native fish species of Lake Mainit (see Fig. 6) that belongs to Family Gobiidae. It is an omnivorous fish that thrives in the littoral zone of the lake. Lake Mainit being the clearest lake in the Philippines has an extensive littoral zone due to its very high transparency of approximately 6.65m and corresponding 1% Photosynthetically Active Radiation (PAR) depth of 33.25m. This eleotrid can still be caught at these depths.

H. agilis exhibits secondary sexual dimorphism (male and female with different morphological attributes) and dichromatism (male and female with different color patterns). Dimorphic characters such as the genital papilla and coloration are distinct between the male and female *H. agilis*. The genital papilla in the male is narrow and tapered to the end while the female have broad, lunate and bilobed papilla (Escudero and Demoral, 1983). Coloration in *H. agilis* differs between the sexes; males appearing bright yellow in deep water and blue to dark blue in shallow water, while females have pale, dusky to light yellow body coloration.

H. agilis caught in Lake Mainit by beach seine (*baling*) and gillnet (*pukot*) ranged in size between 5.1 – 18.0cm although size ranges vary from month to month. The size range of *bugwan* observed in the present assessment is slightly smaller than the size range of 4.0-18.5cm studied by Galicia and Lopez (2000). Monthly length frequency distributions (see Appendix 4) show that May 2008 had the widest range and the months of September 2007, January and March 2008 had the narrowest size range. Monthly sex ratios of mature individuals of *H. agilis* generally show more female (M:F = 1:1.4) than male *bugwan.*

Gonadal maturity in *bugwan* exhibits monthly variations. Descriptions of the different stages of gonadal are provided in Appendix 5. Monthly gonadal stage frequency distributions for *bugwan* (Appendix 6) show the occurrence of gravid male and female fish in most months, indicating an ability to spawn continuously within an annual cycle. High percentages of gravid females were observed, however, between November to February 2008 (Fig. 20) with the peak occurring in December 2007. Data in January 2008 were too limited to exhibit agreement with this observed pattern. It is apparent in Fig. 21 that many immature individuals of *bugwan* are gathered throughout the year as expected when fishers continually use fine meshed nets such as beach seine (*baling*) and bottom-set gillnet (*pukot*) to catch goby and other demersal fish in the lake.

The length –weight relationship of *H. agilis* is presented in Table 7 as separated by sex and as overall values for the species. The derived value of regression slope (**b**) is 3.11 for combined sexes of *H. agilis,* indicating a positive allometric relationship, *i.e.* growth in weight tends to occur faster than growth in length. For an ideal fish which maintains dimensional equality, the isometric value of b would be 3, as occasionally observed in many species of fish (Allen 1938). The slope **(b)** value less than 3 indicates that a fish becomes more slender as it increases in length. Conversely, a slope value greater than 3 denotes stoutness or allometric growth (Pauly 1984). However, deviation from isometric growth is often observed, as most fish change their body shape as they grow. Estimates of length-weight parameters on a monthly basis are found in Appendix 7.

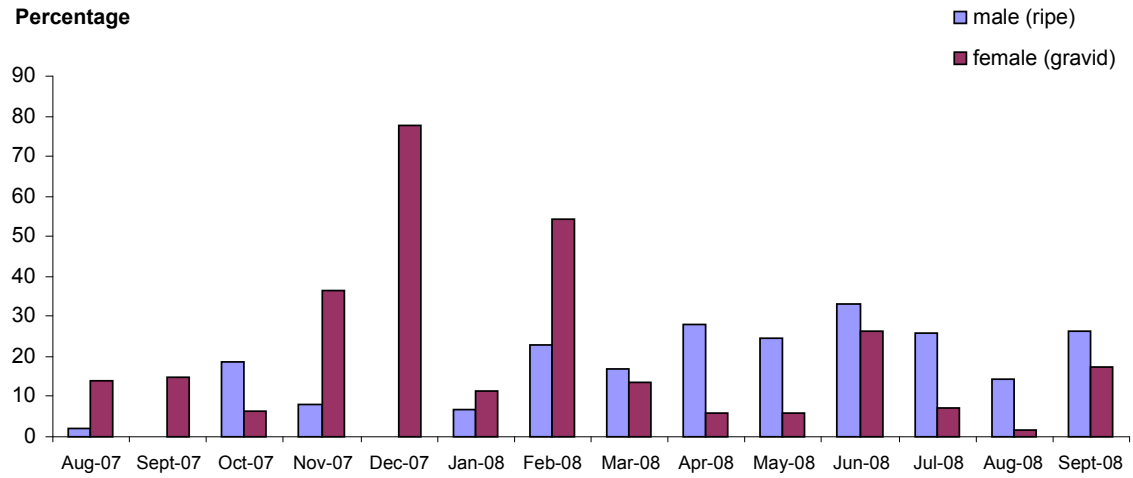

Figure 20. Monthly profile of spawning male and female *H. agilis* caught by beach seine and gillnet in Lake Mainit.

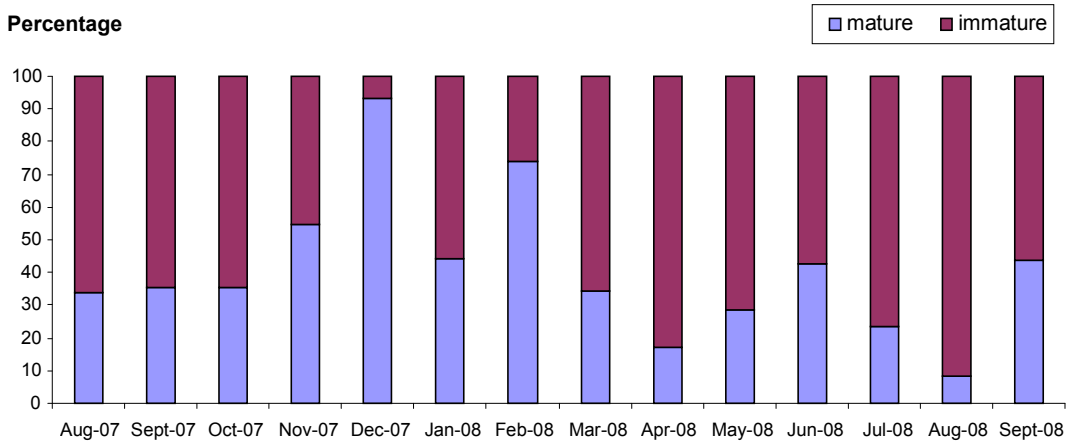

Figure 21. Proportion of mature to immature individuals of female *H. agilis* caught from Lake Mainit (August 2007-September 2008).

Table 7. Length –weight relationships and related statistics for the two gobies collected in Lake Mainit, Philippines.

Species	Sex	No.	Length		Weight		Regression Parameters		
			min	max	min	max	a	b	R^2
Hypseleotris agilis	Male	994	5.5	18	2	58	0.0102	3.1073	0.9439
(Bugwan)	Female	1177	5.2	14.8	2	46	0.0096	3.1252	0.9511
	Overall	2311	5.1	18	1	58	0.0099	3.1104	0.9517
Glossogobius giuris	Male	2278	5.9	22	2	100	0.0088	3.0348	0.9296
(Pijanga)	Female	2845	5.7	24.1	2	128	0.0079	3.0792	0.9273
	Overall	5629	5	24.1	1	128	0.0051	3.2457	0.9414

Results of length-frequency analysis using FiSAT are presented in Table 8. Growth parameters of *H. agilis* show an asymptotic length, L_{∞}, of 19.16 cm and a relatively slow growth rate of 0.27 per year (Fig. 22). Total mortality was estimated at 1.55 year^{-1}, natural mortality at 0.87 year^{-1}, and fishing mortality at 0.66 year^{-1}. The ratio of fishing to total mortality represents an estimate of exploitation rate E at 0.43, suggesting optimum exploitation as commonly observed among small, fast-growing fishes in tropical countries (Silvestre, et al. 1991). Recruitment of *H. agilis* shows a bimodal pattern with slightly unequal pulses (Fig. 23). Most tropical fishes have polymodal recruitment patterns indicating multiple spawnings within a year. Monthly gonadal maturity profile of *H. agilis* (see Fig. 20) indicates a tendency toward continuous spawning, and thus, recruitment, albeit at different intensities throughout the year. Fecundity of female *Bugwan* is variable across individuals, ranging between 64,097 – 117,416 eggs/gonad, thus a large capacity for producing abundant young in the lake.

Table 8. Parameter estimates of population dynamics of the two common gobies of Lake Mainit.

Parameter	*Hypseleotris agilis*	*Glossogobius giuris*
Total Number (N)	2,826	6,262
L∞ (cm)	19.16	25.73
K (per year)	0.27	0.27
Total Mortality (Z)	1.55	1.62
Natural Mortality (Pauly's M)	0.87	0.82
Fishing Mortality (F)	0.66	0.80
Exploitation Rate (E)	0.43	0.50
Recruitment Pattern (Annual)	Bimodal; Unequal pulses	Bimodal; Unequal pulses
Fecundity (no. eggs/gonad)	64,097 – 117,416	52,618 – 248,023

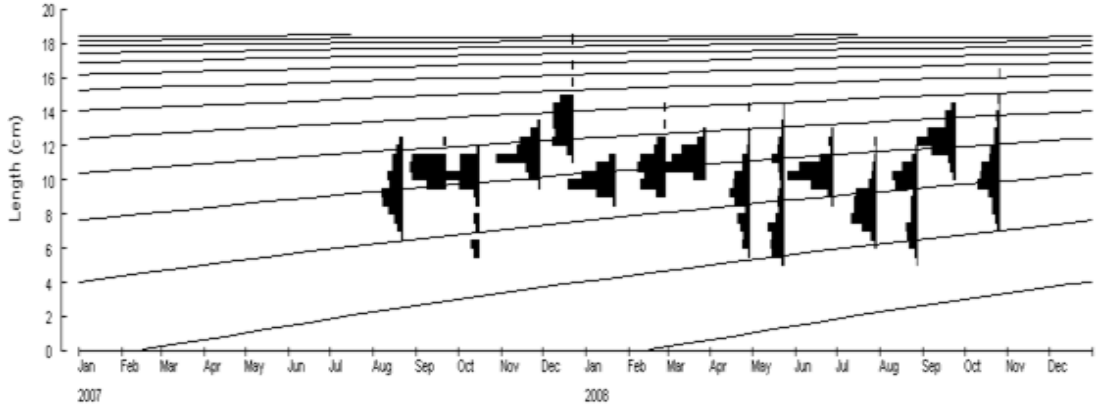

Figure 22. Growth curve of *Hypseleotris agilis* generated by FiSAT (L∞ = 19.16cm; K = 0.27 year^{-1}).

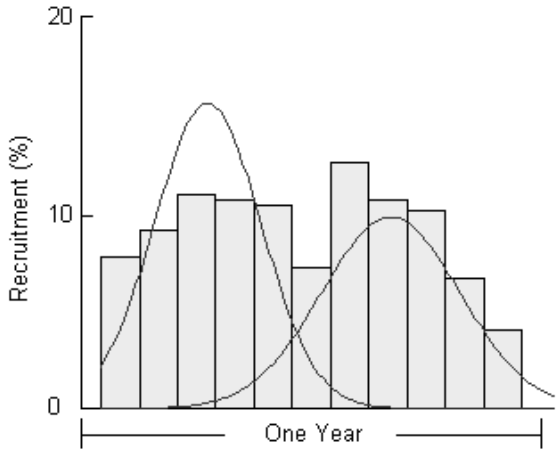

***Figure 23**. Bimodal pattern of annual recruitment of H. agilis in Lake Mainit.*

The White Goby (*Glossogobius giuris*) Herre. The white goby (*Glossogobius giuris*) locally known as *pijanga* (Fig. 4) is characterized by having fused ventral fins which are used functionally to anchor on substrates. The *pijanga* from Lake Mainit are found in littoral and limnetic zones and support a major fishery in the lake ecosystem.

The *G. giuris* catches from Lake Mainit during August 2007 to September 2008 range in size from 50 – 241 mm, which are smaller than the size range of 25 to 305 mm reported by Galicia and Lopez (2000) (Appendix 8). Monthly gonadal stage frequency distributions show variation of peaks from month to month (Fig. 24; Appendix 9). Monthly sex ratios are variable, with the tendency toward more female than male (M:F = 1:1.46) individuals.

A description of gonadal maturity stages of pijanga is presented in Appendix 5. The occurrence of ripe male and gravid female fish in all months suggests the ability of *pijanga* to spawn throughout the year. The present results suggests a single spawning peak as indicated by high frequencies of gravid female *G. giuris* between January to April 2008 that peaks around February (Fig. 25). Galicia and Lopez (2000) reported that spawning in both species of goby in Lake Mainit occurred twice a year (i.e., bimodal pattern). The earlier study observed that spawning in *pijanga* peaked on August to September then on December to January. Spawning in *bugwan* took place in July to August, then September to October. On the other hand, the monthly profile on gonadal maturity presented by Galicia and Lopez (2000) did not show a distinct bimodal seasonality. Moreover, the interval between the two spawning peaks that Galicia and Lopez (2000) reported was too close (by 1-2 months) that it can be assumed that the two peaks were just one. The periods corresponding to the peaks show overlaps with the observations of the present study (January to April in *pijanga;* November to February in *bugwan*).

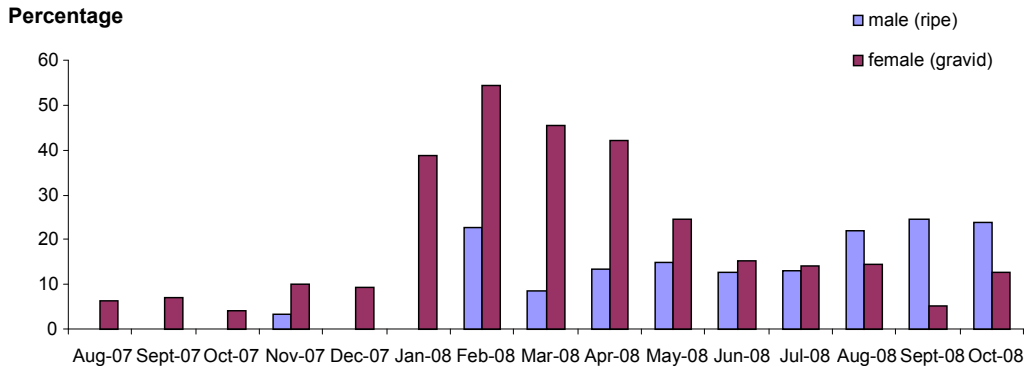

Figure 24. Monthly profile of spawning male and female *G. giuris* caught by beach seine and gillnet from Lake Mainit for the period August 2007-October 2008.

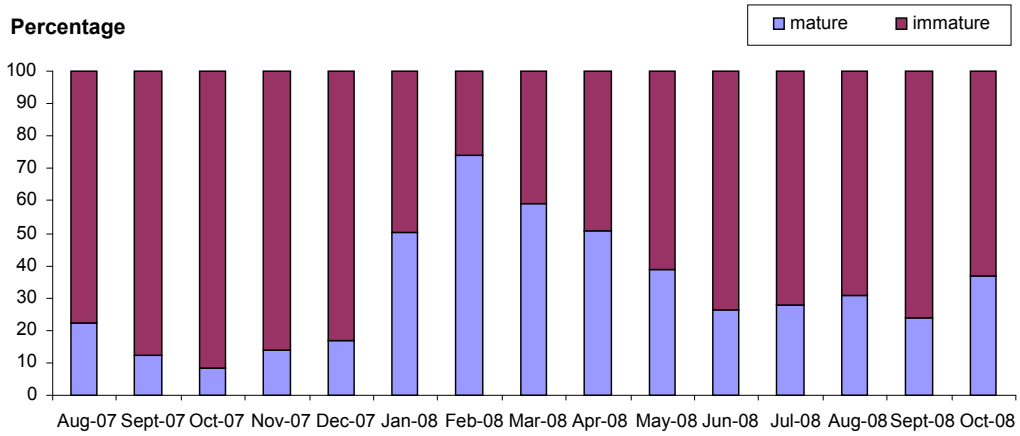

Figure 25. Proportion of mature to immature individuals of female *G. giuris* caught from Lake Mainit (August 2007-October 2008).

At least both studies on the biology of gobies in Lake Mainit agree that spawning in *pijanga* and *bugwan* may occur throughout the year. It is interesting to note that the high frequency of gravid stage in *pijanga* coincided with the onset of seasonal *guob* (November – February). This result becomes useful in planning conservation measures to protect the fish during its critical spawning period that may coincide with environmental phenomena and human-associated impacts.

Just like *H. agilis* the length–weight relationship in *G. giuris* (Table 7) also shows a positive allometric pattern (weight increases faster than length) with a derived value of the regression slope (b) of 3.25 for combined sexes of *pijanga*. As the two gobies are close relatives that share a common habitat it is not surprising that they exhibit similar morphological and growth characteristics.

Growth parameters of *G. giuris* show an asymptotic length, L_{∞}, of 25.73 cm and a growth rate, K, of 0.27 per year (Table 8; Fig. 26). The slow growth rate (small K value) is

unexpected as gobies are fast growing fish. Galicia and Lopex (2000) obtained very high K values for *G. giuris* (K=1.752 year^{-1}) and *H. agilis* (K=1.158 year^{-1}) indicating fast growth in these gobies. Other studies estimated a range of K (0.70-0.99 year^{-1}) values on *G. giuris* from other places in the Philippines. The estimated total mortality of 1.62 year^{-1} is higher than that obtained in *H. agilis,* while natural mortality is slightly lower at 0.82 year^{-1}. A higher fishing mortality at 0.80 year^{-1} results in a higher exploitation rate E of 0.50, suggesting optimum exploitation. Silvestre et al. (1991), on the other hand, maintains that small, fast-growing fishes in tropical countries tend to be overexploited easily, with optimum E within the range of 0.2-0.5.

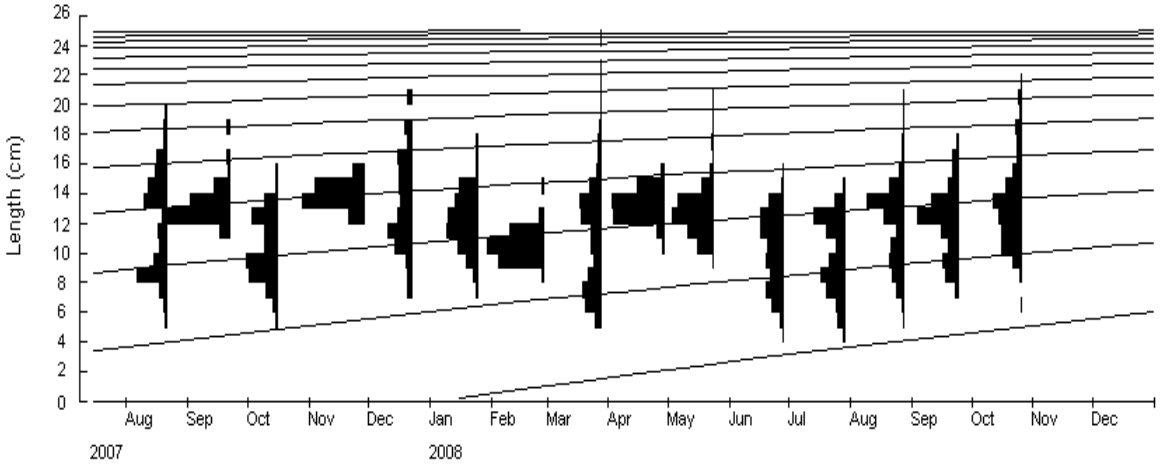

Figure 26. Growth curve of *G. giuris* generated by FiSAT using monthly length-frequency data ((L∞ = 25.73 cm; K = 0.27 year^{-1}).

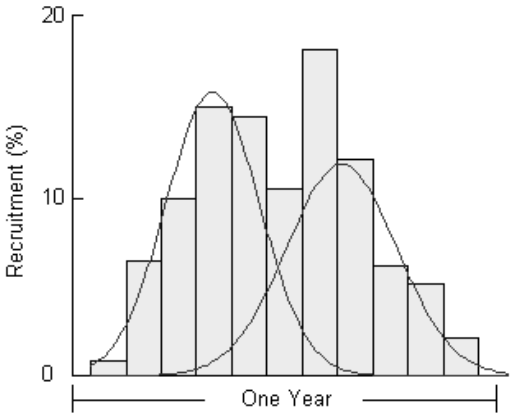

Figure 27. *Bimodal pattern of annual recruitment of G. giuris in Lake Mainit indicating unequal spawning pulses.*

Recruitment of *G. giuris* also shows a bimodal pattern with unequal pulses (Fig. 27). Monthly gonadal maturity profile of *G. giuris* (Fig. 23) indicates a tendency towards continuous spawning throughout the year. Fecundity of female *pijanga* is widely variable, ranging between 52,618 – 248,023 eggs/gonad but on the average is higher than that of *Bugwan.* This result indicates *Pijanga* has a large capacity for higher recruitment, producing abundant young to replenish stocks in Lake Mainit.

Other commercially important fishes. Some biological data were obtained on six commercially important fishes, including three (3) top (or apex) predators and three exotic or introduced fishes. The apex predators occupy three different habitats around the lake: the giant mottled eel *A. marmorata* is mostly caught in rivers, *C. striata* inhabits the littoral zone and floodplain, and *G. celebius* occupies the benthic and rocky zones. During its juvenile stage *G. celebius* coexists with *G. giuris* in sympatric association but in the adult stage it becomes solitary, becoming yellowish in color and growing relatively larger than the white goby. The three exotic species: *O. niloticus, O. mossambicus, and C. carpio*, inhabit the littoral and benthic zones and are largely caught in Kitcharao, Jabonga, and along the stretch of the Kalinawan River. The common tilapia (*O. mossambicus*) is known to grow slower than *O. niloticus* in Lake Mainit.

Estimates of length-weight parameters, size ranges, and other related statistics are presented in Table 9 for six commercially important species. Eels and carps can grow to very large sizes and biomass, Sex ratios among other commercially important fishes tend toward more female than male individuals, although it is also surprising that the 61 specimens of *A. marmorata* examined were all female. Scientific literature worldwide report that male eels are often found only in estuaries and mouth of rivers, thus, explaining the unintended bias of female eels in the samples. The apex predators have positive allometric growth while the carp and tilapia species have negative allometric growth.

Table 9. Length – weight relationship and other statistics for six other commercially important species from Lake Mainit.

Species	Local Name	N	a	b	Size Range (cm)		Weight (g)		Sex Ratio
					Min	Max	Min	Max	M:F
Anguilla marmorata	Kasili	61	0.003	3.02	44	112	185	4,800	All female
Channa striata	Hayuan	443	0.006	3.12	23.5	51	95	1,250	1:4.76
Cyprinus carpio carpio	Karpa	78	0.026	2.91	24.5	87	248	11,100	1:1.58
Glossogobius celebius	Pijanga	172	0.008	3.08	14	33.5	23.6	374	1:1.37
Oreochromis mossambicus	Lipunan	47	0.030	2.85	10.1	18.2	21	115	1:1.76
Oreochromis niloticus	Tilapia	909	0.026	2.91	7.1	37	8	920	1:1.39

Food and Feeding Habits

The food habits of seven commercially important freshwater fishes from Lake Mainit were determined based on their stomach contents (Fig. 28). Major commercial fishes from Lake Mainit can be classified as carnivores, omnivores, and detritivores. Carnivorous fishes from Lake Mainit include the mudfish (*C. striata*), the golden tank goby (*G. celebius*), the white goby (*G. giuris*), and the Mainit eleotrid (*H. agilis*). Omnivorous fishes include the walking catfish (*Clarias batrachus*) and the Nile tilapia (*O. niloticus*), while detritivorous fishes are represented by the common carp (*C. carpio*).

Cluster analysis based on similarity of stomach contents are presented in Fig. 29. It is noted that the diets of *G. celebius* and *C. striata* are most similar than that of other fishes. Being the only detritivore in the group of fish from Lake Mainit subjected to food type analysis, the common carp is found in the outermost food habit cluster. The mudfish *C. striata* is an apex predator in Lake Mainit, preying on small shrimps and fish. The two most common prey items in Lake Mainit are the small schooling freshwater shrimp (*Isik*) and the shrimp commonly called *ulang* (*Macrobrachium lanciefrons*) which are found abundant along the littoral zone. The abundant *H. agilis* is possibly the most preyed upon fish by other piscivore fishes such as mudfish and the golden tank goby. The eleotrid goby *H. agilis* and white goby *G. giuris* show cannibalistic behavior as they feed upon the *saguyon* which are found abundant near the edge of the littoral zone. *Saguyon* is a collective term referring to mixed fry of *H. agilis* and *G. giuris* which becomes a main source of food for other fishes in the lake following the spawning season of the two gobies.

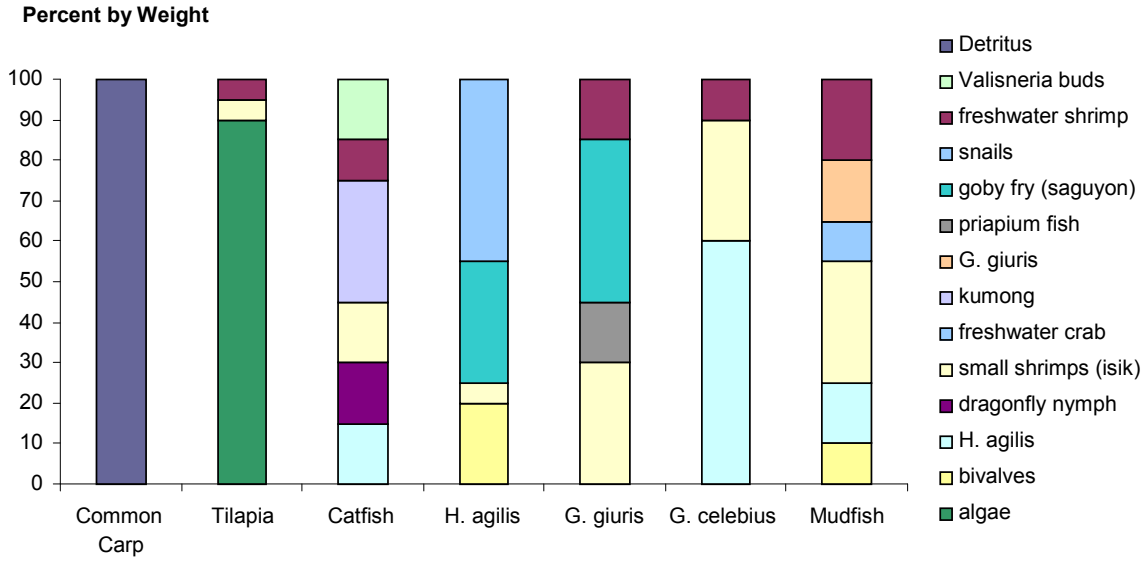

Figure 28. Food habits of commercially important freshwater fishes from Lake Mainit.

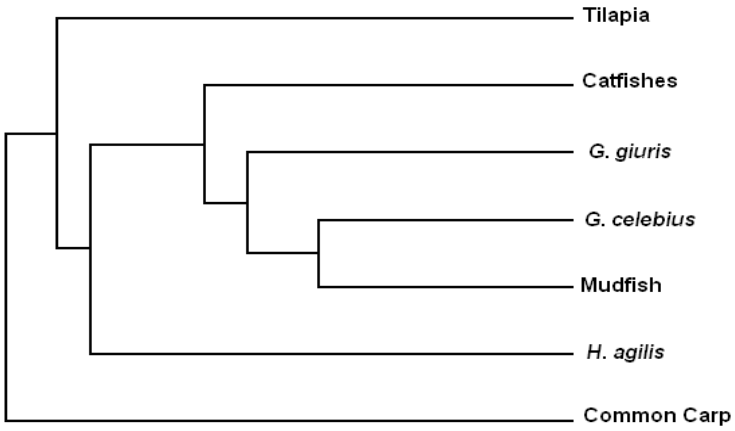

***Figure 29**. Dendrogram showing similarity in food habits of fishes from Lake Mainit. The dendrogram is an output of cluster analysis based on paired group algorithm using Bray-Curtis similarity index.*

The golden tank goby and the mudfish are lie-in-wait predators that rely on ambush of prey items. The mudfish are usually found in the littoral areas (i.e. benthopelagic) with algae and marsh grasses. The golden tank

goby frequents areas with rocks and sometimes remain solitary on the bottom. The white goby in Lake Mainit is a rover predator that frequent the littoral and the limnetic zone of the lake.

3.3 Socio-Economics, Institutional Arrangements, and Intervention Programs

3.3.1 Political jurisdiction and economy

Lake Mainit belongs to two provincial jurisdictions in Caraga Region: Agusan del Norte and Surigao del Norte. The municipalities along Lake Mainit and Kalinawan River are classified as fourth (Mainit, Jabonga, and Santiago) to fifth class (Alegria, Kitcharao, and Tubay) economies based on the LGU's average annual income in the last three calendar years. Fourth class municipalities must generate an annual income from Php20-30 million while fifth class municipalities should earn from Php10-20 million. The level of municipal classification of Lake Mainit LGUs (Table 10) had not changed since 2000, indicating that municipal revenues have not improved in the last seven years.

Table 10. Income classification and population of the six municipalities around Lake Mainit and Kalinawan River as of 2000.

Province	Surigao del Norte		Agusan del Norte			
Municipality	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
Class	4th	5th	5th	4th	4th	5th
Population	23,417	12,923	14,604	20,501	17,925	17,668
No. of Households	4,621	2,350	2,623	3,742	2,651	3,336

Source: Provincial Profiles

3.3.2 Relevant Demographics & Economic Activities

Estimates of fishing population in coastal barangays surrounding Lake Mainit (Fig. 30) obtained from three sources, namely, Focus Group Discussion in 46 barangays (Fig. 31) around the lake and river, municipal profiles, and inventory by the local research partners (LRPs) show wide variations (Table 11). Estimates of fisher population by FGD participants were much higher than the number validated by the LRPs from each municipality, with the exception of Alegria where the FGD estimate is much too low. Based on data provided to the LRPs by barangay officials, BFARMCs and fisherfolk associations, a total of 1,754 fishers depend on the fisheries resources of Lake Mainit and Kalinawan River. Data on full-time and part-time fishers are, however, incomplete as fisher registration was not religiously made each year.

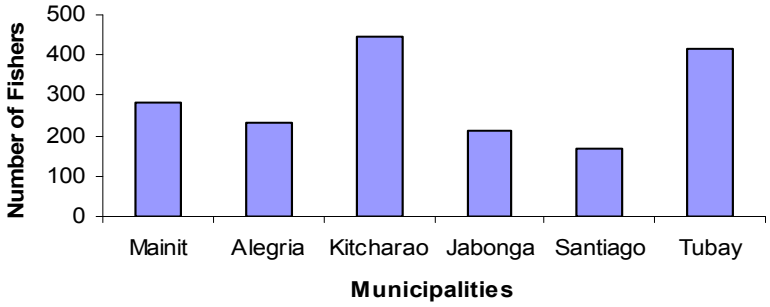

***Figure 30**. Profile of fisher population around Lake Mainit.*

Figure 31. A series of focus group discussions was conducted in the six municipalities around Lake Mainit and Kalinawan River to obtain relevant data on fishing effort and socio-economics of fishing households.

Table 11. Lakeshore and fishing populations in Lake Mainit municipalities.

Province	Surigao del Norte		Agusan del Norte				Total
Municipality	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	
Shore population*	2007	2005	2004	2004	2006	2004	
	18,817	No data	10,056	4,582	211	8,778	
No. of Fishers: (Based on LRP* survey)	280	233	444	212	170	415	1,754
Full time	99	No data	54	No data	45	290	-
Part time	170	No data	390	No data	125	125	-

**Data from Local Research Partners (Municipal Agriculture Offices), 2008*

On the average, about 27.8% of these fishers are full-time while the rest only fish on a part-time capacity, presumably because they have other livelihood opportunities. More fishers (69.9%) are engaged full time in fishing in Tubay than in Mainit (35.4%), Santiago (26.5%), and in Kitcharao (12.2%). In many municipalities around Lake Mainit fishing comes secondary, as the wide agricultural land attract lakeshore residents to go on farming.

Fisherfolk communities around Lake Mainit and environs have diversified livelihoods, clearly a response to depleted incomes from fishing. For full time fishers, fishing in Lake Mainit and Kalinawan River is the main source of income (85%), followed by farming (12%). Other minor income-generating activities are operating a sari-sari store, engaging in small-scale mining and many others (Fig 32). For part time fishers, farming is the main source of income supplemented by fishing and other livelihood options (Fig. 33) especially in Jabonga and Santiago.

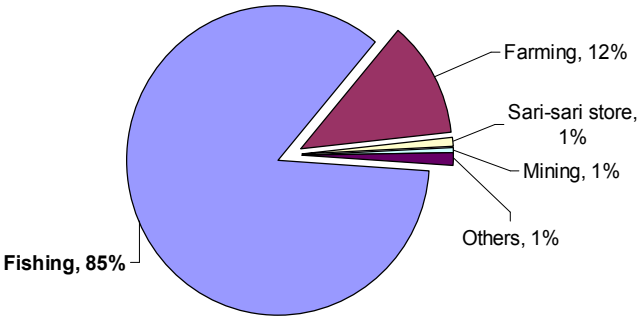

Figure 32. Primary and secondary sources of income of full time fishers.

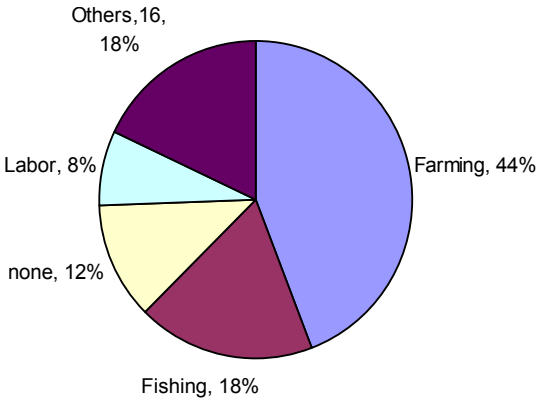

Figure 33. Primary and secondary sources of income of part-time fishers.

An estimated 1,546 fishing boats are owned by fishers in the six municipalities, 53% of these are motorized (owned mostly by Tubay fishers) and 47% are non-motorized bancas of dugout canoes with or without outriggers (Fig. 34). It should be noted that most of the 462 boats in Tubay are engaged in marine fishing rather than in Kalinawan River. Majority of the fishing boats in the five municipalities are non-motorized indicating the municipal or artisanal nature of their fishing activities.

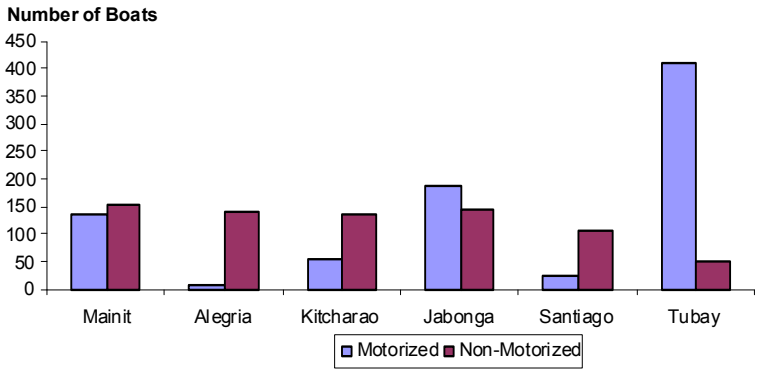

Figure 34. Profile of fishing boats in the six municipalities around Lake Mainit. Most of the motorized boats in Tubay are engaged in marine fishing in Butuan Bay.

3.3.3 Economics of Lake Mainit Fisheries

Municipal or small-scale fishermen in the Philippines are considered among the poorest sectors of society. The fishers living off the fisheries resources of Lake Mainit are no exception, earning marginal incomes from using a highly diverse gear technology. The lake is state-owned but the agricultural lands and the ricefields bordering the lake and Kalinawan River are privately owned. Much of the land is claimed as ancestral domain of the native Mamanwa tribe and their descendants are still visible in the lowlands, although most of them had moved to the uplands. A number of fishers have been identified as belonging to this tribe. About only 34% of the fisherfolk have permanent tenure, owning a lot and house either through inheritance or purchase; the rest either rent or squat in privately owned land.

Income from fishing

Output from focus group discussions showed that incomes derived from fishing varied among fishers in Lake Mainit and Kalinawan River depending on the type and number of gears they operate and on the fishing season (Table 12). On the average, daily income per fisher ranges from P223 during the lean months to as much as P1,537 during peak season. Certain gears have meager incomes during the lean fishing season, such as *bingwit, taan,* and *pukot.* Gears such as *baling, pana, laya, bungsod,* and *timing* seem to be quite profitable, earning moderate daily incomes even during lean months, and potentially large incomes during peak seasons when they experience "jackpot" catches. Some fishers using *bantak* experience widely variable income, from negative to as high as Php2,625 in a day's fishing.

Table 12. Derived estimates of gross sales and net income of fishers using different fishing gears during lean and peak fishing seasons.

Gear Type	Crew Size	Mean Catch (kg/trip)		Mean Price (P/kg)	Gross Sales (P)		Cost per Trip (P)	Net Daily Income per Fisher (P)	
		Peak	Lean		Peak	Lean		Peak	Lean
Baling	7	125	18	70	8,750	1,260	150	1,229	159
Bantak	1-2	90	2	60	5,400	120	150	2,625	-30
Bingwit	2	20	4	60	1,200	240	75	563	83
Taan	1-2	12	3	60	720	180	100	310	40
Bungsod	2	50	15	70	3,500	1,050	100	1,700	475
Laya	2	90	7	70	6,300	490	150	3,075	170
Pana	1	20	5	70	1,400	350	75	1,325	275
Pukot	1-2	3	2	70	210	140	100	55	40
Timing	1-2	100	15	60	6,000	900	100	2,950	800
Mean		**57**	**8**				**111**	**1,537**	**223**

Traps such as *timing* and *bantak* are popularly used by the most number of fishers in Lake Mainit and Kalinawan River because of lower fishing costs while obtaining large gross sales, resulting in larger net incomes between Php2,700-3,000. The modified cast net (*laya* with light), fish corral (bungsod), and seine (baling) command good daily income per fisher at P1,300-3,000. Wide variations in fisher income between seasons is influenced by changing market prices of fish. Off-vessel prices range widely based on quality and size of fish and quantity of catch. The FGD participants declared that all gears are operated daily for the whole year except during typhoons characterized by rough and turbid waters.

Monitoring of landed catch from six municipalities around the lake and river from August 2007 to September 2008 showed that, all gear types considered, Lake Mainit fishers obtained a mean CPUE value of 5.47 kg/fisher/day. At the prevailing average price of fish at Php60/kg, this value translates to a gross daily income of Php328, or a net daily income of Php217 after deducting the average cost of fishing operation (Php111/day). An estimated monthly income of Php4,340 from fishing in Lake Mainit on an average of 20 days a month falls below the poverty threshold for an average family in rural Philippines.

Household Expenditures

The pattern of expenditures of a fishing household around Lake Mainit comprise of four basic components, namely: food (rice, viand and groceries), educational expenses (fare, allowance, and tuition), payment for basic amenities (medicine, water and light/electricity) and other miscellaneous expenses. The biggest chunk goes to food, comprising 57-69% of the daily budget of a family (Fig. 35 & 36).

The average household around Lake Mainit needs Php228-353 to cover their basic daily requirements. Overall, lakeshore residents of Mainit, Jabonga, and Tubay have the largest daily expenditures. Although fish and other aquatic products are often available for the fishers' family, sometimes they have to buy other viand for variety. These expenses are relative to family size that ranges from 4-10 members per household with an average of seven. These estimates indicate that the daily income of fishers (mean of Php223) from fishing can barely support the essential needs of an average-sized family around the lake.

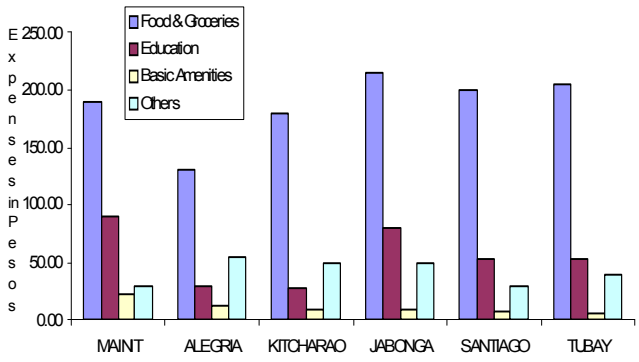

Figure 35. Comparative distribution of average daily HH expenditures per municipality.

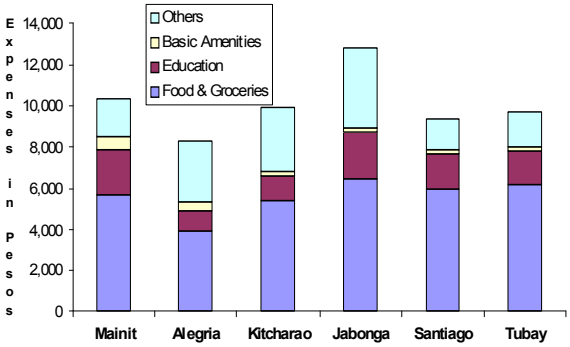

Figure 36. Average monthly household expenses of fishers in Lake Mainit and Kalinawan River.

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Monthly household expenses range from Php8,2700 (Alegria) to about Php12,829 (Jabonga). Education is regarded as important expense item by most fisherfolk, spending from Php990 to Php2,230 on tuition, daily fare and allowance. Expenses for basic amenities such as potable water and electricity is oftentimes within the minimum. Other families, however, can afford to have refrigerators and cassette players, and thus, incur higher electricity costs. Budgetary costs for health and medicines are rather high in some families with maintenance pills, but oftentimes the family resort to herbs and other health remedies known in the area.

Monthly income of the average fisher is surely not enough to meet monthly expenses. On the other hand, most fishers spend a substantial sum on miscellaneous expenses such as cigarettes, cellphone load, gambling bets for card and number games, and 'snacks' that include alcoholic drink such as *tuba* and *kulafu.* On top of meager incomes from fishing, loose spending patterns and no prioritization of expenditures may have caused the destitute situation in most fishing villages. Fishers around Lake Mainit need to do either of two things in order to make both ends meet: earn more income from fishing and other sources, or manage their daily budgets by inhibiting from needless expenditures. Many families in Santiago engage in small-scale mining along the Kalinawan River (Fig. 37), scouring the lakeshore sediments for precious gold and other metals.

Figure 37. Family-based (left) and mechanized (right) gold panning operations along Kalinawan River.

3.3.4 Fisheries-Related Issues and Concerns

The residents of lakeshore communities around Lake Mainit identified several issues and concerns in connection with fisheries-based livelihood, living conditions and socio-political situation around the lake. A compilation of these issues is presented in Table 13, classified arbitrarily based on the following categories: management/governance issues, lack of funds for programs, use of destructive fishing gear, declining fish stock, and habitat or environmental concerns. Problems related to fisheries management and environmental governance top the list (46%), followed by habitat/environmental degradation (21%), while issues related to continued use of destructive/illegal fishing gears, decreasing fish catch and inadequate funds for management comprise the remaining 33% of issues perceived by fisherfolk and other FGD participants.

Table 13. Summary of fisheries-related issues and other problems and concerns in the municipalities around Lake Mainit.

Municipality	Poor Management	Inadequate Funds	Destructive Gear Use	Declining Stock	Habitat/ Environment	Total
Mainit	11	3	3	1	4	22
Alegria	14	5	4	0	4	27
Kitcharao	8	1	2	4	5	20
Jabonga	8	1	2	4	5	20
Santiago	20	5	5	7	9	46
Tubay	16	4	2	2	8	32
Total	77	19	18	18	35	167

3.3.5 Intervention Programs

Lake Mainit is a highly productive wetland ecosystem which has, naturally, attracted the attention of many government agencies and non-government organizations (NGOs) alike. Local communities around the Lake are also politically active, with more than 50 people's organizations (PO's) and local organizations involved in various livelihood and resource management initiatives (Fig. 38). At least 21 international organizations, 12 national line agencies and 3 academic institutions have come to Lake Mainit for a variety of social, economic and research interventions (Fig. 39). The intervention programs are categorized arbitrarily into the following: livelihood options, credit facilities for financial assistance, health care, infrastructure, and environmental programs, based on accounts of FGD participants, barangay/organization's officials, and household respondents. Most of the livelihood projects are on livestock dispersal (introduced since 1980s), farming, provision of farming implements, and fish culture. Financial assistance is largely on small-scale lending to POs and organization members, but several programs have supported infrastructure and health facilities (Table 14). Several national and foreign funding agencies have supported these various programs.

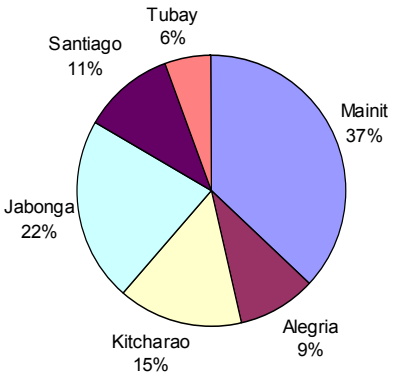

Figure 38. Profile of local NGOs and POs in the six municipalities around Lake Mainit.

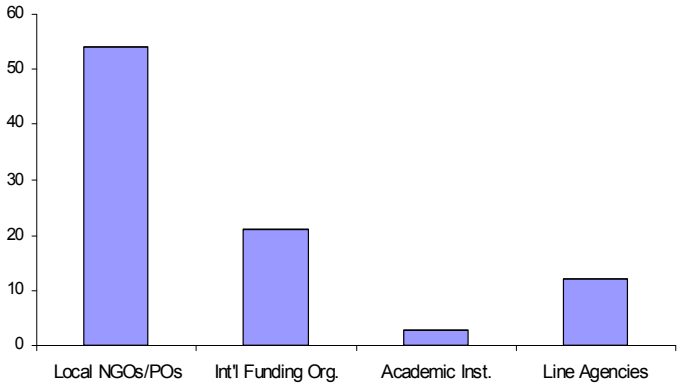

Figure 39. Profile of institutions that have introduced intervention programs around Lake Mainit.

Environmental rehabilitation projects are quite limited, with a focus on tree planting and establishment of fish sanctuaries in Lake Mainit at Alegria and Kitcharao. Among the six municipalities around Lake Mainit covered by the present project, Alegria, Jabonga and Santiago appear to be the most benefited by these intervention programs (Fig. 40), while Tubay has the least number of support programs.

Several development programs were introduced in Lake Mainit and its surrounding municipalities. These programs are categorized arbitrarily into the following: livelihood assistance, credit/financial assistance, health care and sanitation services, infrastructure, and environmental programs. These are based on the accounts of FGD participants, barangay/organization's officials, and household respondents. Most of the livelihood projects

are on livestock dispersal (introduced since 1980s), farming, provision of farming implements, and fish culture (Table 14). Financial assistance is largely on small-scale lending to POs for micro-enterprise development to encourage entrepreneurship. Infrastructure projects are more on buildings in support to social services and health facilities, support to livelihood enterprises and physical development of the municipality. Environmental rehabilitation projects are quite limited in the upland and lake ecosystems. In the upland are micro-enterprise developments under the CBFM program while lakeshore interventions are activated by the CBRM program. In the lake, establishment of fish sanctuaries and lake grass protected areas were done under the program. Parallel to conservation are enhancement of fish stock through dispersal of tilapia and carp fingerlings, and improving fish catch by distribution of gill nets to the POs and introduction of fish cage culture. Tree planting was also initiated by some POs.

Table 14. Intervention programs and projects introduced in Lake Mainit communities.

Programs/Projects	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
. **Livelihood:**						
Hog dispersal	x	x	x	x	x	x
Goat dispersal	x	x		x	x	
Carabao dispersal		x	x	x	x	
Chicken dispersal	x	x		x	x	
Cow/cattle dispersal		x	x		x	
Turtle farm machine					x	
Hunger MitigationProgram	x	x	x			
Upland-Lowland farming				x	x	
Fish Cage culture	x	x	x	x	x	
2. Financial assistance:						
Lending	x	x	x	x	x	x
Vending: meat, food				x		x
Sari-sari Store	x	x	x	x	x	x
3. Health Care:						
Health Center	x	x	x	x	x	
Botica sa Barangay		x				
Birthing Clinic		x		x		
Disease Control/Treatment		x		x		
Daycare Center	x	x	x	x	x	
Senior Citizen Center				x	x	
4. Infrastructure:						
School Building	x					
Water System	x	x	x	x	x	
Solar Power				x	x	
River spillway				x		
Farm to market road	x	x	x	x	x	
5. Environmental rehabilitation						
Fish Sanctuary	x	x	x	x	x	
Tree Planting	x		x			
Fish dispersal	x	x	x	x	x	
Lakegrass Protected Zone			x			

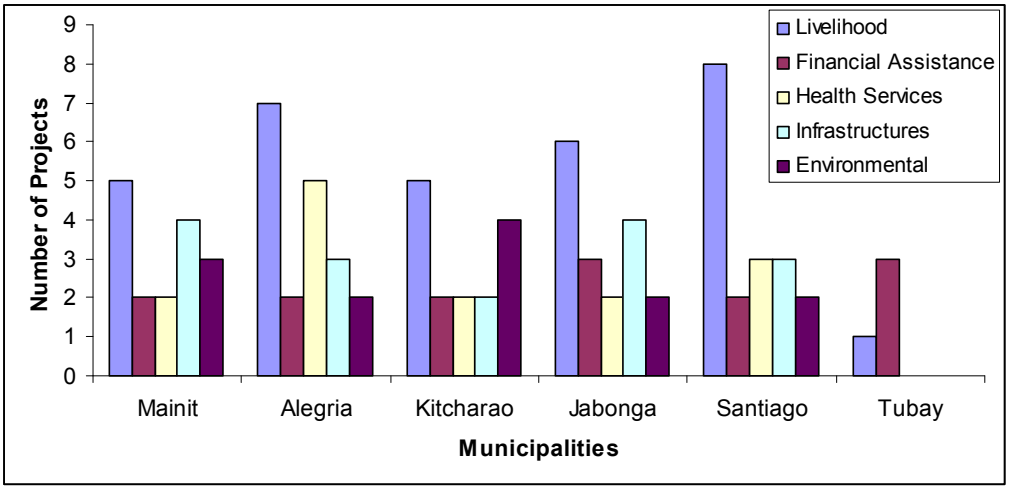

Figure 40. Number of intervention activities per municipality.

4. MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Results of the fisheries resource assessment project have indicated that fish production from the lake has been rapidly declining over the last two decades, and that most fishers are earning marginal incomes barely enough to meet basic daily needs such as food, education of children, and health. Lake Mainit experiences the typical syndrome of a threatened fisheries: biodiversity loss, high fishing pressure, use of unsustainable fishing gears and methods, declining fish catch and catch-per-unit-effort, decreasing size of fish caught, and marginal or meager fisher incomes.

4.1 Threatened Fisheries and Biodiversity

The latest inventory of finfish resources in the lake and Kalinawan river suggests that majority of the finfish species (>65%) in the lake and river are migratory (catadromous and anadromous), using the Kalinawan River as their only route to move between the lake and Butuan bay waters. At least 13 species (35%) listed in Pauly et al's (1990) report were not observed in the present study. Conversely, some 17 species reported in this study were not listed in the earlier report. The difference in species composition of the lake fish resources through time may be due to several reasons. Some species may have become locally extinct due to overfishing, the increased prominence of introduced or exotic species (such as tilapia, carp, and catfish), or degrading water quality because of increasing mining activities. Introduction of exotic or non-native species, intentionally or accidentally, may temporarily increase species diversity, however, dominance of exotic species would later lead to decline in native populations.

Monitoring of the lake and riverine fishery undertaken by this study found that catches of the gobies, *pijanga* and *bugwan* declined by almost 40% in less than a decade since Galicia and Lopez (1990) reported annual production of 225.9 tons in 1997-98 by baling alone. This highly efficient gear, which has been banned from the lake by most LGUs, still landed most of the goby (50.4%) at 19.5 tons in Mainit where the gear is still operated.

4.2 Degrading Environmental Quality

The members of the Lake Mainit Development Alliance must take the issue of mining and its adverse effects on the environmental quality of the lake, rivers, and Butuan Bay more seriously than ever. A very recent development in the proliferation of mining in the Lake and environs is the approval of mining exploration for the Agata North Nickel Laterite project in Santiago, Agusan del Norte by the Mindoro Resources Ltd. (http//www.mindoro.com). The project has an exploration target of 30-40 million wet metric tons (WMT) of laterite known to contain 0.9 to 1.5% nickel and 18 to 28% iron and considers on-site processing. Small scale gold panning activities are on-going along E. Morgado-La Paz areas and parts of Alegria and Kitcharao. Large-scale earth movement has its associated effect of siltation of coastal and river waters as already experienced in many parts of mineral-rich Caraga region. LMDA must commit to implement the Environmental Management Plan for the five ecological zones of the Lake Mainit watershed in order to ensure sustainable economic and ecological development in the region.

4.3 Management of Commercially Important Stocks

The littoral zone of Lake Mainit plays a very significant role in the production of commercially important fishes. The littoral zone supplies food for almost all the commercially important fishes such as tilapia, carp, mudfish, catfish, *bugwan* and *pijanga,* except for the *pijanga lawodnon* that are found on the edge of the deep scattering layer of the lake. Protection of the littoral zone as an important habitat for fish becomes even more critical in view of the impending establishment of a mini-hydroelectric plant near Jabonga. The proposed project is expected to cause a considerable drawdown of the lake's water level – a move that can threaten littoral environments in Lake Mainit.

The *bugwan* and *pijanga* have high percentage of gravid or spawning stages during January to April, peaking in February which coincide with the flood period or *guob.* A closed season for the fishing of bugwan and pijanga is recommended at least in the month of February of each year to protect the spawning stock of these fish, and thus, ensure successful recruitment of young fish to sustain the fishery. Observations show that Mainit and Jabonga are favored for *pijanga* breeding as there are extensive areas that are most covered with sand (Mainit) and gravel (Jabonga). *Bugwan* breeding can be observed throughout the lakeshore areas with muddy substrates. Establishment of protected areas within the lake for these resources would be most appropriate.

The LMDA and BFAR should also take a strong stand against potential impacts of introducing exotic species in the lake. Next to the native gobies, introduced tilapia, carp, and Thai catfish have become the dominant fish resources in the lake. Many inland waters in the Philippines, including Lake Mainit, are now facing a new threat: that of culture of the irridiscent catfish *Pangasius spp* being promoted by BFAR, DTI and giant feed corporations. Generally, native fishes in Lake Mainit do not grow to large sizes, thus an introduction of large fish such as *Pangasius* (that may grow to 50 kg) may have an adverse effect on the native fish populations as there are no predators on fish of such large size.

4.4 Impacts of Intervention Programs

Numerous intervention programs introduced into the lakeshore communities have barely made a dent in the complex ecological and socio-economic situation around the lake. On the other hand, there is need to undertake a more detailed analysis of the impacts of all these intervention programs on the economy and quality of life of local communities. Determination of the positive or negative impacts of the numerous interventions implemented in the lake and environs is important in evaluating the efficacy of programs, and in finding ways to improve future implementation. From the donor or sponsor's perspective, impact evaluation would determine if the amount of funding expended on the program is commensurate with the results or outcome.

The municipalities around the lake have responded to these problems by passing ordinances to protect and rehabilitate the lake's resources, however, while some LGUs seem to be vigilant in policy implementation others seem to have weak or negligent governance. For instance, members of the Lake Mainit Development Authority (LMDA) have implemented the ban of illegal or destructive gears such as beach seine or *baling*, but the municipality of Mainit is yet to declare this gear illegal in Lake Mainit by 2009. *Baling* is operated as a drag seine with fine mesh net and therefore not selective, catching juveniles along with the adult fish. The continued use of this gear would reduce the juvenile fish population and threaten the sustainability of fisheries resources in the lake.

4.5 Recommendations for Sustainable Fisheries Management

As an inland water body, Lake Mainit is a shared resource of the municipalities fringing it – but with a limited area and unregulated fishing effort, the lake resources can be easily depleted. There is a need for the municipalities surrounding the lake to share the responsibility of protecting it and ensuring its sustainability for future generations of fishers. The Fisheries Code of the Philippines in 1998 (RA 8550) has mandated certain mechanisms to regulate access in municipal fishing grounds, including registry of municipal fisherfolk, coding of vessels, and establishment of closed areas and seasons, whenever appropriate.

A sustainable fisheries management program must consider ways to improve the social and economic status of the fisherfolk, such as improved fishing technology, credit support to increase capital, and capacity training and extension for alternative livelihood sources. On the other hand, these interventions must be balanced with the goal of regulating fishing effort and reducing pressure of the fragile fishery resources of the lake.

A preliminary planning workshop conducted on October 23, 2008 generated the following suggested activities for sustainable fishery production and improved living conditions of the fisherfolk in Lake Mainit and its associated river systems:

1. Establishment of closed season and protected areas to protect spawning of the most important fish resources of the lake, *pijanga* and *bugwan.* Results of this study indicate that the best time for the "no fishing period" would be the months of January to April (peak of gravid goby), specifically one week after the full moon or third quarter lunar period. Recommended areas for "no fishing zone" or *pijanga* protected zones are the sandy littoral areas of Mainit and Jabonga.

2. Regulate fishing effort through regular (annual) fisherfolk, boat, and gear registration. This task can be assigned to the Barangay Council and its Secretary in coordination with the Municipal Treasurer's office.
3. Impose municipal ordinances that ban fine mesh nets and other destructive fishing gears, such as *baling* from Mainit, Surigao del Norte.
4. Activation and strengthening of fishermen's associations and co-operatives to enable them to undertake resource management activities.
5. Establishment of land-based income-generating activities to alleviate fishers' income and reduce pressure on the lake's fishery resources.
6. Implement research and development (R&D) program to cover ecological monitoring to update limnological data, monitoring of water quality, fish stock assessment, and primary productivity of the lake.
7. Technical assistance on sustainable methods of upland farming to protect the watershed areas.
8. Fish stock enhancement through seeding, fish pen/cage culture, establishment and maintenance of fish sanctuaries and other rehabilitation strategies.
9. Regulate aquaculture activities, stop the practice of introducing exotic species for aquaculture, and actively prevent entry of invasive alien species (e.g. janitor fish, new strains of catfish, etc.)
10. Capacity building of resource management bodies (FARMC, *Bantay Dagat*) and LGU staff through training in CRM, sustainable fisheries management, fish sanctuary monitoring and other technical skills development. The training in Sustainable Fisheries Management in the Context of the Code of Conduct for Responsible Fisheries (CCRF), jointly sponsored by IFAD-NMCIREMP, PCAMRD-DOST, LMDA and MSU Naawan Foundation, Inc., is an important step in this direction.

Perhaps the brightest prospect of a sustainable management program for Lake Mainit is the existence of an active alliance, the LMDA, that can pool the resources of member LGUs into a cohesive and collective effort of natural resource management. The role of LMDA as an alliance of local government units is crucial to the successful implementation of all resource and environmental management programs for Lake Mainit and its associated river systems. Integrating fisheries management to the Lake Mainit development agenda is an important step in implementing a truly holistic, integrated approach to addressing issues on declining fish catch, multiple resource use conflicts, degrading environmental quality, and low incomes of fishing communities.

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Appendix 1. Description of fishing gears in Lake Mainit.

Spearfishing (Sapang)

Gear Specifications
Materials Stainless, 4 pointed barbed blades
Length of the blade: 20 cm
Handle: Bamboo, L=1.5 m, diameter: 1.5 cm

Accessories: Search light

Description: Instrument is provided with pointed barbed blades which are not detachable from handle or shaft. The entire implement is thrown by hand at an individual fish.

Operation: The gear is operated during night time with the use of a search light. A non-motorized boat is paddled to find fish with the aid of the light. Once the fish is caught by the powerful light beam it becomes motionless and the harpoon is thrown at the fish. Then, it is retrieved and the fish is removed from the blade. The boat will then move on looking for another fish to catch.

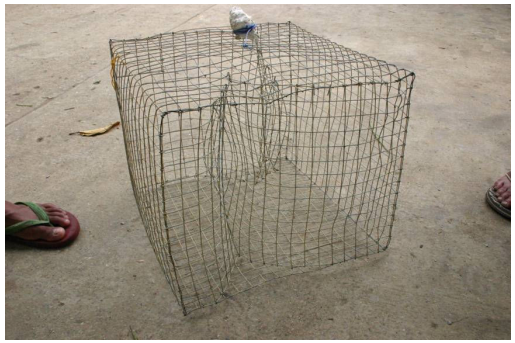
Spearfishing (pana)

Gear Specifications
Materials Iron rod, diameter= 5 mm, L=0.6-1.0 m
Handle Aluminum/GI tube, L= 12 cm
Googles bamboo and glass

Description: Spear fishing in the area is locally called “pana”. This type of fishing uses a spear, a gear having a sharp pointed heart at the end of a long shaft which is thrown at a single fish at a time.

Operation: Time of fishing depends on the weather and visibility of the water. The spear is hand-carried underwater by a fisher with a diving mask. Spear fishing is a daytime activity where it is operated at depths ranging from 1-7 meters, usually along the periphery of aquatic plant or vegetation. Some fishers use a compressor in spear fishing in order to lengthen their stay underwater.

Fish Trap for Tilapia (Timing)



Gear Specifications

Frames: Chicken wire, ms= 2.75 cm
Dimension, L= 45 cm, W= 45 cm,
H= 20 cm
Float: Styrofoam as marker
Sinker: Stone
Retrieving line: Mononylon # 80
Setting Time: 12 – 24 hours

Description: Fish traps used in Lake Mainit are classified as small traps measuring 45 cm long, 45 cm wide and 20 cm in height. They are intended for catching tilapia. The gear has 2 entrances with 2 pointed funnels which prevent the escape of the fish after entering the trap.

Operation: The number of traps to be set range from 10 to 20 units. The 10 units per fisher is adopted at Mansayao, Mainit Surigao del Norte while 20 units are operated at E. Morgado, Santiago, Agusan del Norte. The trap frames are painted black. The traps are provided with stone weights at the corners during operation. Baits are not needed. The retrieval of the traps with the catch is by hooking the line, or the trap itself. Removal of the catch is through an opening located at both sides.

Beach Seine (Baling)

Gear Specifications

Net Knotless, L = 190 m
ms = 2.5 cm in the cod-end
ms = 3.0 cm in both wings and body

Rope
Floatline Nylon twisted, 5 mm, 2 pcs L= 187.5 m
Sinkerline Nylon twisted, 5 mm, 2 pcs L= 187.5 m

3 mm, 2 pcs L= 21.5 m
Float Rubber (cylindrical), 5x8 cm (100 pcs)
8x10 cm (center float)
Sinker Lead (semi cylindrical) 6x3 cm (14 g)

Net Knotless, L=24 m
ms=2.0 cm (wing & body)
ms= fine mesh (cod-end)

Rope
Floatline: Nylon twisted, Accessories

Sinkerline Nylon twisted
3 mm, 2 pcs L= 21.5m

Accessories:
Float: Rubber (slipper)
Sinker: Lead (cylindrical) Weight, 5g

Description: A fishing gear where members of the family or neighbors help in the fishing operation, is structurally similar to the Danish seine in construction. Beach seines are only found at Mainit, Surigao del Norte where two sizes or length of the net are used. The small ones are found in Mansayao, Mainit, Surigao del Norte with mesh sizes ranging from very fine meshed net (screen) to 2 cm, while the big ones are found in Mainit Poblacion with mesh size from 2.5 to 3 cm.

Operation: In its operation, the net is set at the deeper part of the lake and is dragged along the sandy and muddy bottom toward the littoral zone in a semi-circle, then pulled towards the lakeshore by ten or more people. A fisher on board a non-motorized boat also helps to drag the net towards the lakeshore with the use of a wooden winch. Gathering of the catch is done in the lakeshore.

Crab Trap (Bantak)

Gear Specifications

Materials	Plastic, L=32 cm	Bamboo, L= 36 cm
	Diameter: 10 cm	Diameter: 10 cm
	Form: Cylindrical	Form: Cylindrical
Distance	1.6 m between unit	3.2 m between unit
	1000 units/fisher	300 units/fisher
Bait	Coconut/cassava	Coconut/cassava
Setting Time	24 hours	24 hours

Description: This is a tubular trap made either of bamboo (with two (2) non-return valves on each end) and plastic (one non-return valve at one end). The dimensions are 32 cm long for the plastic and 36 cm long for the bamboo. They have the same diameter of 10 cm. The traps are tied to a common line at an interval of 1.6 m for the plastic and 3.2 for the bamboo. Plastic traps are found in Mansayao, Mainit, Surigao del Norte and San Roque, Ktcharao, Agusan del Norte while the bamboo traps are operated throughout Lake Mainit.

Modified Cast Net (Laya)

Gear Specifications

Net	Mononylon # 4	Zipper: 1 m above from the sinker line
	Ms = 3 cm	
	Net circumference: 48 m	Accessories
	Depth: 10 m	Kerosene lamp, Bamboo booms 6pcs
Sinker line	Mononylon # 80 and 50 (doubled)	
Sinker	Lead (round), weight= 50 g	Fishing Time: Night time
	Interval: 3 cm	

Description: The form is conical in shape and the net is heavily weighed around the base. The circumference of the net is 48 m with a depth of 10 meters. It has a zipper which is located 1 m above the sinker line purposely to close the body of the net during hauling.

Operation: Before setting the net its corner is tied with polyethylene rope and is lowered to the bottom. It is operated during night time with the aid of a kerosene lamp to attract fishes particularly "*pedianga*". After 2 hours of soaking, the net is hauled and before hauling the zipper is pulled in order to close the sinker line which traps the fishes. Then the net is hauled slowly with the aid of a pulley attached to each bamboo boom. The catch is removed from the net on-board and then it will be prepared and readied for the next setting.

Set Gill Net for Carp (Pukot)

Net	Mononylon #4	Accessories: Float	Plastic gallon
	Ms = 15 cm; 10 cm		30 m interval
Dimension: Length	2,500 m	Sinker	Lead, cylindrical (10g)
Depth	8 m	Interval:	30 m
Rope : Floatline	Polyethelene rope #5		
Sinkerline	Mononylon #100		

Description: There is a variation as to the length of the net and mesh size used by the fishers around Lake Mainit. The longest net for carp (6,000 m) was found in San Roque, Kitcharao, Agusan del Norte where its mesh size is the smallest (10 cm) compared to other areas like Jabonga, Mainit and Alegria where they are using the 15-cm mesh. The depth of the net (8 meters) is uniform throughout all the areas.

Operation: During daytime, the fishers will roam around the Lake scouting for schools of carp feeding at the surface of the water. As soon as they spot such school they will go nearer, then the net is set at 6:00 pm until 6:00 am the following day. The soaking time of the net is 12 hours. At 6:00 am, the net is hauled by pulling it up slowly and placed on board. The fishers will rush to the middleman after hauling to dispose their catch at higher market prices.

Drift gill net (paanod)

Gear Specifications

Net	Mononylon # 4, L=100-400 m
	ms= 4 cm
	Depth, 2 m
Float	Rubber
Sinker	Lead
Buoy	Plastic container or bamboo

Description: Drift gill net is made of 100-400 meter long monofilament nylon net with a width of 2 meters which is equivalent to 50 meshes. This is similar to set gillnet in method of construction and differs only in its operation. This type of gill net is only found and operated in Kalinawan River particularly in the station of Tubay, Agusan del Norte.

Operation: This is operated during daytime allowing it to drift along one foot from the water surface. The catch is hauled by pulling the net slowly on board. The removal of catch is done at the homeport. The setting time of this net is 2-3 hours a day. This type of fishing is intended for catching a target fish especially pelagic fishes that often school together at the surface of the water .

Simple Hook and Line (Bingwit/Pasol)

Gear Specifications

Mainline	Mononylon # 6, L = 10 m	Sinker: Lead (cylindrical) 100g
Secondary line	Mononylon # 4, L = 6 cm	Swivel: Small (1 pc)
Hook	J-type, # 571, 5 pcs Spread: 1.0 cm, Interval: 20 cm	

Description: Simple hook and lines are known as "*bingwit*" or "*pasol*",.a single vertical line carrying five barbed hooks. Other gear components are the main line, branch line, swivel and lead sinker. This kind of fishing requires constant attention. This is used for catching "*pedianga*", "*buguan*" and "*tilapia.*"

Operation: This is usually operated along Lake shoreline and along kalinawan river. Bait used is either crab meat or filamentous algae. It is used to catch fish dwelling in midwater and near/on the Lake bottom. It worked by simply dropping it into the water and waiting for the fish to bite (Placia 1999). Once the fish will bite the bait, the mainline is jerked so that the mouth of the fish would be hooked. Hauling of the catch is done by pulling it up into the boat. It is usually operated during daytime for 4 hours.

Scoop Net (Sarap)

Gear Specifications

Materials	Bamboo, diameter: 1.0 cm Semi-circular in form, diameter: 1.5 m Net: fine-meshed or screen
Handle	Wood

Description: A semi-circular net with a handle for catching small shrimp or "isik" that schools at the surface of the water.

Operation: The boat is moved around looking for a school of fish and shrimp at the surface of the water. The capture of fish is effected by a brailing or dipping action.

Multiple Handline (Buldos)

Gear Specifications

Mainline Mononylon # 8, L = 60 m Sinker Steel, 1.5x 9 cm
Swivel: Small (1 pc)

Secondary line: Mononylon # 4, L = 6 cm

Hook J-type, # 571, 240 pcs, Fishing time Early morning till noon
Spread: 1.0 cm, Interval: 20 cm

Spool Bamboo, 10x10 cm

Description: Multiple handlines is made of a single vertical line with a series of small barbed hooks attached to it by spreaders at regular interval. It is locally known as "*buldos* "in San Roque, Kitcharao, Agusan del Norte and is used for catching goby or "*pedianga* ."

Operation: Fishing operation is from early morning at sunrise up to 12:00 noon. The hooks are baited and lowered at desired depths and a jerking motion is done to lure the fish to take the bait. A crystallite cloth is also used as artificial bait.

Palangre (taan)

Main line	Mononylon #50, L = 1000 m	Sinker	Stone (3 pcs), Weight=1.0 kg
Secondary line	Mononylon #50, L = 1 m	Bouy	Plastic gallon
Hook	J-type, # 556,900 pcs Interval: 1.5 m	Setting time	11 hours (4pm – 5am)
Bouy line	Polyethylene rope #6, L = depth dependent		

Description: This is a longline without a fixed attachment to the bottom and is free to drift with the current. It consists of a mainline made of mononylon # 50 with attached vertical secondary line of mononylon # 50 equally spaced at 1.5 m interval. Each secondary line is tied with barbed J-type hook and is baited with raw fish or crab.

Operation: The hooks are baited either with raw fish or crab. The bait preference is solely determined by the availability of cheap and readily available species. The most common bait in the lake is goby. The gear is set either at dusk or dawn at the shallow or deeper part of the Lake. When the gear is set at the shallow part of the Lake, it is expected that mudfish are caught or at the deeper part, eel are caught. A square box is used for the stacking the gear. The gear is set by dropping slowly the mainline to the lake bottom and is hauled by means of pulling it up and simultaneously removing the catch. The mainline is placed directly in the square box while continuously pulling the gear.

Dumpil

DUMPIL

Gear specifications

Bamboo; for structural posts
Split bamboo for framing the guiding barriers
Net (fine-meshed); square form, height, 5 meters
Scoop net for scoping the catch
Mononylon #80 for tying

Description

It is a funnel shaped structure made of bamboo for the entry of fishes. At the base of the structure, a net in a square form was placed for entrapment of fishes.

Operation

It is set in weeded areas around the lake and is very effective during flood season where the water level is high particularly from December to February. Most catch are *pijanga* and tilapia.

Bungsod

Gear Specifications

Materials	Bamboo weirs Knotless net, ms=3 cm	Cod-end	diameter=2 m ms= 3 cm
Guiding barrier	L= 100 m, ms=3 cm	Accessories	Scoop net
1st playground	diameter= 2.5 cm ms= 3 cm	Setting time	24 hours
2nd playground	diameter= 2.5 m ms=3 cm		

Description; The fish corral is a semi-permanent gear consisting of a guiding barrier (leader), two playgrounds and a cod-end. The design allows the fish to be directed into the cod-end. The guiding barrier is usually positioned perpendicular to the shore and the entrance faces the current at ebb tide. It guides the fish into the playground which is a heart-shaped enclosure constructed of bamboo weirs reinforced with knotless nettings and fixed with 3 cm mesh size net.

Operation: Most fish corral units are set perpendicular to the shore while others are parallel to the shore especially in the tidal flat of Jabonga, Agusan del Norte. Catch retrieval is done on a daily basis particularly in the early hours of the day timed with marketing hours. The retrieval of the catch starts with the closing of the cod-end entrance. The fisher uses a scoop net for brailing out the catch the catch from the cod-end. After hauling, the cod-end entrance is opened for the next setting time.

FISH SHELTER OR TABON

Gear specifications

Wood or bamboo: for posting the structure
Net; fine meshed for framing the structure
Mononylon: for tying the frame

Description

The fish shelter is made out of a group of water lilies drifting along the river where it is barred by sticks to stop them from drifting and likewise stay permanently in a place. The fishers will observe such group of lilies in 1-3 days if there are bubbles coming from the bottom. This is a sign of the presence of fish sheltering on the lilies. When this happens the four corners of the aggregation will be posted by bamboos and framed with the net.

Operation

The gear is operated in Kalinawan river where it is intended for sheltering carps. The fishers would apply feeds to sheltered fish until the schedule for catching. Fishers will then dive into the water to collect the fish in the enclosed area with the use of a scoop net or spear gun.

Set Gill Net for Gourami (Pukot)

Gear Specifications

Net	Mononylon #2		
	Accessories	ms = 3.2 cm	
	Float: Rubber (slippers)	Interval:	1 m
	Dimensions:	Length	60 m
	Sinker	Lead (5 g) cylindrical at 1mnterval	
	Depth	1.6 m	
Rope			
	Floatline	Mononylon #40	
	Bouy	Plastic bottle, 2 pcs	
		Polyethelene rope #2	
	Sinkerline	Mononylon #40, Polyethelene #2	

Description: This type of gill net is only found at E. Morgado, Santiago, Agusan del Norte. It is made up of 60 meter long mononylon net with a depth of 1.6 meters, rubber floats, lead sinkers and plastic bottles as bouys. Its construction is the same as that of the set gill net for goby.

Operation: The net is set along Kalinawan River for 2-4 hours with the use of a non-motorized boat during daytime. After setting the net, the fisher will paddle the boat to its homeport to wait for about 4 hours. The net is hauled by pulling it slowly onto the boat and brought to the homeport where catch are being removed

Set Gill Net for Tilapia (Pukot)

Gear Specifications

Net Mononylon #2 Accessories Ms = 8 cm; 6 cm; 5 cm
Float: Rubber (slippers) at 1m interval
Dimensions
Length 1000 m; 1,500 m; 300 m Sinker
Lead (5 g) Interval: 60 cm
Depth 1 m; 2.5 m
Rope
Floatline Polyethelene rope #4 (doubled) Bouy
Plastic bottles
Sinkerline Mononylon #90 (doubled)

Description: Set gill net for catching tilapia in Lake Mainit has three different mesh sizes (8, 6 & 5 cm mesh). Its length varies from 300 to 1,500 m and its depth from 1 to 2.5 meter. The 8 and 6-cm mesh set gill nets are used in Tagbuyawan and Mansayao, Mainit, Surigao del Norte and San Roque, Kitcharao, Agusan del Norte while the 5-cm mesh are found in Alegria, Surigao del Norte where the length of the net is the shortest (300 m) and the depth of the net is the highest (2.5 m).

Operation: Set gill net for tilapia is operated during night time for 12 hours from 6:00 pm to 6:00 am the following day. The net is set perpendicular to the direction of the current. Hauling is done by pulling up the net which is placed on board slowly. Common catch of this net is the Bangkok Catfish and is observed in Tagbuyawan, Mainit, Surigao del Norte.

Set Gill Net for Goby (Pukot)

Gear Specifications

Net Mononylon #2 Accessories
Ms = 2 cm
Float: Styrofoam/plastic bottle Interval: 100 m
Dimensions: Length 2,500 m Depth 1.5 m
Sinker Lead (5 g) cylindrical Interval: 30 cm

Rope Float line Polyethele rope #5
Sinker line Mononylon #60 (doubled)

Description: There are four types of set gill net for goby used in Lake Mainit, the 2-cm mesh, 3.2-cm mesh, 8-cm mesh and the 15-cm mesh. The first, the third and the fourth type are common and dominant in lake and they are intended for catching specific fish species like the 2-cm mesh for catching goby, both "*pedianga*" and "*buguan*", the 8-cm mesh for"tilapia" and the 15-cm mesh for carp. The 3.2-cm mesh is only found in E. Morgado, Santiago, Agusan del Norte where it is used for catching *gourami*. These types of gill nets are similar in construction and differ in length and height of the net.

Operation: The 2-cm mesh gill net is commonly known as 'pukot" in the area where it is set during daytime. The soak time is 4 hours. The net is set perpendicular to the direction of the current. Hauling of the net is done by pulling it on board. In cases where only the catch is small, while hauling the fish are removed from the net and the fisherman can set the net again following same soaking time.

Bottom Set Longline
(Taan)

Main line	Mononylon #50, L = 1000 m	Sinker	Stone (3 pcs), Weight=1.0 kg
Secondary line	Mononylon #50, L = 1 m	Bouy	Plastic gallon
Hook	J-type, # 556,900 pcs	Setting time	11 hours (4pm – 5am)
	Interval: 1.5 m		
Bouy line	Polyethylene rope #6, L = depth dependent		

Description: This is a longline without a fixed attachment to the bottom is free to drift with the current. It consists of a mainline made of mononylon # 50 with attached vertical secondary line of mononylon # 50 equally spaced at 1.5 m interval. Each secondary line is tied with a barbed J-type hook.

Operation: The hooks are baited either with raw fish or crab. The bait preference is solely determined by the availability of cheap and readily available species. The most common bait is the goby. The gear is set either at dusk or dawn at the shallow or deeper part of the Lake. When the gear is set at the shallow part of the Lake, it is expected that mudfish are caught or at the deeper part, eel are caught. A square box is used for the stacking the gear. The gear is set by dropping slowly the mainline to the lake bottom and is hauled by means of pulling it up and simultaneously removing the catch. The mainline is placed directly in the square form box while continuously pulling the gear.

Barrier Net
(Panira)

Gear Specifications

Materials Knotless Netting, L=50-100 m, Depth: 2 m
ms= 2 cm
Bamboos for posting
Scoop net

Description: Barrier net is found and operated only in Kalinawan River at Santiago, Agusan del Norte. It is made up of bamboos and knotless net. Bamboos are posted in a semi-circular formationenclosing a certain space of the river. The knotless net is used to cover all posted bamboos.

Operation: The gear is operated at the river by enclosing the posted bamboos with knotless net near the presence of water lilies. The setting time is 4 hours and the catch is slowly brailed by a scoop net, then placed in a non-motorized boat or "*bandong*".

Palaksuhan

PALAKSUHAN

Gear specifications

Bamboo: for posting the two guiding barriers
Rectangular structure covered with the net: dimension, width, 1 meter; height, 2 meters and length, 3 meters
Mononylon: for tying and fixing the structure
Guiding barriers: length, 8-10 meters

Description

It is a simple structure found in Kalinawan river where it has a rectangular catching chamber with two guiding barriers set parallel to the river. This gear is a modified river trap designed to catch migrating eels.

Operation

It is installed and operated in Kalinawan river where the incoming fishes will be guided by the barriers and trapped into the catching chamber. The catch will be hauled by the scoop net.

Mosket

BARRIER NET OR MOSKET

Net: fine meshed net used to cover the posted bamboos or sticks in the area reached by high tide.

Description:

This is a fishing method wherein the lakeshore area reached by high tide is posted with bamboos covered with nets to trap the fishes that are carried by the high tide.

Operation:

The net is wrapped around the posed bamboos during low tide. The catch is hauled or collected during low tide by handpicking the trapped fish in the net. The net is not removed but is left ready for the next fishing operation.

Appendix 2. Derivation of raising factors and total annual landed catch from Lake Mainit and Kalinawan River.

Month	Total Recorded Catch (kg)	Total No. FLAs (N)*	Total No. FLAs monitored (n)	No. Fishing Days/Mo. (T)	No. Days Monitored (t)	Raising Factor (NT/nt)	Estimated Total Landed Catch (kg)
Aug 07	20,733	32	20	25	16	2.47	51,298.59
Sep 07	15,750	32	20	25	15	2.61	41,087.58
Oct 07	15,691	32	15	25	13	4.10	64,375.14
Nov 07	25,782	32	18	25	18	2.47	63,659.69
Dec 07	14,488	32	18	25	19	2.34	33,890.08
Jan 08	14,844	32	16	25	18	2.86	42,412.77
Feb 08	15,161	32	18	25	17	2.67	40,428.40
Mar 08	14,072	32	17	25	16	3.04	42,722.88
Apr 08	23,674	32	19	25	16	2.58	61,027.67
May 08	20,568	32	23	25	18	1.99	40,881.29
Jun 08	20,822	32	18	25	18	2.54	52,881.35
Jul 08	21,995	32	18	25	18	2.54	55,859.43
Aug 08	21,724	32	17	25	17	2.74	59,552.20
Sep 08	28,843	32	18	25	18	2.54	73,251.56
	274148				Total landed catch for 14 months		723,328.63
					Average LC per month		51,666.33
					Total annual landed catch (kg)		**619,995.97**
					Total annual landed catch (tons)		**620.00**
					Percent (%) of 1981 catch levels		**4.10**

**Number of FLAs based on data from LRPs per municipality*

Appendix 2. Total landed catch (kg) by gear type for all major landing stations monitored from August 2007 to September 2008.

Mainit	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Baling	2,361.5	3,048.5	1,583.8	4,109.0	1,589.0		3,060.3	1,171.0	6,259.0	5,258.0	5,595.0	3,695.0	3,689.1	6,591.2	48,010.3
Bantak							6.0	28.0	119.0	87.0	143.0	145.0	155.0	249.7	932.7
Bingwit							4.0								4.0
Buldos	3.5														3.5
Bungsod	13.0														13.0
Dompil												13.0			13.0
Kuryente										9.0					9.0
Laya	25.0														25.0
Lukay	13.5														13.5
Palangre									44.0						44.0
Pana							63.0	27.0	92.0	284.5	178.0	109.0	80.5	74.5	908.5
Pukot-Pijanga											72.0				72.0
Pukot	626.5	801.0	390.0	2,214.0	1,376.0		1,618.0	1,283.0	5,171.0	2,734.0	3,405.2	2,603.9	2,915.0	3,206.5	28,344.0
Sarap								76.0	157.0	88.0	86.0	166.0	99.0	137.5	809.5
Skylab												18.0			18.0
Taan	385.3	440.0	225.0	310.0	145.0		255.7	34.0	101.0	81.0	50.0	38.0	81.0	74.0	2,220.0
Timing				35.0					20.0						55.0
Timing/screen		45.0	9.0	603.0	138.0		20.0								815.0
Subtotal	3,428.2	4,334.5	2,207.8	7,271.0	3,248.0		5,027.0	2,619.0	11,963.0	8,541.5	9,529.2	6,787.9	7,019.6	10,333.4	82,310.0

Alegria	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Bantak	17.1	1.0							94.0	159.0	162.0	2.0	206.0	274.0	915.1
Bingwit	82.8	50.4		115.0	108.0	80.0	324.0	90.0	609.0	268.0	263.0	122.0	140.0	183.0	2,435.2
Bungsod											58.0	16.0	94.0	128.0	296.0
Pana	77.8	43.4		103.0					181.0	167.0	124.0	41.0	24.0	28.0	789.2
Pukot	465.7	120.4	1,510.0	2,364.0	2,444.0	752.0	1,697.0	880.0	2,558.0	2,234.0	2,028.0	895.0	870.0	1,569.0	20,387.1
Taan									3.0						3.0
Timing	21.7	3.0	17.0	407.0	244.0	93.0	847.0	176.0	1,266.0	921.0	871.0	387.0	424.0	771.0	6,448.7
Subtotal	665.1	218.2	1,527.0	2,989.0	2,796.0	925.0	2,868.0	1,146.0	4,711.0	3,749.0	3,538.0	1,463.0	1,758.0	2,953.0	31,306.3

Kitcharao	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Bantak	1,022.8	897.0	1,112.1	1,000.7	452.2	337.6	1,020.9	738.0	719.2	1,744.8	762.4	871.0	629.0	297.5	11,605.2
Bingwit		14.3	105.7	122.9	33.1	109.3	5.1	4.7	43.9	41.5	46.6	58.1	55.1	22.3	662.6
Bungsod	53.8	85.8	55.9	60.0	176.8	382.3	11.5		583.5	18.0	133.7				1,561.2
Buso	967.7	1,152.7	849.7			12.4									2,982.5
Laya	55.7	1,001.3	1,455.9	2,160.3	408.5	1,086.9	296.9	102.9	106.2	809.7	192.5	684.2	98.4	24.0	8,483.4
Pana	1,492.7	197.3	1,529.6	931.6	438.8	542.3	1,055.1	668.0	876.9	1,362.7	1,228.4	1,597.0	1,596.5	1,608.8	15,125.6
Pontak		2.0													2.0
Pukot	4,392.0	2,882.3	4,163.1	5,953.6	2,476.4	2,010.0	1,213.4	791.4	939.1	1,820.6	514.1	2,326.5	4,880.0	4,349.2	38,711.7
Sapang	12.7		46.0												58.7
Sapyaw		417.6	138.8	17.3	17.8	23.0				12.3					626.8
Sarap	3,456.0	27.9	559.2	500.9		123.4	283.0	10.9		46.7	29.0		21.0		5,058.0
Taan	40.7	66.8	10.6		19.6	165.3	12.4	30.5	9.1			2.6			357.6
Timing				122.7	90.3	506.5	399.4	221.8					1.8		1,342.5
Subtotal	11,495.3	6,761.4	10,026.6	10,870.0	4,113.5	5,299.0	4,303.3	2,568.2	3,277.9	5,856.3	2,906.7	5,539.4	7,281.8	6,301.8	86,601.1

Jabonga	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Baling				50.0											50.0
Bantak				25.0		17.0	42.0								84.0
Begjo/Pana													61.7	29.0	90.7
Bingwit									3.0						3.0
Buldos									5.0			67.3	207.0	33.3	312.6
Bungsod						207.0	402.0						85.5		694.5
Darak					4.0										4.0
Dompil					10.0	70.0	50.0							7.0	137.0
Laya	2,821.3	1,973.0	399.0	1,265.0	455.0	622.0	757.3	3,854.0	2,696.0	685.7	1,973.0	5,566.8	3,482.5	7,810.9	34,361.4
Palangre	43.0			128.0	119.5	209.0	71.0		34.0	103.2	82.8	114.4	129.6	17.5	1,052.0
Palutaw					70.0										70.0
Pana									34.0	146.5	103.4	67.7	8.5		360.1
Pukot	2,121.8	1,046.0	753.0	1,415.0	1,871.0	819.0	554.0	2,682.0	176.0	511.4	1,369.9	1,311.0	969.1	263.3	15,862.5
Taan	131.0			257.0	95.0	199.0	107.5	150.0	53.5	78.9	141.2	229.6	201.0	39.6	1,683.3
Timing/screen	78.0				10.0	42.0	83.0		17.5	93.7	69.0	109.7	124.5	25.0	652.4
Subtotal	5,195.1	3,019.0	1,152.0	3,140.0	2,634.5	2,185.0	2,066.8	6,686.0	3,019.0	1,619.4	3,739.3	7,466.5	5,269.4	8,225.6	55,417.5

Santiago	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Bantak						20.7	33.8	9.2		2.2					65.9
Bungsod	3.0	7.5		101.3	18.2	223.5	21.1	17.6	8.8				5.0		406.0
Lambat	20.0	29.0	105.5	12.0				12.5		274.3	96.0	22.4			571.7
Palaksuhan		16.0													16.0
Pana		11.0	10.4	34.7	26.1	4.3				26.5				33.0	146.0
Pukot	502.4	730.5	280.1	496.9	228.9	313.8	198.2	451.1	369.4	234.4	280.7	293.8	99.9	108.4	4,588.4
Taan	10.7	9.8	13.6	6.0	60.6	105.9	196.8	264.7	114.3	188.9	225.1	187.8	161.6		1,545.7
Taan													19.1	80.4	99.5
Timing/screen	73.0	42.7	134.8	202.5	154.9	161.5	137.0	101.3	18.8					29.8	1,056.2
Subtotal	609.1	846.5	544.3	853.4	488.7	829.7	586.9	856.4	511.3	726.3	601.8	504.0	285.6	251.6	8,495.4

Tubay	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Bingwit	33.6	134.2	15.0	14.3	10.1						122.4	190.5			520.0
Mosket				22.5											22.5
Palangre	4.3														4.3
Pana	12.7	55.9	8.4						87.6	27.8					192.3
Pante-anod	9.0	104.8	20.0	463.1	1,214.9	5,524.8	365.6	196.3	101.6	4.1	13.0				8,017.0
Pante-taan		35.1	19.5						2.2	44.1	43.0	10.5			154.4
Pasol													116.5	120.5	237.0
Sin-sin		12.0	18.0												30.0
Taan														40.5	40.5
Subtotal	59.6	342.0	80.9	499.8	1,225.0	5,524.8	365.6	196.3	191.4	76.0	178.4	201.0	116.5	161.0	9,218.0

TOTAL	20,733.2	15,750.2	15,691.4	25,782.2	14,488.0	14,844.5	15,160.7	14,071.9	23,673.7	20,568.4	20,822.0	21,994.7	21,724.1	28,842.8	274,147.7

Appendix 3. Total landed catch (kg) by species for all major landing stations monitored from August 2007 to September 2008.

Mainit	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Banak	12.0														12
Bangkok				8.0			87.5	8.0	35.0		44.0	48.5	43.0	15.0	289
Bolinao	8.3														8
Bugwan	316.3	242.5	86.5	310.0	111.0		455.3	202.0	848.0	750.0	801.0	598.0	512.0	550.0	5,783
Bungusan			72.5												73
Carpa	147.2	92.0	146.0	7.0			53.0		82.0	30.0	2.0	43.0	143.2	394.4	1,140
Gingaw													6.6		7
Haluan	389.8	438.0	183.0	292.0	145.0		266.7	30.0	155.0	88.0	106.0	97.5	244.5	248.5	2,684
Ibis	0.2														0
Ige	13.5														14
Isik								76.0	110.0	88.0	86.0	168.0	99.0	137.5	765
Kasili	6.5						16.5	4.0	5.0	13.0	4.0		12.5	5.0	67
Luyab	1,266.8	1,672.0	824.8	3,149.0	1,358.0		1,346.5	376.0	2,835.0	1,630.0	2,059.0	1,553.0	2,185.0	1,873.5	22,129
Mudfish								16.0							16
Olang							6.0	15.0	133.0	103.0	135.0	159.0	155.0	233.7	940
pantat	3.0	2.0	8.0					6.0							19
Pasayan							6.0	13.0							19
Pijanga	793.3	1,492.0	772.0	2,469.0	1,255.0		2,320.5	1,765.0	7,369.0	5,400.0	6,093.0	3,978.9	3,343.3	7,069.6	44,120
Saguyon												34.0			34
Tilapia	471.5	396.0	118.0	1,036.0	376.0		473.0	108.0	391.0	439.5	261.0	141.0	274.5	315.5	4,801
Subtotal	3,428.2	4,334.5	2,210.8	7,271.0	3,245.0		5,031.0	2,619.0	11,963.0	8,541.5	9,591.0	6,820.9	7,018.6	10,842.7	82,917

Alegria	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Banak	5.3														5
Bangkok				10.0	3.0										13
Bugwan	53.2	52.5	57.0	13.0		6.0							2.0	7.0	191
Carpa	74.8	26.3	587.0	496.0	223.0	85.0	148.0	141.0	558.0	408.0	505.0	55.0	136.0	266.0	3,709
Catfish			8.0												8
Haluan			14.0	47.0	59.0	35.0	237.0	56.0	352.0	238.0	220.0	78.0	106.0	120.0	1,562
Kasili										4.0	11.0	4.0	6.0		25
Lipunan							57.0	34.0							91
Olang	14.1	1.0							94.0	159.0	164.0	7.0		271.0	710
Pantat				9.0	17.0	26.0	91.0	34.0	246.0	71.0	84.0	32.0	56.0	74.0	740
Pijanga	137.2	51.2	112.0	61.0	10.0	11.0	11.0		4.0	4.0	17.0	6.0	18.0	24.0	466
Shrimps													196.0		196
Tilapia	380.6	87.3	935.0	2,385.0	2,492.0	770.0	2,288.0	881.0	3,457.0	2,865.0	2,700.0	1,282.0	1,247.0	2,191.0	23,961
Subtotal	665.1	218.2	1,713.0	3,021.0	2,804.0	933.0	2,832.0	1,146.0	4,711.0	3,749.0	3,701.0	1,464.0	1,767.0	2,953.0	31,677

Kitcharao	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Agok-ok	22.5														23
Alimango						7.8									8
Banak				3.6			0.4					1.5			6
Bangkok	10.0	11.8	59.2	1.3	20.2	6.6	17.6	18.8	1.5	41.7					189
Bolinao	6.8	38.7	654.1	323.3	13.3	186.4	261.7	5.8		59.0	24.0			1.0	1,574
Bugwan	631.8	74.5	160.3	210.6	27.5	94.1	136.8	106.2	117.4	23.5	97.8	240.0	457.7	132.2	2,510
Carpa	528.8	655.5	1,520.9	1,323.7	16.8	98.1	2.0		38.3	4.2	18.9		24.3	9.3	4,241
Gingaw	1.7	1.1													3
Haluan	81.8	107.3	52.0	2.8	6.1	91.7	36.0	27.1	4.1	225.2	199.5	152.5	263.3	290.3	1,540
Ige	5.0	96.3	96.3	133.3	22.1	7.0	80.0	96.5	27.5	9.6		1.0			575
Isik	3,484.0														3,484
Kagang					61.8	33.7	96.9		20.8	11.9		43.1	145.0		413

Kasili	83.5	121.6	69.0	87.4	31.9	234.4	26.7	24.3	34.3	6.5	3.6	0.9	16.4	45.7	786
Laya		6.6									5.0				12
Luyab	107.2	745.3	845.0	733.3	152.2	122.7	222.1	211.5	211.2	774.4	324.8	242.6	184.4	12.4	4,889
Olang	892.7	387.6	430.6	307.9	216.5	241.9	590.5	439.3	443.4	1,207.2	511.3	664.3	321.5	297.5	6,952
pantat	1.5			2.0		33.5				0.7					38
Pijanga	4,131.0	2,934.2	5,261.7	7,215.5	3,235.0	3,288.6	2,188.9	1,173.5	1,590.9	2,601.7	910.4	3,241.0	4,924.6	4,677.1	47,374
Saguyon	2.0	822.7	84.7	200.7	4.5	8.4	16.2	5.1					17.0		1,161
Shells				47.1											47
Suso			27.8	5.0		17.4	45.6								96
Tilapia	1,478.0	968.5	728.4	271.1	287.4	899.4	556.7	459.4	788.6	890.7	914.3	951.4	916.3	943.4	11,054
Subtotal	11,468.1	6,971.6	9,990.0	10,868.6	4,095.3	5,371.7	4,278.1	2,567.5	3,278.0	5,856.3	3,009.6	5,538.3	7,270.5	6,408.9	86,972

Jabonga	**Aug-07**	**Sep07**	**Oct-07**	**Nov-07**	**Dec-07**	**Jan-08**	**Feb-08**	**Mar-08**	**Apr-08**	**May-08**	**Jun-08**	**Jul-08**	**Aug-08**	**Sep08**	**Total**
Bakoko										12.0					12
Banak					7.0	26.0	33.0		11.5		1.0				79
Bangkok					15.0				15.0	3.0		3.3	1.0		37
Bayanak														6.0	6
Bugwan	75.5	120.0		135.0	25.0	50.0	46.0	90.0	49.0	233.3	627.2	335.0	320.1	62.3	2,168
Carpa	253.8			642.0	393.0	600.0	580.0	1,950.0	49.0	43.8	256.2	84.2	82.1	55.5	4,990
Gabot							10.0								10
Gurami									12.0	5.0	4.0	3.2			24
Haluan	133.0			257.0	95.0	169.0	107.5	150.0	62.5	152.1	167.2	245.6	203.9	48.6	1,791
Hito				96.0							14.7	2.0	6.0		119
Kasili					10.0	137.0	75.0			6.2	18.0				246
Kikilo												4.5			5
Langob							12.0								12
Luyab									15.0	9.0	5.0				29
Olang				25.0		17.0	52.0								94
Pegok				11.0	5.0			42.0		5.6					64
Pijanga	3,540.8	2,926.0	1,152.0	1,599.0	1,887.5	941.0	923.3	3,899.0	2,720.0	755.7	1,953.0	5,656.0	3,764.9	7,844.2	39,562
Tilapia	377.0			505.0	197.0	245.0	228.0	555.0	85.0	393.7	693.0	1,132.7	890.5	209.0	5,511
Subtotal	4,380.1	3,046.0	1,152.0	3,270.0	2,634.5	2,185.0	2,066.8	6,686.0	3,019.0	1,619.4	3,739.3	7,466.5	5,268.5	8,225.6	54,759

Santiago	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Agok-ok							1.0	21.5	32.6	2.7	2.9				61
bakang						4.5	5.0	2.7		0.5					13
Banak		7.8			0.2	0.3	2.3	13.1	0.7	0.2					25
Bangkok	20.3	5.7		6.0	2.2	10.0	38.5	36.2	7.5	1.2	10.5				138
Carp													24.9	49.5	74
Carpa	52.4	92.3	82.7	466.3	170.0	398.9	94.3	150.0	36.0	355.4	131.7	85.3			2,115
Durod				0.4	0.3										1
Gabot				12.0	16.2		11.9				3.5				44
Gingaw	3.0	4.0													7
Gisaw			3.0												3
Gurami	19.3							11.3	24.6	3.0	3.6				62
Haluan	101.2	44.2	33.4	79.1	105.9	197.7	222.9	384.9	204.1	247.5	289.6	184.8	176.7	81.9	2,354
Ibis	0.5														1
Kasili	0.6	16.0	2.1	2.2	2.5	1.1	1.4	1.1	0.4	1.0					28
Kikilo		1.3				0.5									2
Langob		0.8													1
pantat	21.2	58.3	2.0	34.6	20.0	63.9	3.3	16.1	1.2			4.2			225
shrimps						20.7	59.4	48.9	24.9	2.0					156
Tilapia	512.5	607.6	421.6	251.2	167.0	132.4	147.3	171.4	179.3	112.8	161.0	229.7	81.5	120.2	3,295
Subtotal	731.0	838.0	544.7	851.8	484.3	830.0	587.3	857.1	511.3	726.3	602.8	504.0	283.1	251.6	8,603

Tubay	Aug-07	Sep07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep08	Total
Ahaan	2.0	9.6									4.8		4.5	20.1	41.0
Asohos		5.6	3.5	0.3						0.7	6.9	21.0	7.8	10.3	56.0
Bakoko									1.7	1.3					3.0
Banak				15.5			18.6	1.9							36.0
Bangus								5.3							5.3
Bilbigan		24.7		2.7											27.4
Bugaong	8.8	22.7	22.0	0.6						14.8	58.2	67.3	51.0	38.1	283.4
Bugok	0.7										7.3	11.2			19.2
Bul-a						3.2									3.2
Buras	32.0	145.0	15.0												192.0
Carpa	2.0	23.1	27.9						67.5	21.8	56.0	28.3		49.4	275.9
Gingaw	7.8										29.6	50.2	22.4	7.5	117.4
Gisaw	1.4	26.6	5.5			4.0	4.5	6.3							48.3
Ibis		2.5	1.2	2.7											6.4
Ibis amihan				29.4	228.7	532.0	0.8								790.9
Kasili		5.1													5.1
Kikilo	4.5	48.2	5.8	19.2	48.4				4.0	11.8			17.2	23.8	182.7
Lampohon				360.3	947.9	4985.6	341.7	182.8	102.7	5.3					6926.1
Langob												1.9			1.9
Latab											15.4	19.2	2.0		36.5
Mole				22.5											22.5
Pegok		12.0		46.8											58.7
Potpot		2.3													2.3
Salmoyete/ Bodbod	0.4														0.4
Samin samin											0.4		4.5	10.3	15.2
Sapsap		3.0											7.3		10.3
Tilapia		11.7							15.5	20.4		2.0		1.6	51.2
Subtotal	59.6	342.0	80.9	499.8	1225.0	5524.8	365.6	196.3	191.4	76.0	178.4	201.0	116.5	161.0	9218.0
TOTAL	**20,732.0**	**15,750.2**	**15,691.4**	**25,782.2**	**14,488.0**	**14,844.5**	**15,160.7**	**14,071.9**	**23,673.7**	**20,568.4**	**20,822.0**	**21,994.7**	**21,724.1**	**28,842.8**	**274,146.5**

Appendix 4. Monthly length frequency distributions (expressed as percentages) of Lake Mainit eleotrid goby (*H. agilis*). Bold figures or values represent the modes (or peaks) for each month.

LENGTH	MONTHLY LENGTH FREQUENCY DISTRIBUTION OF LAKE MAINIT ELEOTRID														
(cm)	Aug07	Sep07	Oct07	Nov07	Dec07	Jan08	Feb08	Mar08	Apr08	May08	Jun08	Jul08	Aug08	Sep08	Oct08
5.0 - 5.49										1.67			0.28		
5.5 - 5.99			4						0.98	9.62			2.25		
6.0 - 6.49			6.67						5.88	10.88		0.59	7.04		
6.5 - 6.99	0.92								4.90	9.62		4.12	8.45		
7.0 - 7.49	3.67		2.67						6.86	**12.97**		11.47	8.73		1.59
7.5 - 7.99	6.42		4.00						9.80	7.11		**19.71**	5.07		3.17
8.0 - 8.49	11.01								2.94	4.60		17.65	5.07		5.90
8.5 - 8.99	15.60		2.67			0.98			11.76	5.44	0.53	17.06	4.79		5.22
9.0 - 9.49	**16.51**		4.00			14.71	6.67		**15.69**	4.18	3.72	16.18	3.38		8.84
9.5 - 9.99	10.09	15.25	16.00	0.95		**38.24**	19.49		12.75	2.51	17.55	5.88	17.46		**17.46**
10.0 - 10.49	11.93	27.12	**29.33**	8.57		26.47	16.41	9.03	11.76	3.35	**35.64**	3.24	**20.00**	0.94	15.42
10.5 - 10.99	8.26	**28.81**	14.67	11.43		14.71	**22.05**	**37.42**	5.88	4.18	27.13	2.35	12.11	3.77	14.51
11.0 - 11.49	8.26	27.12	14.67	**35.24**	1.32	4.90	19.49	27.10	5.88	9.62	10.11	0.88	3.94	5.66	7.94
11.5 - 11.99	4.59		1.33	18.10	5.26		8.72	18.71	1.96	5.44	1.60	0.29	0.85	18.87	7.26
12.0 - 12.49	2.75	1.69		16.19	**17.11**		6.15	6.45	0.98	4.60	3.19	0.59	0.56	**31.13**	3.85
12.5 - 12.99				7.62	14.47			1.29	0.98	1.67	0.53			21.70	4.08
13.0 - 13.49				1.90	15.79		0.51			1.67				7.55	1.59
13.5 - 13.99					15.79					0.42				7.55	2.27
14.0 - 14.49					15.79		0.51		0.98	0.42				2.83	0.23
14.5 - 14.99					10.53										0.45
15.0 - 15.49															
15.5 - 15.99					1.32										
16.0 - 16.49															0.23
16.5 - 16.99					1.32										
17.0 - 17.49															
17.5 - 17.99															
18.0 - 18.49					1.32										

Appendix 5. Description of gonadal maturity stages of eleotrid goby (*H. agilis*) and the white goby (*G. giuris*) from Lake Mainit.

Hypseleotris agilis

Sex	Gonadal Stage	Description
Male	Immature	Testis small, translucent, whitish, long, thin strips lying close to the vertebral column
	Developing or Resting	Testis white, flat, convoluted, easily visible to the naked eye, about 1/4 length of the body cavity
	Developed	Testis medium sized, white and convoluted, no milt produced when pressed or cut
	Ripe	Testis medium sized, opalescent white, drops of milt produced when pressed or Cut
	Spent	Testis shrunk, flabby, dirty white in color to translucent.
Female	Immature	Ovary very small, pinkish red in color, close to vertebral column, no eggs visible to the naked eye
	Maturing virgin or Resting	Ovary more extended, firm, small oocytes visible, giving ovary a grainy appearance and pale yellow color
	Developing	Ovary large, orange in color starting to swell the body cavity, contains orange colored ova of two sizes
	Gravid	Ovary large, filling or swelling the body cavity, when opened large bright yellow ova spill out. Ovary yellow in color. Genital papilla reddish and swollen.
	Spent	Ovary shrunken, flaccid, contains a few residual eggs and many small ova. Ovary filled with blood vessels giving a reddish coloration

Glossogobius giuris

Sex	Gonadal Stage	Description
Male	Immature	Testis small, translucent, whitish, long, thin strips lying close to the vertebral column
	Developing or Resting	Testis white, flat, convoluted, easily visible to the naked eye, about 1/4 length of the body cavity
	Developed	Testis medium sized, white, no milt produced when pressed or cut
	Ripe	Testis medium sized, opalescent white, drops of milt produced when pressed or Cut
	Spent	Testis shrunk, flabby, dirty white in color to translucent.
Female	Immature	Ovary very small, pinkish red in color, close to vertebral column, no eggs visible to the naked eye
	Maturing virgin or Resting	Ovary more extended, firm, small oocytes visible, giving ovary a grainy appearance and pale yellow color
	Developing	Ovary large, pale yellow color starting to swell the body cavity, contains yellowish colored ova of two sizes
	Gravid	Ovary large, filling or swelling the body cavity, when opened large bright yellow ova spill out. Ovary bright yellow in color. Genital papilla reddish and swollen.
	Spent	Ovary shrunken, flaccid, contains a few residual eggs and many small ova. Ovary filled with blood vessels giving a reddish coloration Genital papilla reddish and swollen.

Appendix 6. Monthly gonadal maturity frequency distribution of *H. agilis*.

Gonadal Maturity Stage	Aug-07		Sept-07		Oct-07		Nov-07		Dec-07		Jan-08		Feb-08	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Immature (I)	0	0	0	0	4	13	0	0	19	2	3	0	8	1
Maturing (II)	62	31	76	41	41	35	34	20	52	2	46	47	32	20
Mature (III)	24	20	24	21	33	29	34	18	13	16	37	33	36	20
Gravid (IV)	2	14	0	15	19	6	8	36	0	78	7	12	23	54
Spent (V)	11	35	0	24	4	17	24	25	16	2	7	9	1	5
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix 6. Continued.

Gonadal Maturity Stage	Mar-08		Apr-08		May-08		Jun-08		Jul-08		Aug-08		Sept-08	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Immature (I)	11	22	6	40	4	2	8	6	0	1	11	11	16	14
Maturing (II)	26	31	24	27	35	31	27	19	30	25	35	35	35	32
Mature (III)	43	21	32	12	33	23	20	17	36	16	20	7	14	26
Gravid (IV)	17	14	28	6	24	6	33	26	26	7	15	2	27	18
Spent (V)	2	13	10	15	4	38	12	32	9	51	19	45	8	11
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix 7 . Length–Weight relationships for eleotrid goby (*Hypseleotris agilis*) collected from Lake Mainit, Philippines.

		a	b	R^2	n
MALE					
	Aug-07	0.0116	3.0410	0.9317	45
	Sep-07	0.0323	2.6800	0.7368	25
	Oct-07	0.0084	3.2072	0.9876	27
	Nov-07	0.0131	3.0111	0.7131	50
	Dec-07	0.0210	2.7076	0.9134	31
	Jan-08	0.1732	1.8686	0.3416	59
	Feb-08	0.0354	2.5689	0.7471	114
	Mar-08	0.0758	2.2772	0.6582	53
	Apr-08	0.0170	2.8794	0.9555	100
	May-08	0.0114	3.0685	0.9476	49
	Jun-08	0.0319	2.6336	0.8305	85
	Jul-08	0.0133	2.9778	0.9166	135
	Aug-08	0.0035	3.5942	0.9753	172
	Sep-08	0.0841	2.2971	0.6083	49
	Oct-08	0.0095	3.1398	0.9336	226
	All Male	0.0102	3.1073	0.9439	1220
FEMALE					
	Aug-07	0.0116	3.0248	0.9220	65
	Sep-07	0.0266	2.7103	0.6227	34
	Oct-07	0.0102	3.0809	0.9531	48
	Nov-07	0.0224	2.7860	0.7525	55
	Dec-07	0.0247	2.6597	0.8952	44
	Jan-08	0.1004	2.0951	0.4101	43
	Feb-08	0.0178	2.8564	0.8090	81
	Mar-08	0.0907	2.2031	0.7537	102
	Apr-08	0.0100	3.1018	0.9724	104
	May-08	0.0094	3.1375	0.9507	52
	Jun-08	0.0300	2.6596	0.8440	103
	Jul-08	0.0114	3.0291	0.9013	205
	Aug-08	0.0058	3.3468	0.9638	183
	Sep-08	0.0069	3.2738	0.8957	57
	Oct-08	0.0125	3.0038	0.8976	214
	All Female	0.0096	3.1167	0.9511	1390
	Both Sexes	0.0099	3.1104	0.9517	2826

Appendix 8. Monthly length frequency distribution of the white goby (*Glossogobius giuris*) from Lake Mainit, Philippines.

SIZE	MONTHLY LENGTH FREQUENCY DISTRIBUTION														
(cm)	Aug07	Sep07	Oct07	Nov07	Dec07	Jan08	Feb08	Mar08	Apr08	May08	Jun08	Jul08	Aug08	Sep08	Oct08
4.1 - 5.0											0.12	0.68			
5.1 - 6.0	1		0.69					4.10			2.11	5.01	0.15		
6.1 - 7.0	2		2.75					10.56			8.22	5.69	1.93		0.16
7.1 - 8.0	5		7.90		2.94	1.03		**13.29**			12.09	12.76	5.65	1.30	0.00
8.1 - 9.0	21		20.27		2.94	3.08	0.51	8.94			9.62	**16.63**	8.18	8.46	0.79
9.1 - 10.0	9		**21.65**		3.92	7.69	31.79	5.09		0.18	12.32	11.16	10.12	11.06	5.85
10.1 - 11.0	5		8.59		12.75	13.85	**40.51**	6.34	0.61	11.91	11.38	5.69	9.08	6.72	13.59
11.1 - 12.0	6	6.93	8.93		**17.65**	**22.05**	23.59	6.46	5.49	18.91	16.08	12.98	5.95	11.50	13.74
12.1 - 13.0	2	**48.51**	**18.56**	10.91	10.78	21.54	3.08	14.04	35.98	**29.77**	**16.31**	**22.10**	14.43	**28.42**	16.43
13.1 - 14.0	16	28.71	9.28	**44.55**	7.84	15.90		**15.28**	**37.20**	25.74	10.21	6.83	**26.79**	18.87	**20.06**
14.1 - 15.0	13	10.89	0.69	35.45	9.80	12.82	0.51	7.70	18.90	8.06	1.41	0.46	10.57	6.51	10.58
15.1 - 16.0	8	0.99	0.69	8.18	9.80	0.51		2.48	1.83	2.63	0.12		3.27	3.47	5.69
16.1 - 17.0	7	1.98			**10.78**	1.03		2.24		0.35			1.79	3.47	3.48
17.1 - 18.0	2				2.94	0.51		1.99		1.23			1.49	0.22	2.69
18.1 - 19.0	2	1.98		0.91	4.90			0.75		0.18			0.15		3.79
19.1 - 20.0	1				0.00			0.12		0.88			0.30		1.42
20.1 - 21.0					2.94			0.25		0.18			0.15		1.58
21.1 - 22.0								0.12							0.16
22.1 - 23.0								0.12							
23.1 - 24.0															
24.1 - 25.0								0.12							

Appendix 9. Monthly gonadal maturity frequency distribution of *G. giuris.*

Gonadal Maturity Stage	Aug-07		Sept-07		Oct-07		Nov-07		Dec-07		Jan-08		Feb-08		Mar-08	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Immature	8	17	0	0	59	47	0	0	16	15	15	17	8	1	13	6
Maturing	35	40	42	48	4	13	40	26	24	40	41	12	32	20	49	21
Mature	3	16	2	5	3	4	13	4	22	8	7	12	36	20	28	14
Gravid	0	6	0	7	0	4	3	10	0	9	0	39	23	54	8	46
Spent	54	21	56	39	34	31	43	60	37	28	37	20	1	5	2	14
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix 9. Continued.

Gonadal Maturity Stage	Apr-08		May-08		Jun-08		Jul-08		Aug-08		Sept-08		Oct-08	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Immature	3	1	14	6	19	22	9	7	2	0	3	2	0	2
Maturing	42	25	35	33	26	13	44	48	40	33	36	37	42	31
Mature	39	8	21	14	15	11	25	13	20	16	14	19	22	24
Gravid	13	42	15	25	13	15	13	14	22	15	25	5	24	13
Spent	3	24	15	22	27	39	9	18	16	36	22	38	12	30
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Appendix 10. Length–weight relationship in the white goby (*Glossogobius giuris*) collected from Lake Mainit, Philippines.

	a	b	R^2	n
MALE				
Aug-07	0.0036	3.39562	0.98892	37
Sep-07	0.0216	2.70963	0.92427	45
Oct-07	0.0054	3.24877	0.97652	68
Nov-07	0.0081	3.05792	0.93962	30
Dec-07	0.0053	3.17633	0.98163	49
Jan-08	0.0027	3.47580	0.95258	82
Feb-08	0.0354	2.56890	0.74710	114
Mar-08	0.0025	3.47918	0.95288	224
Apr-08	0.0417	2.44189	0.75623	67
May-08	0.0259	2.61290	0.82833	532
Jun-08	0.0109	2.93496	0.95980	285
Jul-08	0.0062	3.15702	0.98405	176
Aug-08	0.0095	3.00544	0.94795	297
Sep-08	0.0048	3.29173	0.97989	272
Oct-08	0.0081	3.07581	0.84973	271
All Male	0.0088	3.03475	0.92958	2549
FEMALE				
Aug-07	0.0040	3.36179	0.98163	63
Sep-07	0.0234	2.68679	0.91979	56
Oct-07	0.0053	3.24184	0.94349	223
Nov-07	0.0053	3.20813	0.76304	80
Dec-07	0.0046	3.23226	0.97018	53
Jan-08	0.0038	3.36065	0.81685	113
Feb-08	0.0178	2.85645	0.80903	81
Mar-08	0.0039	3.32479	0.93543	290
Apr-08	0.0308	2.56930	0.83488	97
May-08	0.0190	2.74274	0.84939	610
Jun-08	0.0111	2.93303	0.95282	369
Jul-08	0.0064	3.14960	0.98130	246
Aug-08	0.0078	3.08617	0.92644	375
Sep-08	0.0105	2.97581	0.74357	189
Oct-08	0.0087	3.05283	0.96603	362
All Female	0.0079	3.07920	0.92731	3207
Both Sexes	0.0051	3.24574	0.94143	6262