INCEPTION REPORT

Sustainable Fisheries Management Program for Lake Mainit: *Phase I. Rapid Resource Assessment*

Prepared by

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February 2008

Lake Mainit Development Alliance

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Funding Agency: *Philippine Council for Aquatic and Marine Research and Development (PCAMRD-DOST)*

Collaborators: *PCAMRD Zonal Center IV, Lake Mainit Development Alliance (LMDA) & BFAR-13*

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Citation: *This report should be cited as follows:*
De Guzman, A.B., W.H. Uy, J.G. Gorospe, A.E. Openiano, R.E. Acuña, R.L. Roa, R.C.Eballe, J.P.Garcia, R.D.Gaid, J.J.Samson and J.R. Santamina. 2008. Sustainable Fisheries Management Program for Lake Mainit: Phase I: Rapid Resource Assessment. Inception Report. Prepared by MSU at Naawan for the PCAMRD-DOST. 75p.

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 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, fishing boats and gears, 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 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.

Phase I (Rapid Resource Assessment), which is funded by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD-DOST) and the Lake Mainit Development Alliance (LMDA), has been completed. Highlights of the results had been presented to the Lake Mainit LGUs at the Inception Report and Validation Workshop last January 22, 2008. Comments and suggestions from the validation workshop had been incorporated in the following report, covering the subcomponents of Aquatic Biodiversity and Fisheries Assessment, Population Biology and Stock Dynamics, and the Participatory Socio-Economic Assessment.

Aquatic Biodiversity and Fisheries

Field and market surveys conducted between August and November 2007 showed that 14 species of aquatic plants, 27 fish, 5 crustaceans, and 10 mollusks were found to occur in Lake Mainit. Very diverse aquatic vegetation occurs in most shallow parts of the lake (Fig. 1), 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 (27 landing areas) between August-October 2007 amounted to 53.6 tons. *Pijanga* made up 47% of the total catch from the lake while *Tilapia* comprised 39% 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 common mollusk are the snails called locally as *Ige, kuhol* and *suso,* while the most common crustaceans are the freshwater shrimps *ulang* and *isik.* Based on reported catch, *pijanga* contributed to almost half of fish caught in the Lake. However, market survey revealed a different scenario since Tilapia appears to be common in the public market. The reason could be that pijanga does not necessarily land in the public market, but are being sold and brought directly to major cities in Northern Mindanao.

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. 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 (July to October 2007) was highest in Kitcharao 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 (Fig. 3). 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, while large CPUE in Tubay is composed of large catches of *surit*. These results indicate that highly efficient gears such as *baling* and *surit* can bring about large fish production, however, the long-term impact of these fishing gears on the sustainability of Lake Mainit and Kalinawan River fisheries should be evaluated.

Population Biology of Lake Mainit 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 (n =100) 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 55-132 mm, which is smaller than the size range of 40-185mm studied by Galicia and Lopez (2000). Specimens of *pijanga* had a size range 57-242 mm, again smaller than reported size range of 25 to 305 mm by Galicia and Lopez (2000). The present results indicate that both *bugwan* and *pijanga* are generally smaller now than in the 1990s. The female fishes are generally smaller than the male. Several small fishes of *bugwan* were caught in October, while a large number of small *pijanga* were caught in August and October. Many individuals of *bugwan* in October and November samples were either maturing or spawning, suggesting that spawning begins to occur in this period. Several maturing individuals of *pijanga* were found within the period, but very few mature individuals. The presence of several spent specimens from August to November suggests that spawning may have occurred earlier than August. Galicia & Lopez's (2000) results showed that spawning in both species occurs throughout the year, but defined peaks were observed. The peak of spawning in *pijanga* occurs between August to January while that of *bugwan* occurs between July- October.

Participatory Socio-Economic Assessment

A survey of the fishing effort made through focus group discussions (FGD) in 46 lakeshore barangays across six municipalities around Lake Mainit (Mainit, Alegria, Kitcharao and Jabonga) and along Kalinawan River (Santiago and Tubay) showed that some 4,063 fishers and 2,776 fishing boats are involved in Lake Mainit fisheries. Majority of the fishing boats are non-motorized *bancas* or *banding* (72%) while motorized boats are fewer (28%). Most of the fishers come from Jabonga and Santiago where many of them engage in fishing on a full-time basis, while Alegria has the smallest number of fishers. 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 Php8,2700 (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. 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.

Acknowledgment

This Inception Report would not have been completed without the invaluable support and cooperation of the following institutions and persons whom we acknowledge here with sincere gratitude and appreciation:

- The Philippine Council for Aquatic and Marine Research and Development (PCAMRD-DOST) for providing the funds used in this project;
- The MSU Naawan Administration for providing the financial management of the project;
- The Lake Mainit Development Alliance (LMDA) through its Project Director, Engr. Kaiser B. Recabo and his program staff, for providing the highly appreciated administrative and technical support;
- Hon. Erlpe John M. Amante, Governor of Agusan del Norte and Chair, LMDA, and Hon. Robert Ace S. Barbers, Governor of Surigao del Norte and their staff: Mr. Larry Hinaloc, Ms. Carmel Ratso, and Ronald Matela;
- The mayors of the six municipalities around Lake Mainit for their encouraging administrative assistance through the Municipal Agriculture Office:
  - Hon. Dominador G. Esma, Jr. – Alegria, Surigao del Norte
  - Hon. Ramon B. Mondano – Mainit, Surigao del Norte
  - Hon. Aristotle E. Montante – Kitcharao, Agusan del Norte
  - Hon. Glicerio M. Monton, Jr. – Jabonga, Agusan del Norte
  - Hon. Franklin D. Lim – Santiago, Agusan del Norte
  - Hon. Fidel E. Garcia, Jr. – Tubay, Agusan del Norte
- The Municipal Agriculturists of the six municipalities and their staff who have been faithful partners in this project undertaking: Ms. Bencula T. Dandan (Alegria), Ms. Virgentina Garido (Mainit), Mr. Raul M. del Aqua (Kitcharao), Mr. Sahibbon B. Julasiri (Jabonga), Mr. Dominador A. Burgos (Santiago), and Mr. Alfeo Tumulak (Tubay);
- The IFAD-NMCIREMP program, under the leadership of Dir. Antonio B. Menor, and Mr. Sid Lagahit for committing funds for the completion of the Fisheries Resources Assessment component; and
- The participants of the Inception Report Presentation and Validation Workshop held on January 22, 2008 at Mainit, Surigao del Norte.

We especially acknowledge the invaluable contribution of our Local Research Partners in the gathering of monthly fisheries data presented in this report:

- Mr. Joelito Senturias and Ms. Eufemia Napalam – Alegria, Surigao del Norte
- Mr. Romar Cubelo - Mainit, Surigao del Norte
- Ms. Flordela Galo - Kitcharao, Agusan del Norte
- Mr. Rolly Carsula - Jabonga, Agusan del Norte
- Ms. Zaida Badayos - Santiago, Agusan del Norte
- Mr. Pedrito Nalam and Eddie Dadios - Tubay, Agusan del Norte

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Chapter 1

INTRODUCTION

1.1 Project Background

Lake Mainit (Fig. 1) 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 falls within the political jurisdiction of the provinces of Agusan del Norte and Surigao del Norte in Northeastern Mindanao. Eight municipalities border the lake and comprise the Lake Mainit Watershed, namely Tubod, Sison, Mainit, Allegria (in Surigao del Norte), Kitcharao, Jabonga, Santiago, and Tubay (in Agusan del Norte), with a total of 31 coastal or lakeshore barangays.

An ecological study of the lake (Tumanda, et al. 2004) has shown it 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). Lake Mainit supports a high diversity of aquatic fauna and a thriving freshwater fishery, particularly of commercially important gobies and Nile tilapia (Galicia and Lopez, 2000).

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 about 140 people's organizations (PO's) involved in various livelihood and resource management initiatives. 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 (Walker, 2003).

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 by Pauly et al. 1990). Baselines have either shifted or changed, and species composition may have been altered. The 1980-81 baseline of total fisheries production of more than 15,000 tons, for example, may have significantly declined in recent years.

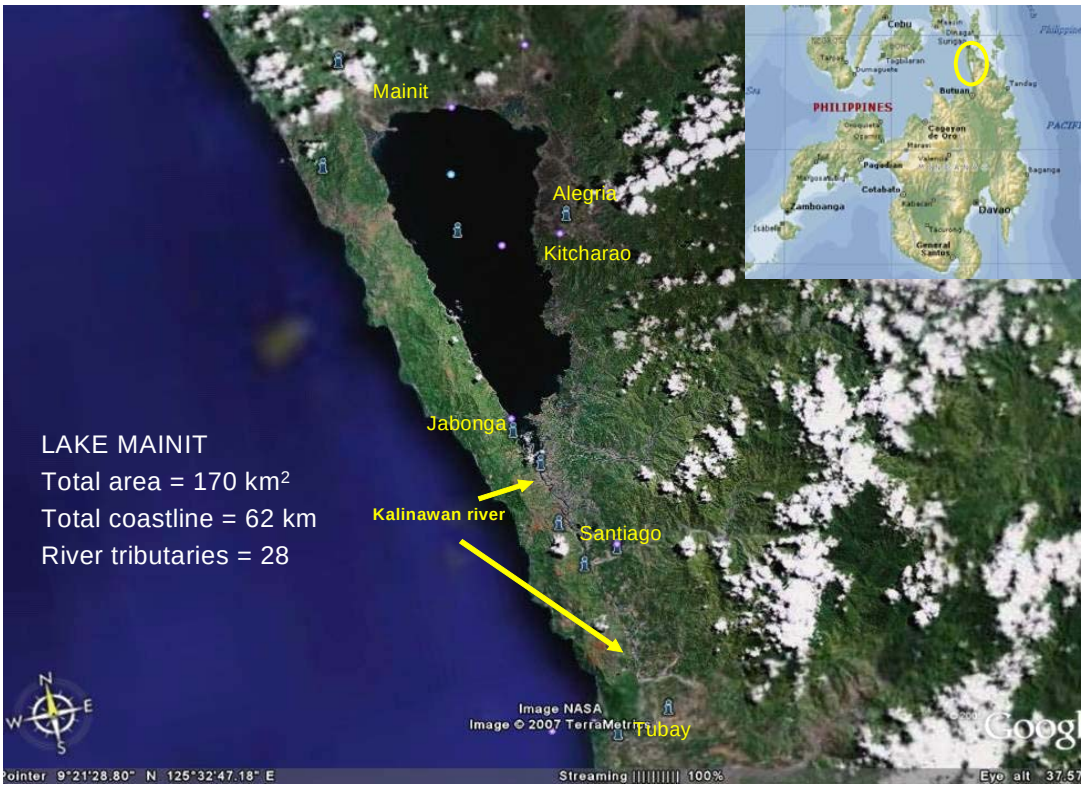

Figure 1. Map showing the location of Lake Mainit in northeastern Mindanao and its single outlet, the Kalinawan River.

The productivity of Lake Mainit has become vulnerable to various environmental and human factors in recent years. There are concerns that the lake fishery is now experiencing a "fishing down" phenomenon (Walker, 2003) with many fishes caught in progressively smaller sizes and lower economic value. Decision makers, however, often require hard evidence of these issues to justify the funding for management programs. Unfortunately, complete data on the state of natural resources are rarely available. A comprehensive resource and fishery assessment of Lake Mainit would provide scientific data that will serve as a decision-support tool for ensuring sustainable fisheries that would benefit lakeshore communities in the long term. An assessment of lake fisheries is a necessary step in formulating a management plan for their sustainable utilization.

Unsustainable fishing practices are considered among the major threats to the Lake Mainit watershed. Fine-meshed nets, electric fishing, and the use of chemicals or poisons have reduced the aquatic biodiversity of the Lake and Kalinawan River. Unsustainable aquaculture practices, such as introduction of exotic species into the lake, have threatened a number of rare and endemic species of fish, such as goby and climbing perch.

Integration of SFM into the Development Agenda

The Lake Mainit Development Agenda has stressed on the watershed approach as a framework for sustainable development of Lake Mainit and its environs. The framework divides the Lake Mainit watershed into five ecozones, including the lakes, rivers and the coastal zone at the mouth of its single drainage - the Kalinawan River. These three ecozones are critical to the hundreds of lakeshore residents in 31 barangays who depend upon the lake and rivers for food and livelihood.

Sustaining the fishery resources of Lake Mainit for future generations of fishers requires a programmatic approach to fisheries management. On the other hand, lack of comprehensive data on fisheries and other aquatic resources is a major constraint to the formulation of a holistic framework for sustainable management. Among the major strategies already identified in the LMDA are resource assessment, restocking or reseeding programs, water quality monitoring, establishment of fish sanctuaries, and strengthening the BFARMCs. Rather than a stand-alone project, the proposed fisheries management program shall integrate into the broader context of environmental management plan for the Lake Mainit watershed as indicated in the Lake Mainit Development Agenda.

A number of projects have been put in place and various interventions are still being proposed, hoping to provide development opportunities within the Lake Mainit area such as: the establishment of mini hydropower plant, flood control projects and construction of more access roads. These activities need to be evaluated for their effectivity and harmonized along with other initiatives and programs.

Figure 2 below is a presentation of the interaction of the identified high impact projects by the LMDA towards the overall management of the lake. Specifically, the lake management component deals with the importance of Lake Mainit as the main source of food and income for the 31 lakeshore barangays. Among its objectives are the development of baseline ecological profile of the lake resources to include its fisheries and biodiversity; enhancing the productivity of the lake; promote greater participation by the stakeholders; and to protect and conserve the endangered aquatic resources of the lake.

1.2 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 identify and analyze the political and institutional arrangements prevailing in Lake Mainit;
6. To determine critical related issues and problems and recommend alternative measures; and
7. To integrate these information into a holistic, implementable program in sustainable fisheries management.

The following are the expected outputs of the project:

1. Comprehensive coastal profile describing status of lake and riverine fisheries
2. Maps of resources and resource uses
3. Checklist of aquatic flora and fauna, fishing gears and methods
4. Comprehensive biology and population dynamics of major fish stocks
5. Seasonal calendars and historical trend-lines
6. Updated socio-economic profile & evaluation of intervention programs
7. Policy and institutional analysis of Lake Mainit management

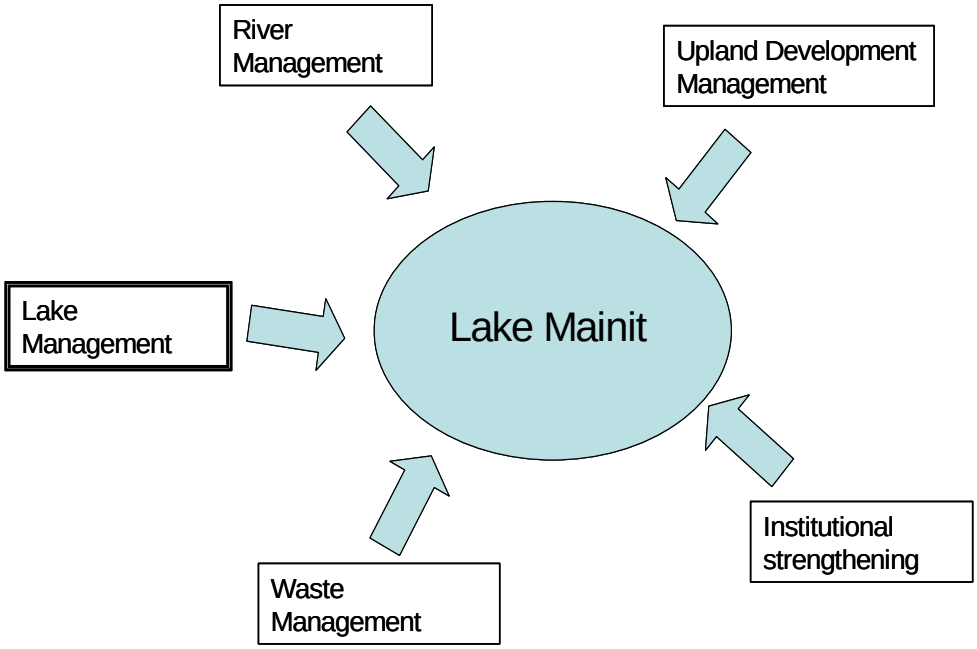

Figure 2. Framework for High Impact Projects under the Lake Mainit Development Agenda **(***from LMDA, 2005)***.**

1.3 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). About 41% of the estimated 22,000 living species by Cohen (1970) account for this resource (Moyle and Cech 1982). With such rich resource attributes, the freshwater habitats of the Philippines are considered economically important but threatened fishery systems.

The great variety of Philippine fishing gears (Umali and Warfel 1950, Talavera and Montalban 1932, Motoh 1980, Lao *et al.* 1990, Aguilar 1990, Gonzales, 1991, Flores *et al.* 1989) and crafts of the country showcase the wide array of localized types. This is the result of the continued modifications and improvements to suit the existing local conditions in a particular area.

There is very limited information on the fishery of Lake Mainit. Pauly et al. (1990) estimated annual catch of Lake Mainit in 1980-81 at 15,108 tons. Accordingly migratory fish contributed most of the catch, since annual catch for Jabonga alone was estimated at 12,900 tons. Galicia & Lopez (2000) estimated annual catch for Pijanga in the municipality of Mainit at 225,857 kg landed by *baling* alone in 1997-98.

Chapter 2

MATERIALS AND METHODS

2.1 Project Components

The fisheries management program for Lake Mainit is implemented in three components, phased out over a period of three years. Each component is comprised of several sub-components, as follows:

Component I – Resource and Social Assessment (Year 1)

Sub-Components:

1. Assessment of aquatic biodiversity and fishery resources
2. Population biology and stock dynamics
3. Socio-economics profiling, livelihood assessment & analysis of institutional arrangements

The resource and social assessment component of Lake Mainit shall be conducted in two phases: Phase I - Rapid Appraisal (3 months) and Phase II -Comprehensive Fish Stock Assessment (12 months).

Component 2 – Development of Sustainable FM Framework for Lake Mainit (Year 2)

Sub-Components:

1. Evaluation of environmental governance, fishery law enforcement, and management initiatives or interventions
2. Issues identification and priority setting (community & institutional levels)
3. Participatory fisheries management planning & plan adoption
4. Community organizing and capacity building for SFM
5. Integration of LM Fisheries Management Plan into provincial & regional development programs

Component 3 – Improving Environmental Governance, Habitat Protection & Biodiversity Conservation (Year3)

Sub-Components:

1. Formulation of improved environmental and resource management plan
2. Advocacy and IEC programs on HP & BC
3. Development of sustainable livelihood and tenurial security
4. Community empowerment programs
5. Participatory program monitoring and evaluation

2.2 Entry Protocol

The entry protocol to Lake Mainit was conducted on July 3-5, 2007 which involved the Project Leader and seven team members. A meeting was held with the Lake Mainit Development Alliance (LMDA), headed by Engr. Kaiser Recabo, and attended by the Municipal Agriculture Officers (MAO), Fisheries Technicians or designate, staff of BFAR, DENR and the Provincial Planning and Development Office of Agusan del Norte and Surigao del Norte.

This activity was intended to obtain the support and commitment of the various stakeholders in order to ensure the success of the project. An important aspect of the project is the participation of local research partners from each LGU in the conduct of field surveys and monitoring as a form of training and building their capacity in undertaking fisheries work. A powerpoint presentation of the project scope, objectives and methodology was given by Dr. Asuncion de Guzman, project leader.

Visits to the municipal halls of the four LGUs were made to meet with the local chief executives to secure their permission to undertake the project and allow the research team access to the lakeshore barangays and communities. Unfortunately, only the Mayors of Allegria, Hon. Dominador G. Esma, Jr. and Tubay, Hon. Fidel E. Garcia, Jr., were available at the time of the visit, but the team endeavored to meet with the other Mayors at a later time.

2.3 Conduct of Training of LRPs

A training of local research partners (LRPs) was conducted on July 19-20, 2007 at the Surigao del Norte College of Agriculture and Technology (SNCAT) campus. This was attended by five participants from Allegria, Mainit, Kitcharao, Jabonga and Santiago who were recommended by the MAOs to form the LRP team. The training consisted of lectures on field and laboratory methods in fisheries monitoring, invertebrate and vegetation surveys, fish stock dynamics, and socio-economic profiling. Hands-on training in fish identification and biological analysis was also conducted. The participants were also brought to a market survey to see the range of fisheries products commonly landed.

Part of the training was to teach LRPs in the proper filling up of fisheries monitoring forms. A meeting was later held in Tubay to brief the LRP there on the use of these forms in recording catch and effort and other data requirements of the project.

2.4 Conduct of Phase I – Rapid Appraisal of Lake Mainit Resources

The Rapid Appraisal phase of the project was conducted between August and October, 2007. The activities covered the following:

2.4.1 Species Inventory

An inventory of aquatic vegetation, fish, mollusk and other invertebrates occurring within Lake Mainit and along Kalinawan River was conducted from August to November 2007 through a combination of strategies, namely, ocular survey and actual field collections, interviews with the fishers and survey of local markets. Voucher specimens of the different plant species, fish and invertebrates were collected during the survey. Species reportedly present in the area, but without voucher specimens, were also listed and noted. The resulting inventory were matched against earlier works (e.g. Pauly et al 1990) to determine if any changes occurred in the biodiversity and community structure of the aquatic organisms. The system of classification for fish species is the arrangement of families in phylogenetic order adopted from Greenwood *et al*..(1966) and FAO "Identification Sheets" (1975). The English names of the different species were taken from De Bruin *et al.* (1994) and Rainboth (1996) while the local names adopted the vernacular names for each species in the area.

An inventory of aquatic vegetation was made through an ocular survey around the lake. Broad-scale estimates of percent cover of aquatic vegetation were read on board the boat while cruising along the lake, and specific points were marked by a global positioning system (GPS). In areas with very low visibility, however, estimates of percent cover were not obtained. A spot check survey by random quadrat sampling was conducted in selected sites to obtain reliable estimates of vegetation cover and abundance of benthic invertebrates. At least five quadrats (measuring 0.5 x 0.5m) were randomly thrown in each sampling site at an interval distance of approximately 300m. Percent cover was estimated for submerged plants while the associated fauna (such as mollusks) were identified and counted in each quadrat. Samples of both aquatic plants and invertebrates were collected to confirm their identification.

2.4.2. Inventory of fishing crafts and gear

Actual count of fishing crafts was undertaken during the lakeshore survey around Lake Mainit and along Kalinawan River between August and October 2007. Various types of fishing gears were also counted and documented during the survey. Interviews of fishers encountered in the survey were conducted to obtain the specifications of the different gear types used in Lake Mainit fisheries. Photographs and measurements were taken for every gear. Other details of fishing gears and crafts that have been missed in the survey shall be investigated during the comprehensive phase of the project. Many of the boats that were fishing at that time of the lakeshore were unaccounted for but a complete count was obtained from focus group discussions conducted in the coastal barangays.

2.4.3 Catch Assessment of lake and riverine fisheries

Data gathering beginning August 2007 already formed part of the comprehensive fish stock assessment component of Year 1. Monitoring of fish catch and effort from different sampling sites around the lake was made monthly from August to October. The LRPs were assigned to record relevant information on standard data sheets for a minimum of 15-20 days each month. Some secondary fisheries data available from municipal agriculture and regional BFAR offices and LMDA were also gathered.

The following are the data gathered from each fisher per day of fishing:

a) Gear and boat type used and number
b) Kinds of fish caught
c) Volume or weight of fish (kg)
d) Number of hours fishing (including travel time)
e) 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 the amount of catch landed by various gear types. Maps showing the distribution of fishing gears and major fish and invertebrate resources were also generated.

2.4.4 Fish Stock Dynamics

Data on body length, weight, sexual maturity, and other biological parameters of major fishery resources were gathered each month. Detailed analysis is 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 middle 1990s by Galicia and Lopez (2000). Whenever possible, at least 100 individuals of each species were sampled from catches of *pukot* and *baling* in the lakeshore municipalities of Jabonga, Kitcharao and Mainit 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.

2.4.5 Participatory resource assessment

Participatory assessment of socio-economic condition of fishing communities in lakeshore municipalities bordering Lake Mainit was conducted from August to October 2007. In order to facilitate data gathering through focus group discussions (FGD), the neighboring barangays were clustered whenever possible. Information on fishing effort, estimates of fisher income, seasonality and historical trends of Lake Mainit fisheries was gathered through a series of focus group discussions (FGD) attended by fishermen, barangay officials, women and youth, and other sectors. Interviews with key informants, such as older fishers and community elders were also conducted to supplement FGD data. Important outputs generated from the FGD were structural information such as fishing effort (number of fishers, boats, gear types, etc) and estimates of catch rates by gear type by municipality, seasonal calendars, fisheries trendlines, resource maps and gear maps.

Chapter 3

RESULTS AND DISCUSSION

This report covers only the results of the Rapid Appraisal phase of the Resource Assessment component of the project. The findings presented here have been presented and validated in a workshop conducted on January 22, 2008 at the Fisheries Training Center in Mainit, Surigao del Norte. This report incorporates the corrections and suggestions made by the participants during the workshop.

3.1 Aquatic Biodiversity and Fisheries of Lake Mainit & Kalinawan River

3.1.1 Finfish Resources

A total of twenty seven (27) species of finfish were identified in Lake Mainit and Kalinawan River based on collected samples during the survey (Table 1). This number is lower compared to 37 species reported by Pauly et al. (1990). The 27 species identified in the present study belong to 8 orders, 20 families and 23 genera. Of these, 11 species are freshwater fishes and 16 species are noted to be marine fishes. The inclusion of 16 marine species in the list of species caught is not surprising because they 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.

Table 1. List of finfish species identified from catches in Lake Mainit and Kalinawan River between August to October, 2007.

Family	Scientific Name	Local Name	Common Name
Cyprinidae	*Cyprinus carpio*	*Carpa*	Common carp
Clariidae	*Clarias batrachus*	*Bangkok*	Walking catfish
	Clarias sp.	*Agok-ok*	Native catfish
Anguillidae	*Anguilla sp.*	*Kasili*	Eel
Phallostethidae	*Neostethus thessa*	*Bolinao*	Priapium fish
Hemiramphidae	*Hemiramphus sp.*	*Suloy-suloy*	Halfbeak
Channidae	*Channa striata*	*Haluan*	Chevron snakehead
Mugilidae	*Mugil cephalus*	*Banak*	Flathead mullet
	Valamugil cunnesius	*Gisao*	Long-arm mullet
Chandidae	*Ambassis sp.*	*Ibis*	Glassfish
Centropomidae	*Lates calcarifer*	*Laya*	Giant sea perch
Theraponidae	*Therapon jarbua*	*Bugaong*	Convex-lined therapon
	Therapon plumbeus	*Bilbigan*	Therapon
	Mesopristis cancellatus	*Pigok*	Cross-barred grunt
Leiognathidae	*Leiognathus equulus*	*Mawalay/sap-sap*	Common slipmouth
Lutjanidae	*Lutjanus argentimaculatus*	*Gingaw*	Red snapper
	Lutjanus sp.	*Aha-an*	Snapper
Sillaginidae	*Sillago sihama*	*Aso-os*	Common whiting
Carangidae	*Caranx sp1*	*Langub*	Trevally
	Caranx sp2	*Bogok*	Caranx
Mullidae	*Upeneus sp.*	*Bod-bod*	Goatfish
Scatophagidae	*Scatophagus argus*	*Kikilo*	Spotted scats
Cichlidae	*Oreochromis nilotica*	*Tilapia*	Nile tilapia
Siganidae	*Siganus sp.*	*Danggit*	Rabbitfish
Eleotridae	*Hypseleotris agilis*	*Bugwan*	Goby
Gobiidae	*Glossogobius giuris*	*Pijanga, Pijanga*	Goby
Anabantidae	*Anabas testudineus*	*Puyo*	Gourami
Other species reported at Lake Mainit in 1980 (Pauly et al (1990).			
Elopidae	*Elops hawaiiensis*	Bid-bid	Hawaiian ten pounder
	Megalops cyprinoids	Bulan-bulan	Tarpon
Anguillidae	*Anguilla mauritana*	Kasili	Eel
	Anguilla celehbesensi	Kasili	Eel
Chanidae	*Chanos chanos*	Bangus	Milkfish
Cyprinidae	*Puntius binotatus*	Pait	Spotted barb
	Rasbora philippina		Mindanao rasbora
Atherinidae	*Atherina sp.*	Bolinao	Silverside
Lutjanidae	*Lutjanus johni*	Agba-on	Golden snapper
Pomadasyidae	*Pomadasys hasta*	Ago-ot	Spotted grunt
Cichlidae	*Oreochromis mosambicus*	Tilapia	Mosambique tilapia
Mugilidae	*Mugil vaigiensis*	Panak	Mullet
Gobiidae	*Ophiocara aporos*	Borod	Snakehead gudgeon
Anabantidae	*Trichogaster ireri*	Gorami	Gourami
	Trichogaster pectoralis	Gorami	Snakeskin gourami
	Trichogaster trichopterus	Gorami	Three spot gourami
	Trichogaster sp.	Gorami	Gourami

Majority of these fishes are caught at mature stages except for *Therapon jarbua* (family Theraponidae) where many juveniles or young stages are caught by various gears. Young stages of *T. jarbua* and young adults of *Valamugil cunnesius* (Conlu 1982) are known to enter freshwater ecosystems. Ambassids, represented by *Ambassis sp.* 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. Two freshwater species, namely, *Oreochromis nilotica* (*tilapia*) and *Cyprinus carpio* (*carpa*) are known to be introduced fishes in the Lake. 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.

Figure 3 shows some of the most common species of finfish in Lake Mainit. The gobies *Glossogobius giuris* (locally called *pijanga*) 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 1995-96 study of Galicia and Lopez (2000). These gobies are considered by fishers in Lake Mainit as native or indigineous, although Pauly et al. (1990) reported that they may be marine species entering freshwater ecosystem of the lake. The eel *Anguilla sp.* (*kasili*) used to be caught in abundance, but recent reports suggest its abundance has diminished. A species of anchovy, locally called *bolinao*, was formerly identified as *Atherina sp.*, but recent taxonomic references identify it as *Neostethus thessa* (FishBase 2007).

3.1.2 Fishing Crafts

A total of 336 units of fishing crafts were recorded in spot surveys conducted in Lake Mainit and Kalinawan River between August and October 2007 (Table 2). Not all areas, however, have been covered in the present survey. About 67.3% of the fishing crafts are motorized and 32.7% are non-motorized, dug-out canoes with or without outriggers. Among the six municipalities around Lake Mainit, Kitcharao, Agusan del Norte has the highest number of boats accounting for at least 43.8%, followed by Jabonga, Agusan del Norte (27.4%) and Mainit, Surigao del Norte (23.0%). Kitcharao also has the highest number of motorized boats (43%), followed by Mainit (27.9%) and Jabonga (27.4%). Kitcharao (45.5%) and Jabonga (27.3%) also have the highest number of non-motorized boats around Lake Mainit.

All motorized boats are made from carved-out logs, with sidings made up of a plain sheet, and equipped with outriggers. They are powered by gasoline engines that range between 8-16 horsepower. Two typical designs for the non-motorized boats occur in the lake and river. The first one is a simple dugout with outriggers and the sidings made of plywood. These boats are used in fishing using simple handline, longline, gillnet and spear. The second type consists of boats carved out of logs, locally known as *banding*, and may or may not have outriggers. These are used by the fishers operating gears such as fish corral, crab trap, set gillnets and spear.

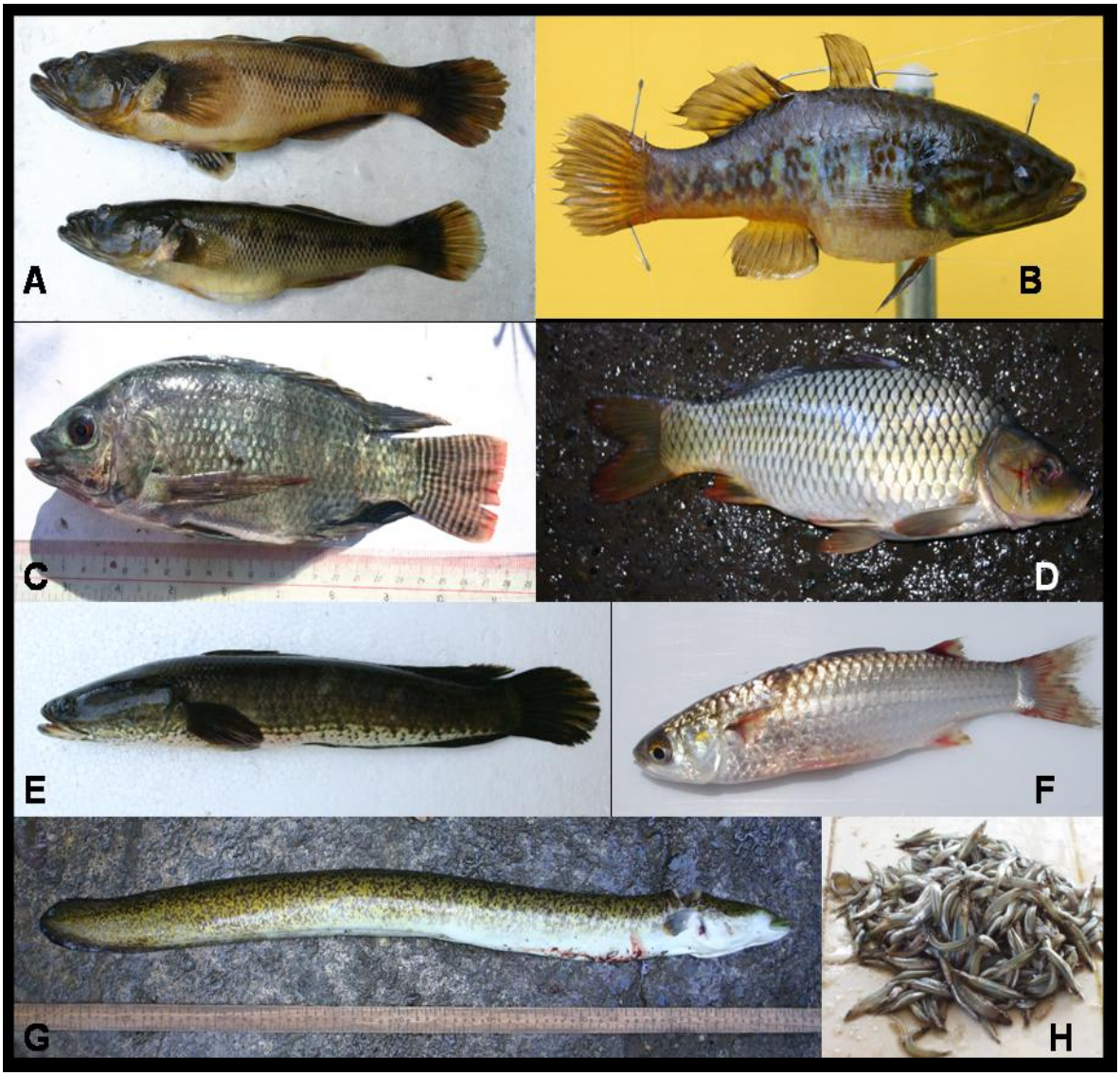

Figure 3. Common finfish species of commercial value in Lake Mainit. A) *Glossogobius giuris* B) *Hypseleotris agilis* C) O*reochromis nilotica* D) *Cyprinus carpio* E) *Channa striata* F) *Mugil vaigiensis* G) *Anguilla sp.* H) *Neostethus thessa.*

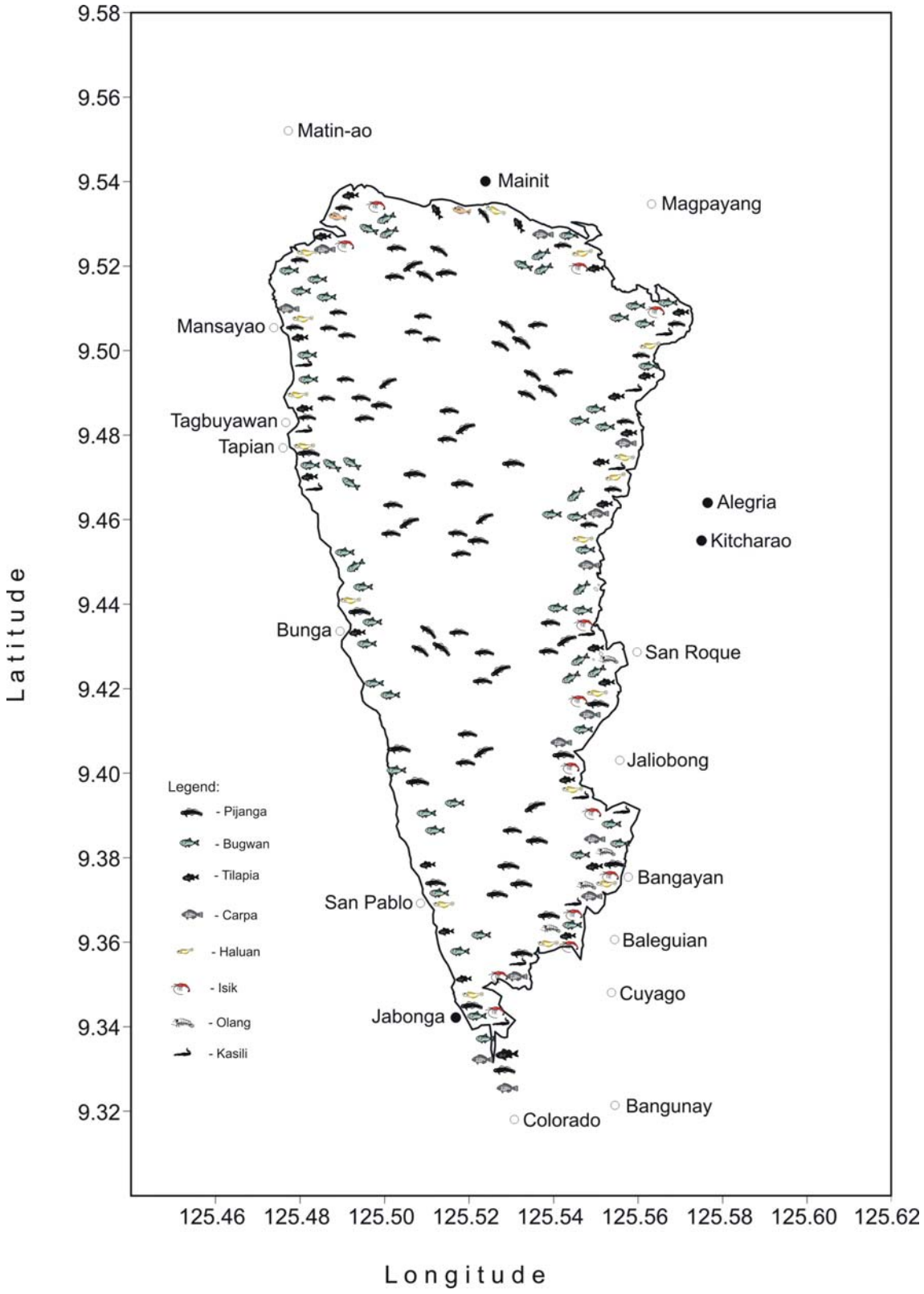

Figure 4. Resource map of Lake Mainit generated from spot check surveys and FGD.

Table 2. Number of fishing crafts by type and locality based on actual lakeshore and river surveys.

Locality	Motorized	Non-Motorized	Total
Mainit, Surigao del Norte	63	14	77
Alegria, Surigao del Norte	3	3	6
Kitcharao, Agusan del Norte	97	50	147
Jabonga, Agusan del Norte	62	30	92
Santiago, Agusan del Norte	0	9	9
Tubay, Agusan del Norte	1	4	5
Total	226	110	336

3.1.3 Fishing Gears

An inventory of fishing gears around Lake Mainit shows that there are 1,683 units belonging to 18 types involved in lake and river fisheries (Table 3). 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 traps, fish traps, gillnets and hook and line, are active, *i.e.* those that capture fish and invertebrates by active pursuit or gear movement.

Fish trap or "*bantak*" (Fig. 5), either made of plastic or bamboo, is the most dominant gear type used accounting for at least 74.6% in terms of number (Table 3). One fisher can use from 100-400 units for every fishing operation. Most of these traps are operated in Kitcharao and Jabonga. Other numerically important gears are the fish corral or "*bungsod*" (5.7%) and bamboo fish trap or "*timing*" (5.4%). Spear is commonly used by fishers in all stations, while set gillnet (often used on tilapia) is also common in all stations except Tubay. Other common gears are the set gillnet for *pijanga*, set gillnet for carp, and bottom-set longline. Figure 6 and Table 4 show the distribution of the major fishing gears used in Lake Mainit and Kalinawan River. Although banned in most municipalities, beach seine or "*baling"* is operated in the northern part of the lake, while "*boso"* or diving with compressor has been reported to still operate in the midsection of Lake Mainit.

Figure 5. Fish trap commonly used in the lake.

Modifications have been made on some gears that allow increased exploitation of fish resources in the lake and river. The need to increase catch has driven the development of species-specific fishing gears such as set gillnets where specific mesh sizes catch target species. For instance, a gillnet with 2cm mesh size catch *pijanga*; 3.2cm mesh catch *gourami*; *tilapia* is caught by 6cm mesh and *carpa* by a 15cm mesh. Fishing using a cast net or "*laya*" has also been modified. Instead of the usual daytime operation which involves hand-throwing by a fisher to cover a school of fish, it is now operated during night time, provided with light to attract specifically goby. Bamboo booms are installed in the boat to lift and haul the bigger-sized net. Prior to hauling, the zipper is pulled to close the sinker line of the net, thus trapping fish inside. Still another modification is on the operation of the drag seine or "*baling*", where an installed wooden winch in the boat help to drag the net ashore instead of relying on crew members to manually haul the net.

3.1.4 Landed Fish Catch

Monitoring of fishing effort and landed fish catch was made in six municipalities around Lake Mainit every month by the local enumerators (Table 5). A total of 27 major and minor landing areas were covered by the enumerators, which comprise about 84% of the 32 fish landing areas around Lake Mainit based on records from the municipal profiles. Among the fish landing areas surveyed from August to October, 2007, the municipality of Tubay recorded the most diverse fish catch with 18 species caught by various gears. Most of the species reported, however, are marine species caught near the mouth of Kalinawan River draining into Butuan Bay. Landed catch in Kitcharao comprise 16 species, while the lowest number of six species comprise the landed catch in Jabonga.

Based on recorded catches, the most abundantly caught fish in the six municipalities around Lake Mainit is the goby, locally called *pijanga*, accounting for 44.15% of the total landed catch between August and October (Table 5; Fig. 7). 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.

Results of monitoring fish catch also show that Lake Mainit and Kalinawan River have distinct fishery resource profiles (Fig. 8). *Pijanga* contributes almost half (47%) of the total fish catch from the lake followed by the *tilapia* (12%) and *luyab* (11%). In Kalinawan river, *tilapia* (39%) dominates the fish catch followed by *langub* (34%) and *carpa* (7%). The fishing gear with the largest contribution to fish production in all municipalities is the set gillnet (*pukot*) which accounted for 39.4% of landed catch from the lake and 41% from Kalinawan River (Fig. 9). *Baling* (15%) and *laya* (14%) also landed larger catches compared to other fishing gears (Table 6). The encircling gillnet called *surit* landed a substantial catch (34%) in Kalinawan River, and is exclusively operated at the river mouth of Tubay.

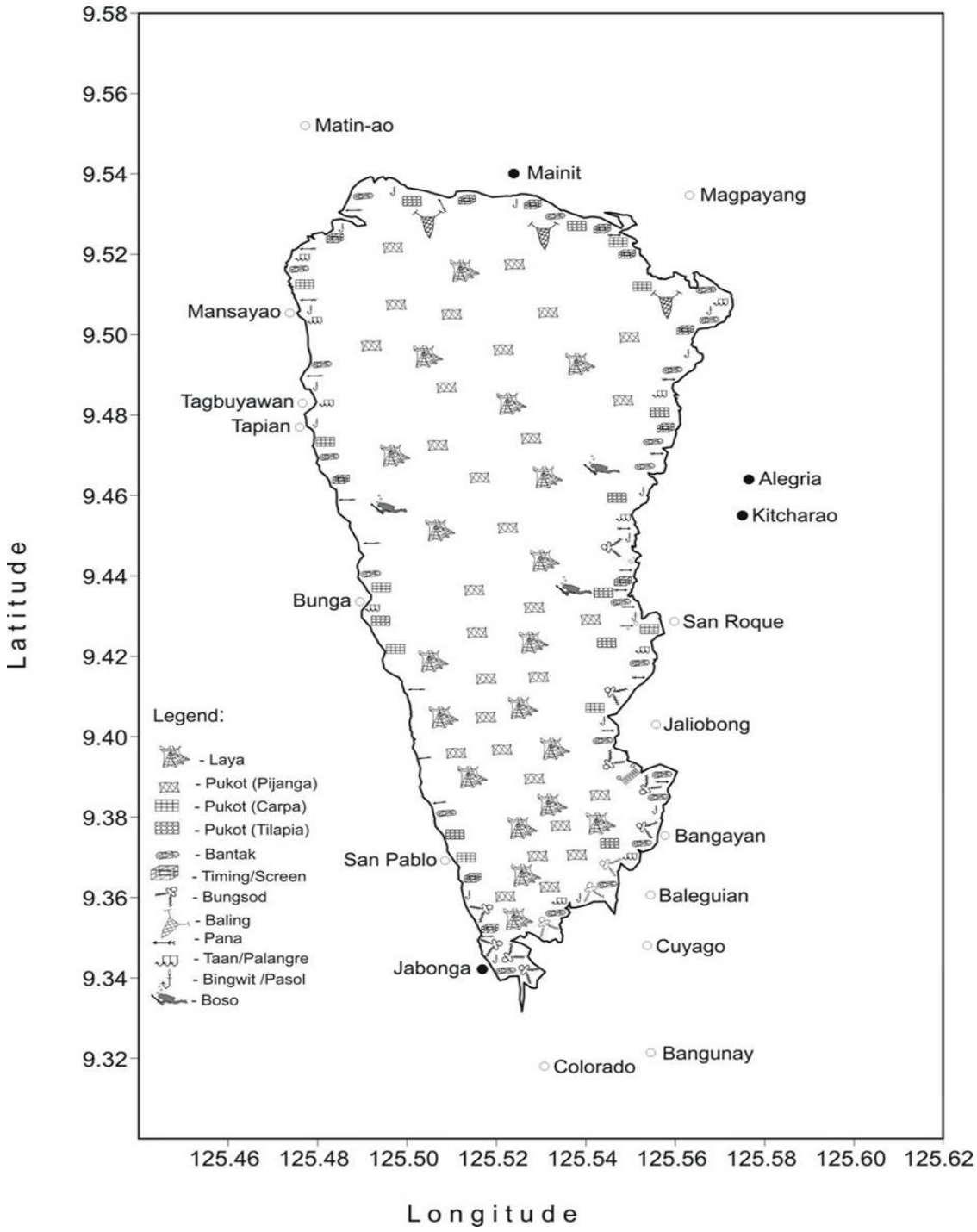

Figure 6. Map of fishing gear distribution in Lake Mainit.

Table 3. English, local names and numbers of fishing gears used in Lake Mainit based on ocular survey and personal interview conducted last August to October 2007.

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English Names	Local Names	Number of Units	Relative Abundance (%)
Seines			
Beach seine	*Baling*	8	0.48
Impounding Nets			
Barrier net	*Panira/lambat*	1	0.06
Fish corral	*Bungsod*	96	5.70
Mobile Impounding Nets			
Cast net	*Laya, paapong*	56	3.33
Gill Nets			
Set gill net			
2 cm mesh (goby)	*Pukot pang-pijanga*	52	3.09
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	1.25
Drift gill net	*Paanod*	4	0.24
Traps/Pots			
Crab trap	*Bantak*	1255	74.57
Fish trap	*Timing*	90	5.35
Modified fish trap	*palaksuhan*	2	
Hook and Line			
Simple hook & line	*Bingwit/Pasol*	31	1.84
Multiple handline	*Buldos, bundak*	4	0.24
Bottom set longline	*Taan, palangre*	21	1.25
Hand Instruments			
Spear	*Pana*	28	1.66
Harpoon	*Sapang*	1	0.06
Scoop net	*Sarap*	3	0.18
Total		**1683**	**100.00**

Table 4. Distribution of fishing gears among the municipalities in Lake Mainit and Kalinawan river.

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

Table 5. Profile of landed catch (kg) by species from August to October, 2007 as recorded by the local enumerators.

Comon Name	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	Total	%
Pijanga	3457.3	300.4	12326.9	7618.8			23703.3	44.16
Tilapia	985.5	1402.9	3174.9	377.0	1423.2	11.7	7375.0	13.74
Luyab	3763.6		1697.4				5461.0	10.17
Carpa	385.2	688.1	2705.2	253.8	222.1	53.5	4307.9	8.03
Isik			3484.0				3484.0	6.49
Bugwan	645.3	162.7	866.5	195.5			1870.0	3.48
Uwang		15.1	1710.9				1726.0	3.22
Haluan	1005.8	14.0	241.0	133.0	158.9		1552.7	2.89
Langub					8.0	1241.5	1249.5	2.33
Saguyon			909.4				909.4	1.69
Bolinao	8.3		699.6				707.9	1.32
Kasili	6.5		274.1		18.7	5.1	304.4	0.57
Ige	13.5		192.6				206.1	0.38
Buras						192.0	192.0	0.36
Bangkok			81.0		26.0		107.0	0.20
Pantat	8.0		1.5		81.5		91.0	0.17
Bungusan	72.5						72.5	0.14
Kikilo					1.3	57.5	58.8	0.11
Bugaong						53.5	53.5	0.10
Gisaw					3.0	33.9	36.9	0.07
suso			32.8				32.8	0.06
Banak	12.0	5.3			7.8		25.0	0.05
Bilibigan						24.7	24.7	0.05
Agok-ok			22.5				22.5	0.04
Gurame					19.3		19.3	0.04
Gingaw			2.8		7.0	8.8	18.6	0.03
Catfish	5.0	8.0					13.0	0.02
Pigok						12.0	12.0	0.02
Ahaan						11.1	11.1	0.02
Asohos						9.1	9.1	0.02
Laya			6.6				6.6	0.01
Ibis	0.2				0.5	3.7	4.4	0.01
Sapsap						3.0	3.0	0.01
Potpot						2.3	2.3	0.00
Bogok						0.7	0.7	0.00
Total	**10368.5**	**2596.3**	**28429.7**	**8578.1**	**1977.2**	**1724.0**	**53673.7**	**100.00**

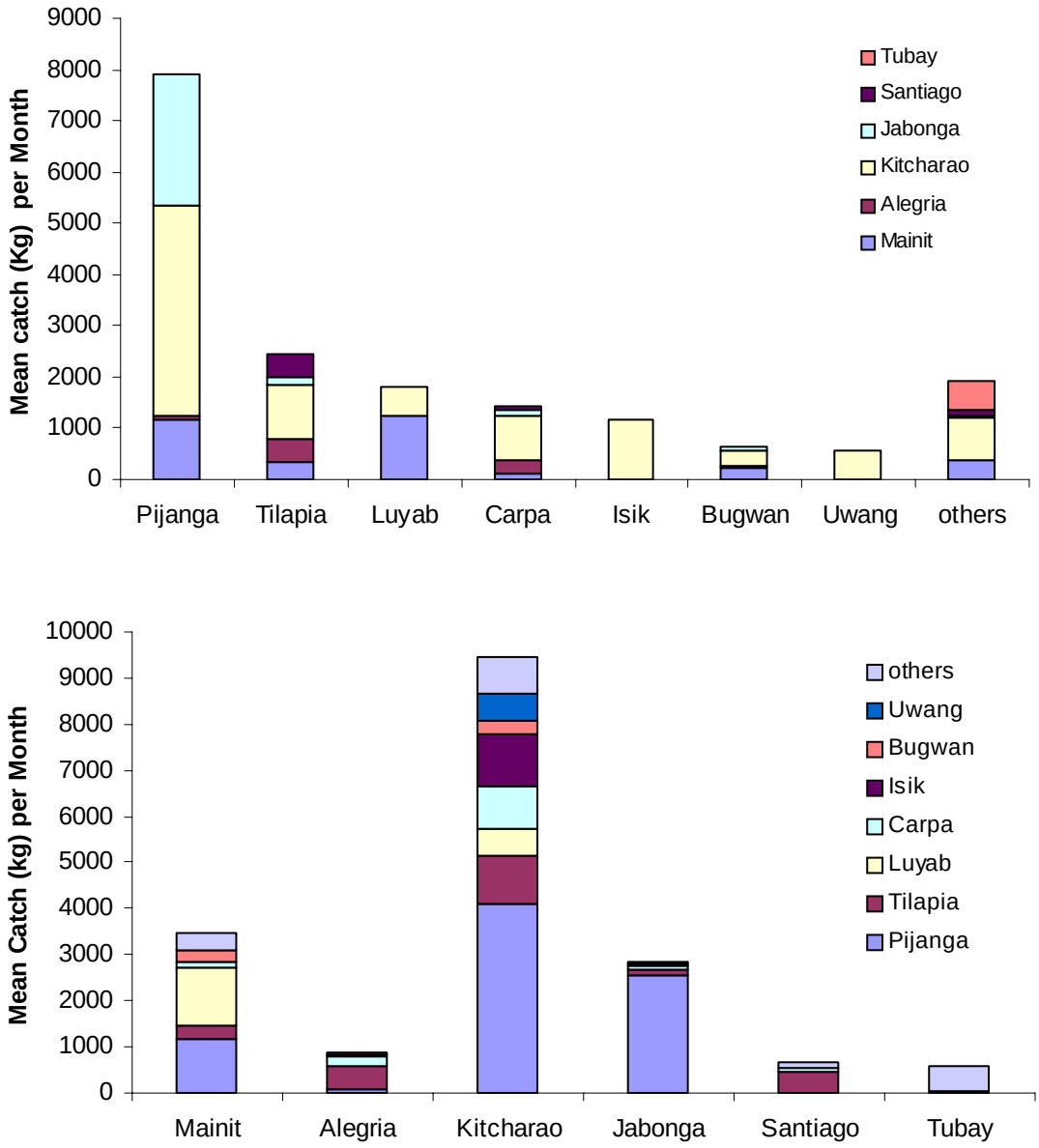


Figure 7. Comparison of average monthly catch by species (top) and by municipality (bottom) around lake Mainit and along Kalinawan river.

Kitcharao recorded the largest catch among the six municipalities monitored from August to October 2007, accounting for at least 53% of the total catch largely comprised by *pijanga*. Figure 10 shows that the total fishing effort (number of fishers) was highest in Kitcharao during the period and account for the large landed catch. Mainit (19.3%) and Jabonga (15.9%) followed in rank of landed fish catch, while the municipalities of Alegria, Santiago and Tubay recorded small volumes, their combined catches accounting for only 11.7% of the total landed catch (Fig. 10).

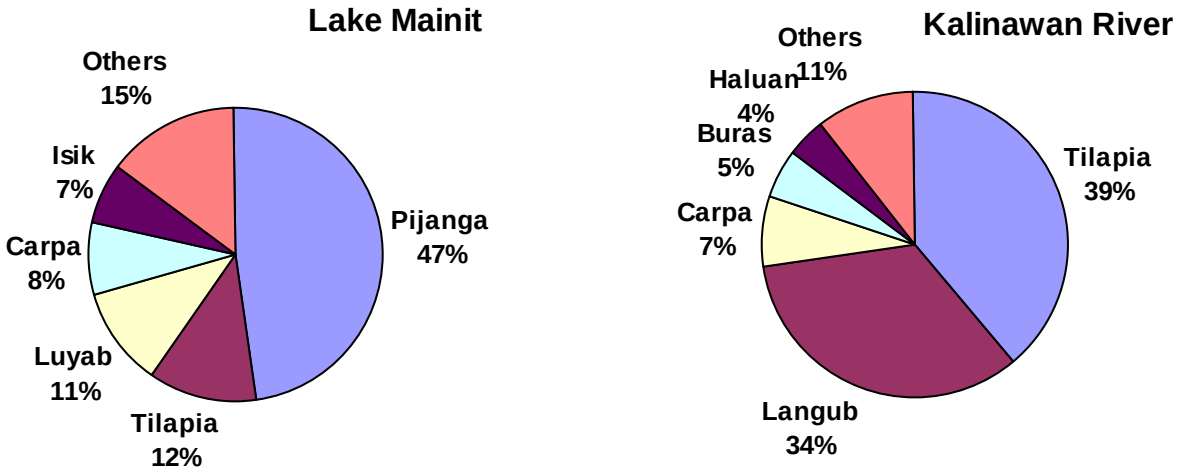


Figure 8. Relative composition of major fishes caught by all gears in Lake Mainit and along Kalinawan river.

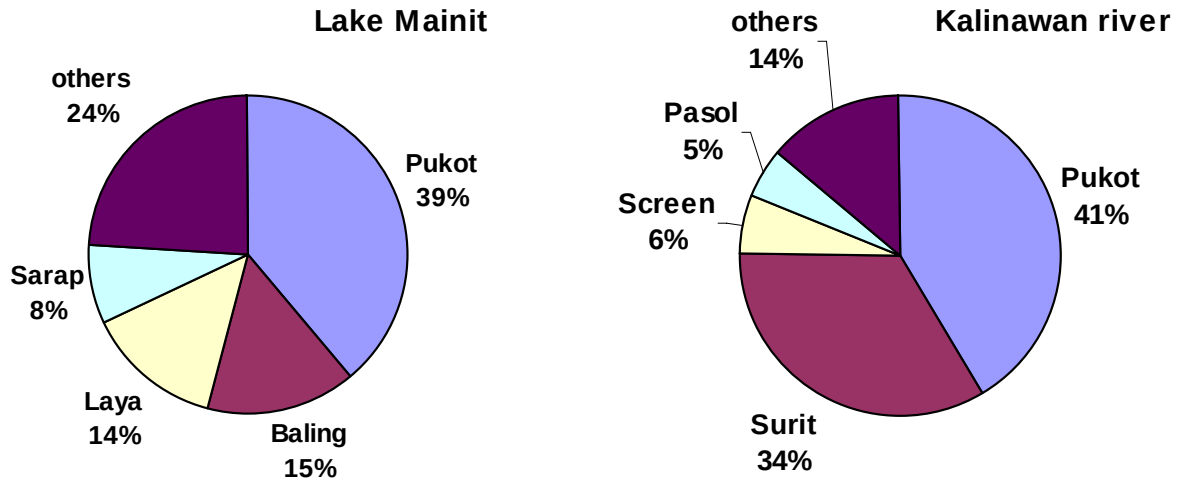
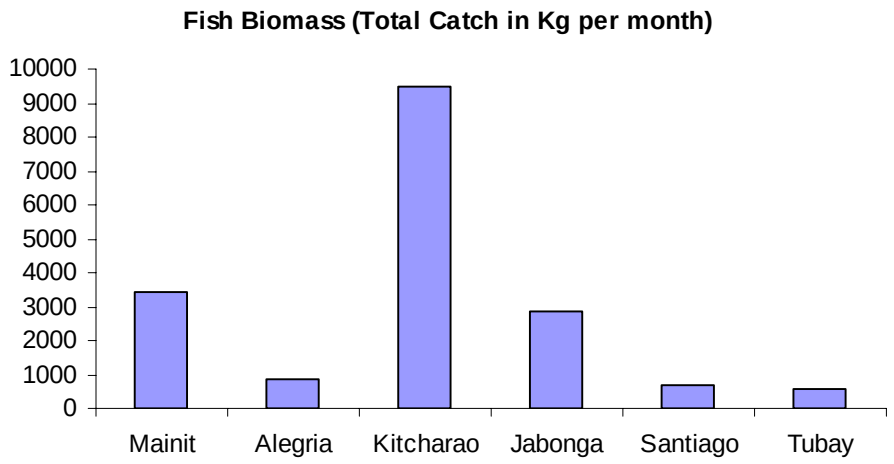


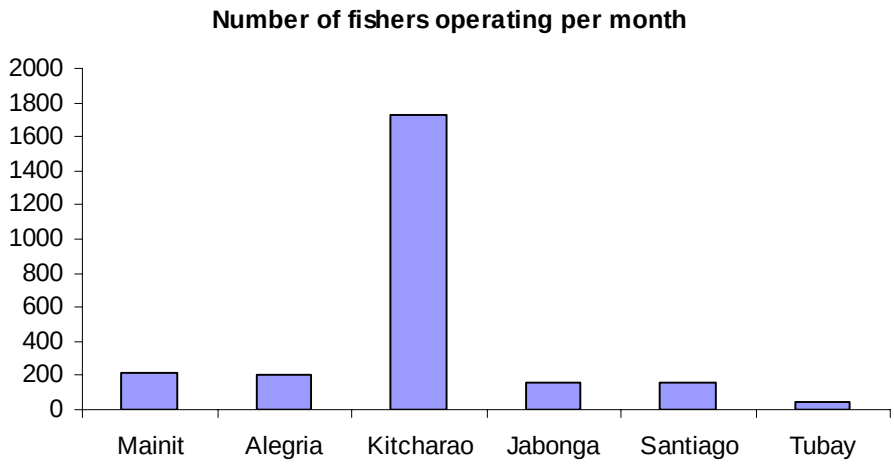
Figure 9. Relative contribution of major gear types in Lake Mainit and Kalinawan river fisheries.

Table 6. Total recorded catch (kg) by gear type from August to October, 2007.

Fishing Gear	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	Total	Percent
Anod						3.8	3.8	<0.1
Baling	7,393.8						7,393.8	13.8
Bantak		15.1	3,031.0				2,515.5	4.7
Bingwit		133.2	120.0				253.2	0.5
Bobo		3.0					3.0	<0.1
Buldos	3.5						3.5	<0.1
Bungsod	13.0		198.2		10.5		221.7	0.4
Buso			3,048.2				3,048.2	5.7
Lambat					132.0		132.0	0.2
Laya	25.0		2,494.2	4,472.3			6,991.5	13.0
Lukay	13.5						13.5	<0.1
Palaksuhan					16.0		16.0	<0.1
Palangre				43.0		4.3	43.0	0.1
Pana		121.2	3,142.5		21.4	77.0	3,362.0	6.3
Pana/Bigjo			8.5				8.5	<0.1
Pante taan-lagod						3.2	3.2	<0.1
Pante-anod						130.0	130.0	0.2
Pasol						182.8	182.8	0.3
Pontak			2.0				2.0	<0.1
Pukot	1,817.5	2,282.1	11,488.4	3,862.8	1,531.7		20,982.5	39.1
Pukot/Laya			26.4				26.4	<0.1
Pukot/Sarap			27.9				27.9	0.1
Sapang			58.7				58.7	0.1
Sapyao			556.4				556.4	1.0
Sarap			4,017.8				4,017.8	7.5
Screen	54.0			69.0	231.5		354.5	0.7
Sin-sin						30.0	30.0	0.1
Surit						1,241.5	1,241.5	2.3
Taan	1,048.3		118.1	131.0	34.1	51.0	1,350.9	2.5
Timing		41.7					41.7	0.1
Total	**10,368.5**	**2,596.3**	**28,413.1**	**8,578.1**	**1,977.2**	**1,724.0**	**53,657.1**	100.0

Despite its large landed catch, average catch per unit effort (CPUE) or fisher is smaller in Kitcharao (Fig. 10) owing to higher fishing effort, and highest in Jabonga, Mainit and Tubay. Estimates of average CPUE of all fishing gears operating in the area is listed in Table 7. Average CPUE ranged from as low as 1.26 (*timing*) to 620.75 kg (*surit*) per fishing operation. The extremely high CPUE value recorded for *surit*, which is a modified encircling gillnet operating around the river mouth, indicates that this gear is a highly efficient one. This gear, however, was reported only twice during the three-month survey period and thus precludes drawing conclusions on its overall efficiency the rest of the year. Estimates of CPUE for *baling*, another efficient gear, are quite low (15.87 kg) and may represent the lower limit of production of this gear. Data from focus group discussion (*see Socio-economics Profile in this report*) would indicate that this gear can land much larger catches.





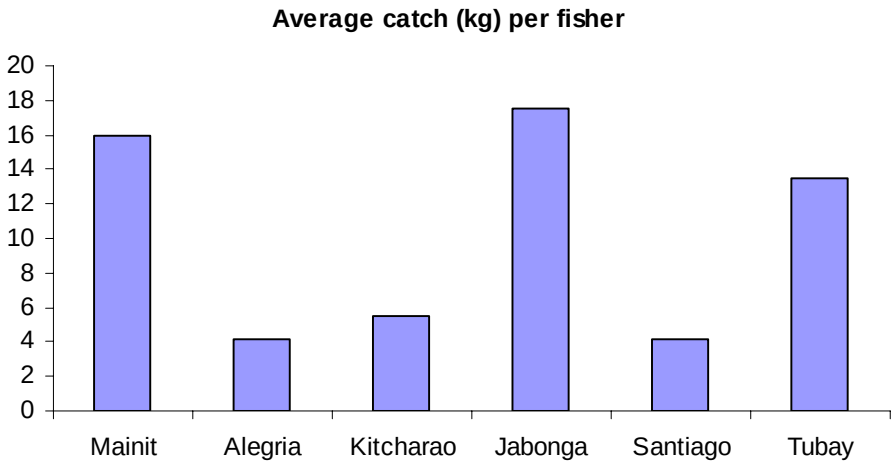


Figure 10. Estimates of average landed catch (kg) per month, fishing effort and fish catch per fisher in Lake Mainit and along Kalinawan river (Santiago and Tubay) based on recorded catch data from August to October, 2007.

Table 7. Average catch per unit effort (CPUE) in kilograms by gear type from August to October, 2007 as recorded by the local research partners.

Fishing Gear	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	Average	Percent
Anod						1.27	1.27	0.2
Baling	15.87						15.87	1.9
Bantak		0.43	2.20				2.15	0.3
Bingwit		1.40	2.50				1.77	0.2
Bobo		1.50					1.50	0.2
Buldos	3.50						3.50	0.4
Bungsod	4.33		4.13		3.50		4.10	0.5
Buso			6.99				6.99	0.8
Lambat					12.00		12.00	1.4
Laya	12.50		6.25	19.03			10.99	1.3
Lukay	13.50						13.50	1.6
Palaksuhan					16.00		16.00	1.9
Palangre				10.75			10.75	1.3
Pana		2.53	2.85		5.35	4.05	2.86	0.3
Pana/Bigjo			2.83				2.83	0.3
Pante taan-lagod						3.20	3.20	0.4
Pante-anod						2.03	2.03	0.2
Paranghe						4.30	4.30	0.5
Pasol						8.31	8.31	1.0
Pukot	18.18	5.65	7.81	16.79	4.56		8.26	1.0
Pukot/Laya			3.30				3.30	0.4
Pukot/Sarap			9.30				9.30	1.1
Sapang			5.34				5.34	0.6
Sapyao			14.64				14.64	1.8
Sarap			27.90				27.90	3.3
Screen	7.71			9.86	2.29		3.08	0.4
Sin-sin						7.50	7.50	0.9
Surit						620.75	620.75	74.4
Taan	15.19		1.84	10.08	1.55	19.50	7.99	1.0
Timing		1.26					1.26	0.2
Average	**15.98**	**4.21**	**5.49**	**17.54**	**4.14**	**13.47**	**7.12**	
Total	**90.78**	**12.77**	**98.88**	**66.51**	**45.25**	**670.91**	**834.25**	**100.0**

3.1.5 Comparison with past fisheries scenario

Based on the data from August to October, 2007, the total catch from 27 major and minor landing areas representing the six municipalities around Lake Mainit and along Kalinawan river is estimated at 53.7 tons. The total number of landing areas in Lake Manit based on municipal records is 31. Extrapolating our estimates based on the 27 monitored landing areas yields an estimated 61.6 t of fish caught for a three month period. A first estimate of the annual fish yield 246.4 tons, assuming that present catches are average over the year. Our present value is only less than 2% of the total annual catch of 15,108 t in 1980-81 reported by Pauly et al. (1990).

3.1.6 Aquatic plants

A total of fourteen (14) species of aquatic plants classified into six submerged and eight floating plants were identified in Lake Mainit (Table 8; Fig. 11). Voucher specimens were collected and preliminary identification was made based on Winterton & Shcer (2007) and a poster published by PCAMRD. All submerged plants form extensive underwater meadows with the exception of *Ottelia alismoides*. A common aquatic plant is *Vallisneria* sp., locally called *lusay* and is akin to the marine eelgrass, is found growing along clear shoreline waters together with *Hydrilla verticillata, Najas graminea* and *Ceratophyllum* sp. *Hydrilla,* known locally as *dugman,* tends to grow quite extensively as monospecific mats with an average percent cover of 86%, particularly in the municipality of Jabonga along the mouth of Kalinawan river and along Alegria toward 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. This information is significant in lakes where the water is quite stagnant, unlike rivers with relatively strong current. Since *dugman* is a very fast growing plant it can compete for space with other plant species in the lake.

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. 12). 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.

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, which become fish shelter and fishing areas for the local communities. During the flood season or *"guob"*, the river may be impassable due to the build up of dense growth of the plant. The piling up of this plant in the shallow parts of the river can cause back flow, 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. Another unidentified floating plant characterized by its succulent leaves and star-shaped spongy floaters (Fig. 11) was also noted. Downstream Kalinawan River is characterized by sandy to muddy areas. 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 comprise of at least six species which were identified based on their local names, namely: *Tigbao, Ayaganay, Dawpang, Moti-moti, Tamok,* and *Makahiya.*

Table 8. Preliminary list of aquatic plants occurring in Lake Mainit and its outlet Kalinawan River.

	Local Name	Common Name
Submerged Plants		
Vallisneria sp.1	*Lusay*	Eel grass, tape grass
Vallisneria sp.2(rosette type)	*Lusay*	Eel grass
Hydrilla verticillata	*Dugman*	Hydrilla
Najas graminea	none	Water nymph
Ceratophyllum sp.	none	Coontail, hornwoot
Ottelia alismoides	none	Duck lettuce
Floating & Emergent plants		
Echornia crassipes	Water lilies	Water hyacinth
Pistia stratiotes	none	Water lettuce
Nelumbo nucifera	*Paguse*	Sacred lotus, lotus lilly
Azolla sp.	none	Pond fern
Neptunia sp. (*oleracea*?)	*Kupo-kupo, hibi-hibi*	Small leaf sensitive plant, Neptunia
Ipomea sp. (*aquatica*?)	*Tangkong*	Kangkong, water spinach,
Unidentified 1	Red lotus	Red lotus
Unidentified 2 (see Fig. 11)	No local name	-

Aquatic Invertebrates

At least ten major groups of aquatic invertebrates are found around Lake Mainit which are composed of bivalves, gastropods, crabs, and shrimps (Table 9). The most common bivalve is of the genus *Corbicula* (Family Corbiculidae) locally called *kabibi* which probably composed 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 Tubay River. Also found was the Taiwan shell, *Anodontia* (Cristaria) *woodiana* (Family Unionidae), an introduced species occurring along San Pablo, San Roque, Mainit, Jabongga, and La Paz.

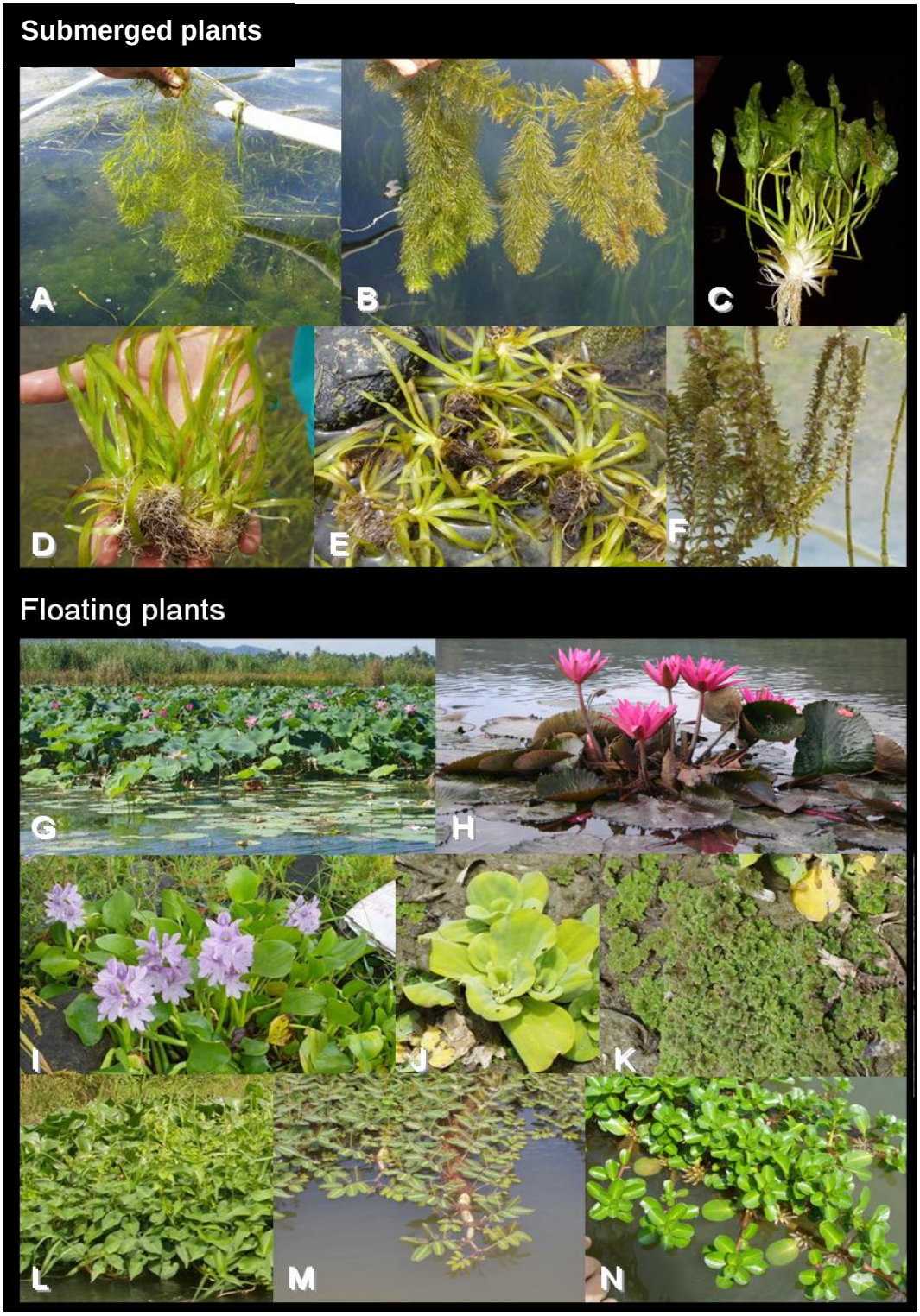


Figure 11. Aquatic plants of Lake Mainit and Kalinawan river: A) water nymph B) coontail or hornwoot C) duck lettuce D) eel grass or tape grass E) eel grass rosette type F) Hydrilla G) lotus lily H) red lotus I) water hyacinth J) water lettuce K) pond fern L) kangkong or water spinach M) Neptunia or small leaf sensitive plant N) unidentified.

Gastropod snails are the most abundant mollusks in the lake and river, such as *Igi* (*Vivipara angularis*), the Golden Apple Snail or *Kuhol* (*Pomacea canaliculata*), a native snail known locally as *Punggok* (probably *Ampullaria luzonica*), and two other species similar to *Igi* (local names are *Hapyuso*n and *Kuyambuway*). Also found was *Melania* sp. known locally as *Suso*. The Golden Apple snail or *Kuhol*, an introduced species, could be found along Mansayao, Mainit, Kitcharao, San Pablo, San Roque, and Jabonga while the native *Punggok* could be found in Mainit, San Pablo, San Roque, Jabonga, and La Paz. The *Igi* snail is abundant in Bunga at a density as high as 213 individual per m^2, and could also be found in Tagbuyawan, Jaliobong, Mainit, San Pablo, San Roque and Jabonga (Fig. 13). This snail is collected in large quantities, allegedly sold as feed in fishponds in surrounding areas. *Hapyuson* could be found in Mainit, San Pablo, San Roque, and Jabonga while *Kuyambuway* occurs in San Pablo and Jabonga.

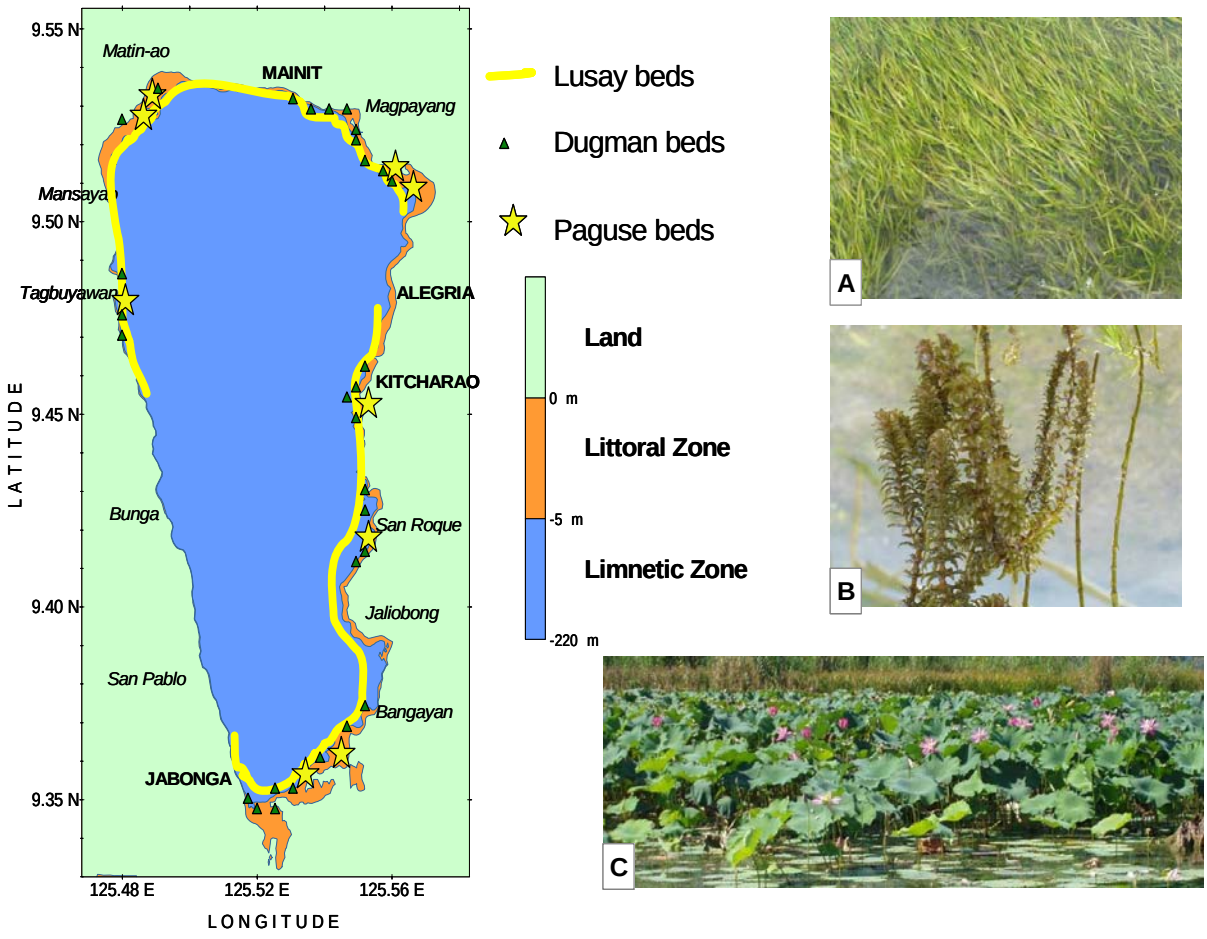


Figure 12. Distribution of major aquatic plants A) *Vallisneria* sp or *lusay*. B) *Hydrilla verticillata* or *dugman* C) *Nelumbu nucifera* or *paguse* in Lake Mainit.

Table 9. Preliminary list of aquatic invertebrates of Lake Mainit.

Scientific Name	Description	Local Name
Corbicula sp.	Bivalve (probably two or more species)	Kabibi
Anodontia (Cristaria) *woodiana*	Bivalve (introduced species)	Taiwan Shell
Melania sp.	Univalve	Suso
Vivipara angularis	Univalve	Igi
Pomacea canaliculata	Univalve (introduced species) Golden Apple Snail	Kuhol
Ampullaria luzonica ??	Univalve (native kuhol)	Punggok
Unidentified	Univalve (similar to Igi)	Hapyuson or Uwak uwak
Unidentified	Univalve (similar to Igi)	Kuyambuway
Unidentified	Freshwater crabs	Kagang
Macrobrachium sp.	Freshwater prawn	Ulang
Unidentified	Freshwater shrimps	Isik

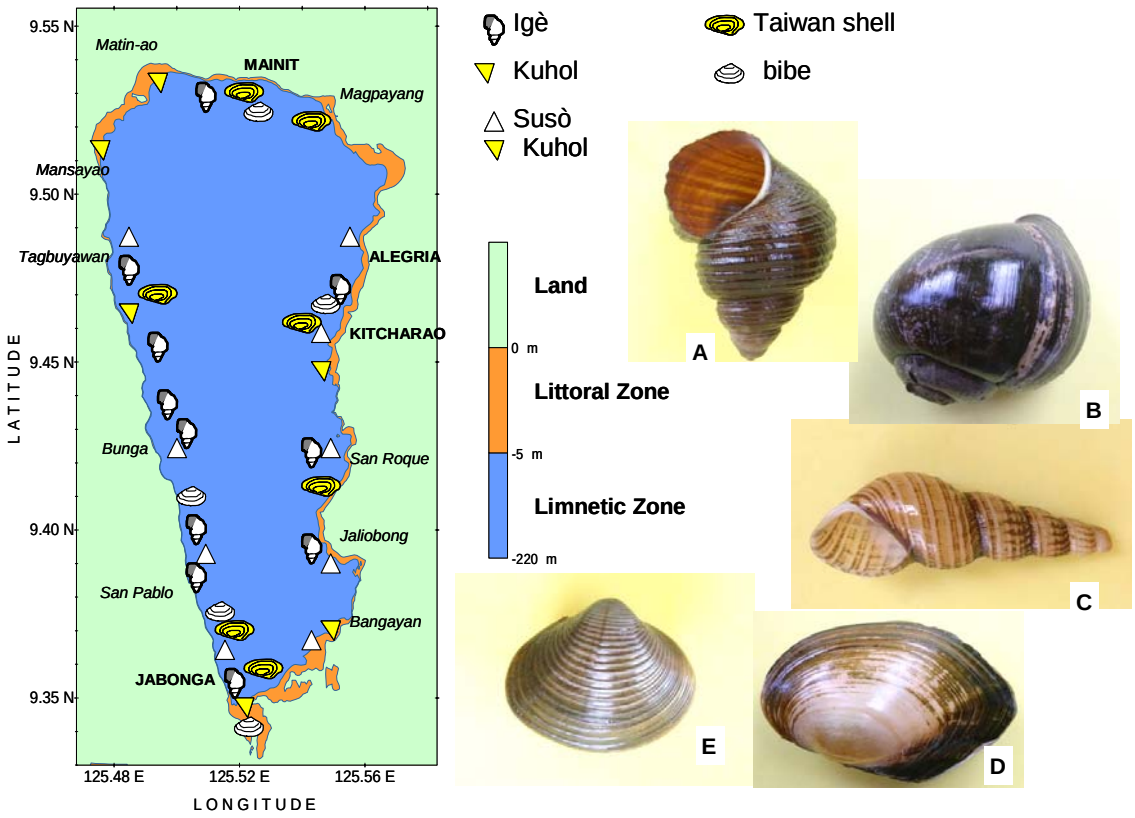


Figure 13. Distribution of mollusks in Lake Mainit. A. *Viviparia angularis* (*ige*) B. *Pomacea canaliculata (kuhol)* C. *Melania* sp (*suso*). D. *Anodontia woodiana* (Taiwan shell) and E. *Corbicula* sp. (*bibe*).

Three crustaceans were found along Lake Mainit: one crab and two species of shrimps (Table 10). The freshwater crab is locally known as Kagang while the two shrimps are the Isik and Ulang. *Isik* are tiny shrimp while Ulang is bigger and probably of the genus *Macrobrachium*.

Table 10. Distribution of the aquatic invertebrates in Lake Mainit as observed during the survey conducted last September to October, 2007.

Location	Kabibi	Taiwan Shell	Suso	Igi	Kuhol	Punggok	Hapyu-son	Kuyam-buway	Kagang	Ulang
Bunga			100.0	213.3					x	
Tagbuyawan	x		14.7	57.3						
Mansayao	x		x		x					
Jaliobong				98.0						
Mainit	x	x	64.0	34.7	x	x	x		x	x
Kitcharao	x	x	x	x	x					
San Pablo	x	x	392.5	133.5	x	x	x	x		x
San Roque	x	x	x	16.0	x	x	x		x	x
Jabonga	x	x	x	77.3		x	x	x	x	x
Colorado Bridge		x				x				x
Habungon	x									
La Paz	x	x				x				x

3.2 Population Biology and Dynamics of Fishes in Lake Mainit

This component deals with the biology and population dynamics of important species of fish in the lake. The gobies *Glossogobius giuris* (*Pijanga*) and *Hypseleotris agilis* (*Bugwan*) are among the most abundant species of fish found in the lake that support a major and traditional fishery. Their abundance in recent years, however, had been threatened by overfishing and their recruitment may have been reduced by the continued use of fine-meshed nets and other illegal fishing gears. The generated data in this research update the information and can guide efforts in conservation and management of these resources.

3.2.1 Types of Fishes of Lake Mainit

The fishes in Lake Mainit can be classified into four different groups, namely, lake fishes, temporary lake fishes, riverine fishes, and catadromous fishes. The lake fishes are confined in the lake and these include commercially important fishes such as catfish,

mudfish, tilapia, common carp, and the eleotrid and white goby. Small lake fishes that are of low commercial importance include the climbing perch, spotted barb, priapium fish and the freshwater halfbeak.

The temporary lake fishes are euryhaline fishes (wide tolerance to salinity range) that migrate to Lake Mainit during *guob* or periods of flooding and inundation (November – January). These include snappers, mullets, milkfish, scats, tarpons, tenpounders and trevallies. These temporary lake fishes are caught mostly by traps along the Kalinawan River. The Kalinawan River is a migration pathway for fishes in Lake Mainit. The riverine fishes are those that occur in the 28 watershed rivers, Kalinawan River, and the seasonal Pagusi Lake along the Kalinawan River. Riverine fishes caught in Kalinawan River include carps, tilapia, silversides, tapiroid grunters, and fishes still to be identified but locally known as *Anga*, *Bunog, Durod* and *Ibis*. 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 but migrate to marine waters during spawning.

In Lake Mainit, the most abundant and economically important species are the gobies, locally known as *Pijanga* and *Bugwan* and the exotic Nile Tilapia (Galicia and Lopez, 2000). In this study, the gobies represented by the white goby (*Glossogobius giuris*) and the eleotrid (*Hypseleotris agilis*) were investigated.

3.2.2 Biology and dynamics of major fish stocks

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 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.

The common goby *Hypseleotris agilis* Herre

The eleotrid locally known as *bugwan* (*Hypseleotris agilis* Herre) is a native fish species of Lake Mainit (Fig. 14). 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 6.65 m and corresponding 1% Photosynthetically Active Radiation (PAR) depth of 33.25 m. This eleotrid can still be caught at these depths.

Fig. 14. The eleotrid *Hypseleotris agilis* Herre.

H. agilis exhibits secondary sexual dimorphism (male and female individuals have distinct morphology) and dichromatism (two color patterns). Dimorphic characters such as the genital papilla and coloration are distinct between the male and the female *H. agilis*. The genital papilla in the male is narrow and tapered to the end while the female has broad, lunate and bilobed papilla (Escudero and Demoral, 1983). Coloration in *H. agilis* differs between the male, having blue to dark blue color, and female fish having pale to light yellow body coloration.

H. agilis caught in Lake Mainit by beach seine (*baling*) between August and November ranged in size between 55 – 132 mm although size ranges vary from month to month (Table 11). August catches of *H. agilis* ranged between 68 - 132 mm with mode observed at 81 – 90 mm size class and dominated by female fish (Fig. 15). The size range of *bugwan* observed in the present assessment is smaller than the size range of 40-185mm studied by Galicia and Lopez (2000).

Table 11. Monthly catch of *H. agilis* from Lake Mainit showing size ranges and corresponding gonadal stages.

SEX	GONADAL STAGE	TOTAL LENGTH (mm)			
		August	September	October	November
Female	Immature			60 -106	
	Maturing	68 - 107	96 - 113	58 - 114	105 - 129
	Mature	83 - 117	98 - 113	97 -111	104 - 130
	Gravid	82 - 122	103 - 113	100 - 110	107 - 131
	Spent	75 - 120	95 - 113	86 - 111	107 - 128
Male	Immature			55	-
	Maturing	71 - 124	96 - 121	57 - 104	102 - 202
	Mature	81 - 115	100 - 107	75 - 118	99 - 123
	Gravid	98		91 - 113	110 - 120
	Spent	100 - 132		111	102 - 120

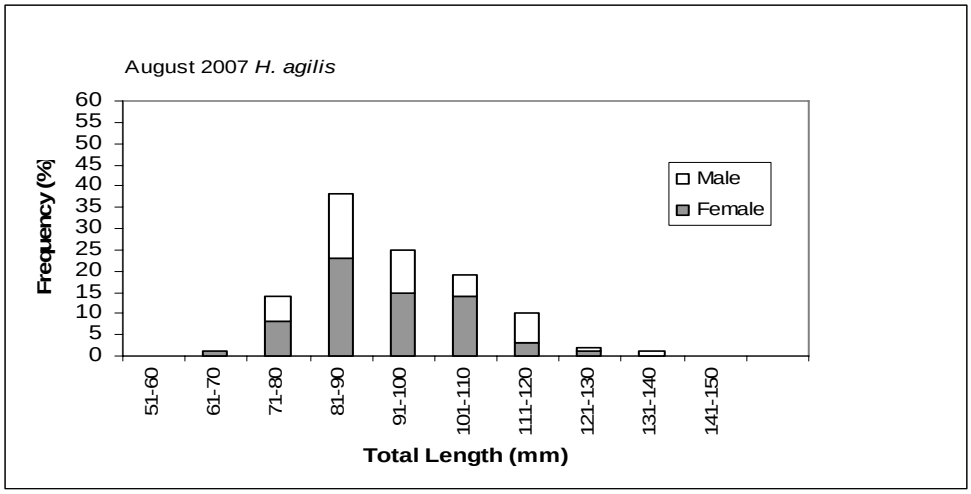


Figure 15. Length frequency and sex distribution of *H. agilis* caught by beach seine from Lake Mainit in August 2007.

The August 2007 catches of *H. agilis* from Lake Mainit show a high frequency of maturing individuals with the males dominating the catches. Mature individuals are classified as those maturing, mature and gravid gonadal stages while immature individuals have gonadal stages of immature and spent or resting stage. As the gonadal stage progresses, the males diminish in abundance while the proportion of the female increases. This result suggests that males exhibit higher mortalities than female fish (Fig. 16).

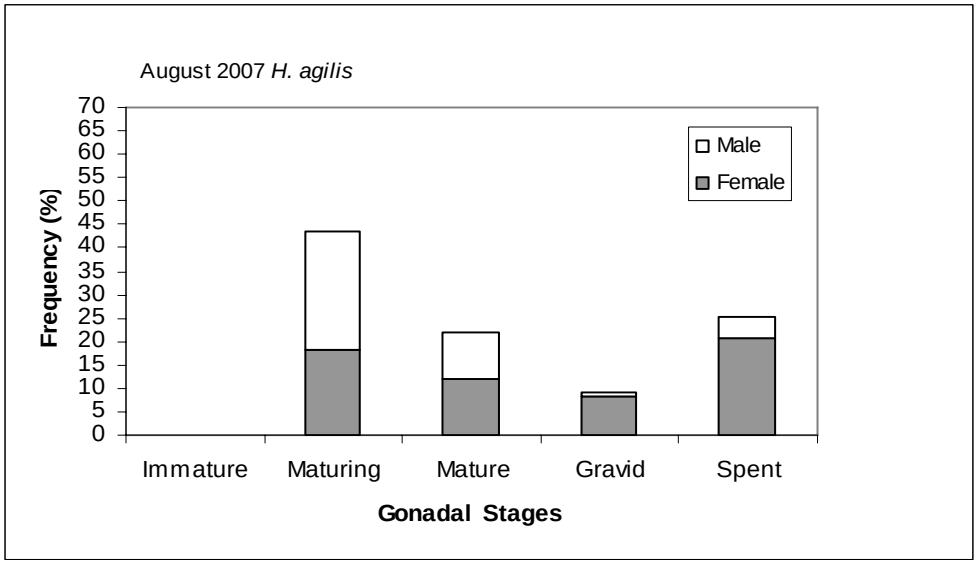


Figure 16. Frequency distribution of gonadal stages of *H. agilis* caught from Lake Mainit on August 2007.

The September 2007 *H. agilis* catch ranged between 95-121 mm with peaks observed at 101-110 mm class size (Fig. 17). Frequencies of gonadal stages (Fig. 18) show a peak in maturing individuals dominated by male fish. As the gonadal stage progressed, however, frequencies of males diminished indicating higher mortalities in males. This may be explained by the sexual dichromatism exhibited by the species, where a darker and brighter coloration in males make them more vulnerable to predation. Lighter color pattern in female fish, on the other hand, reduces their visibility to predators. Predation is considered as a probable factor affecting survival among individuals of this goby, based on the assumption that both male and female *bugwan* are equally vulnerable to fishing gears.

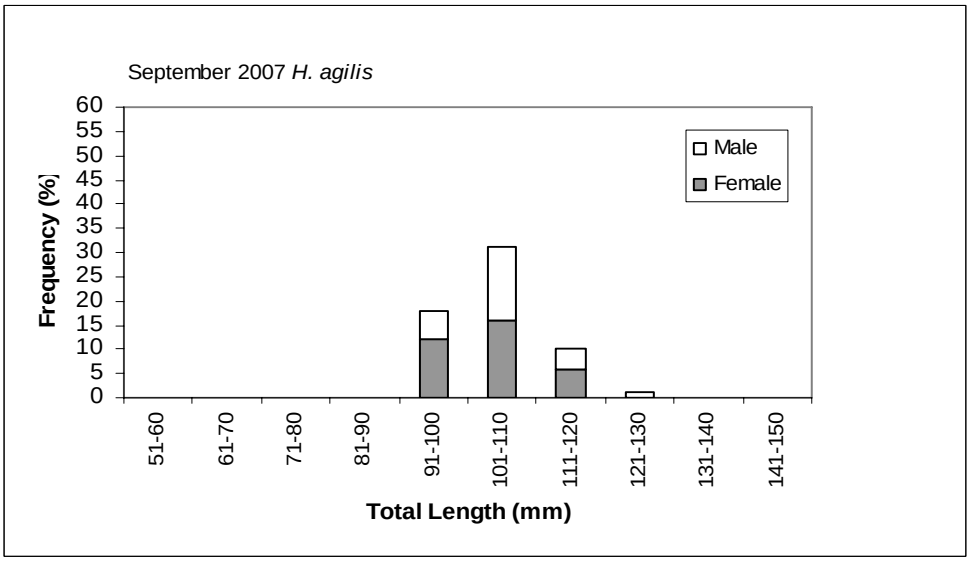


Figure 17. Length –frequency and sex distribution of *H. agilis* caught from Lake Mainit on September 2007.

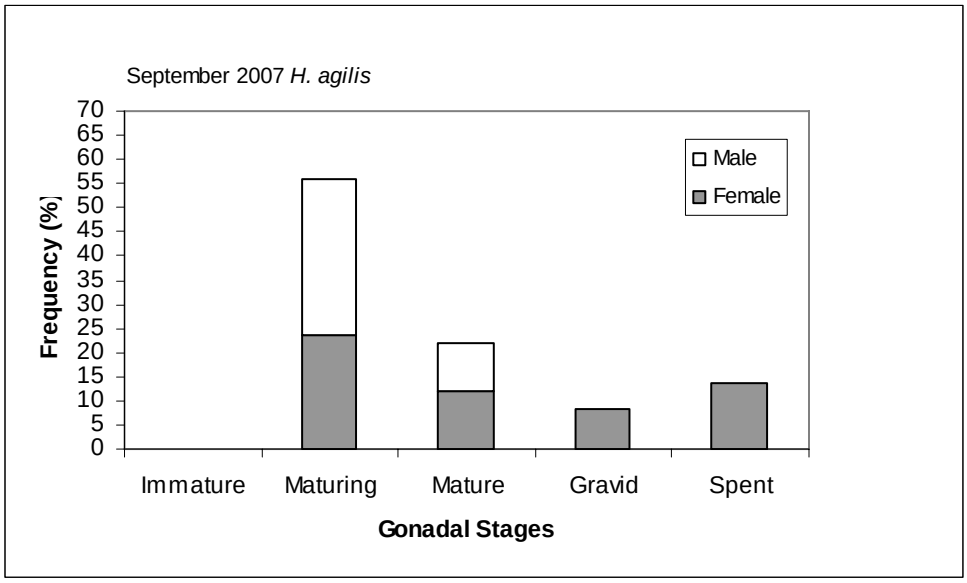


Figure 18. Gonadal stage frequency distribution of *H. agilis* caught from Lake Mainit on September 2007.

The catches of *H. agilis* from Lake Mainit on October 2007 show a wider range of sizes ranging from 51 – 118 mm with peak frequency at 101 – 110 mm (Fig. 19). The wider size range indicates recruitment or addition of young individuals into the population, as shown by the presence of small individuals in the sample. Frequency distribution of gonadal stages (Fig. 20) shows the presence of immature individuals, but the peak frequency is still observed in maturing individuals.

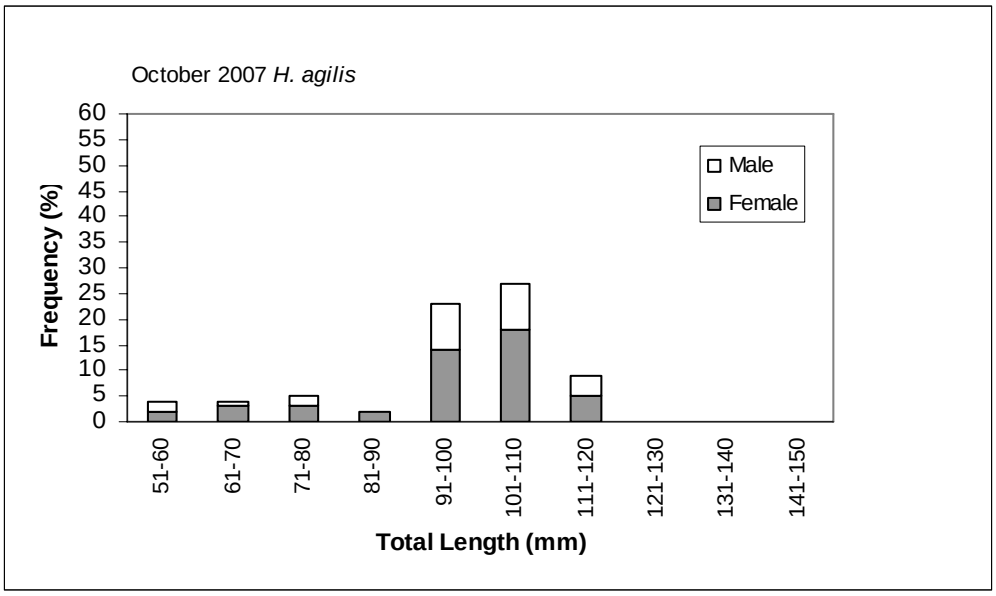


Figure 19. Length –frequency and sex distribution of *H. agilis* caught from Lake Mainit on October 2007.

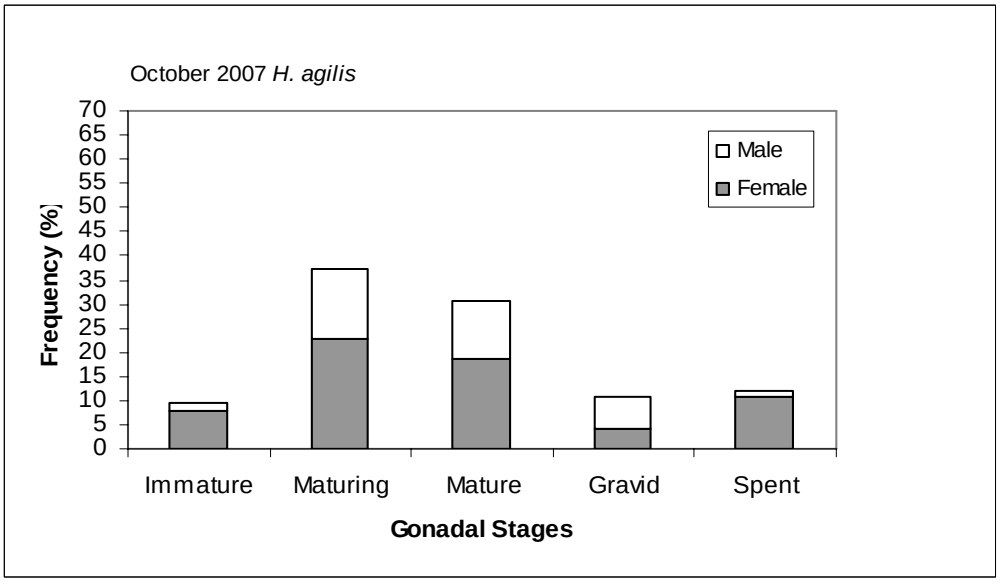


Figure 20. Gonadal stage frequency distribution of *H. agilis* catches from Lake Mainit on October 2007.

The catches of *H. agilis* in November 2007 indicate a size range between 99-131 mm with peak frequency observed at 111-120 mm (Fig. 21). Frequency distribution of gonadal stages (Fig. 22) shows peak frequency in mature individuals. It is apparent in Fig. 21 that mature female fish far exceed mature males.

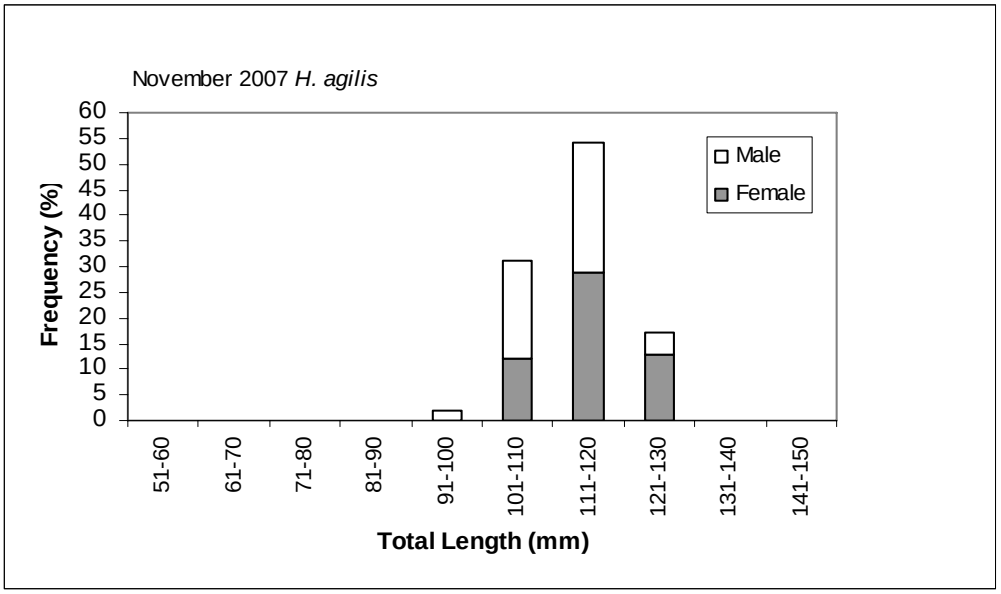


Figure 21. Length –frequency and sex distribution of *H. agilis* catches from Lake Mainit on November 2007.

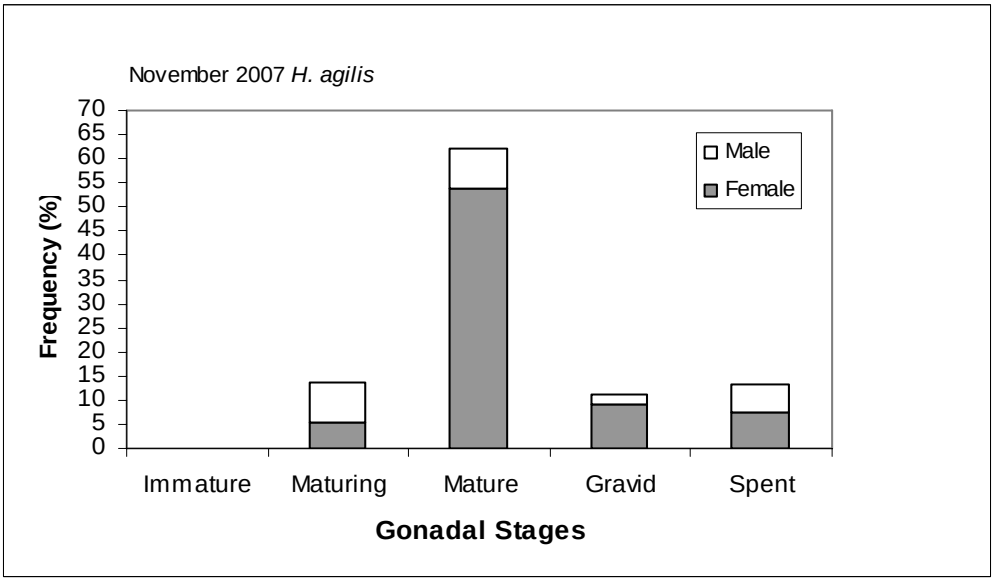


Figure 22. Gonadal stage frequency distribution of *H. agilis* catches from Lake Mainit on October, 2007.

The high frequency of mature individuals in November 2007 coincides with the start of the flood season which inundates the banks of Lake Mainit by as much as 1-2 meters. The inundation, locally known as *guob*, causes the death and decay of terrestrial plants growing

along the banks, thus releasing higher amounts of nutrients and organic matter for plankton use, thus enhancing production on subsequent organisms in the aquatic food web.

The monthly sex ratios by gonadal stages are presented in Table 12, although these values alone do not provide any trends unless studied together with gonadal maturity in *H. agilis* catches from Lake Mainit. The sex ratios of mature individuals of *H. agilis* (Fig. 23) show an almost equal representation by both sexes during the months of August and September. The month of October towards November showed a decline in mature male individuals. Immature *H. agilis*, on the other hand, show a decline in the number of males from August to September but an increase in males in October and November, indicating biased female mortality.

The monthly length frequencies of *H. agilis* catches from Lake Mainit (Table 13) show a shifting mode (or highest frequency) from August to November 2007. The mode in August can be observed between 81-90 mm size range while in September and October the mode can be observed at 101-110 mm size range. The mode in November can be observed at 111-120 mm size range. This progression of the monthly mode of size range is reflective of the growth of *H. agilis* from Lake Mainit.

The report of Galicia and Lopez (2000) showed a different monthly pattern in the size frequency distribution of *H. agilis*. This difference may be attributed to the difference of fishing gear being monitored. Galicia and Lopez (2000) used only beach seine or *baling* while in this study both *baling* and *pukot* were monitored. The highest frequency was observed in August and September 1997 at 100 - 105 mm while that in October and November 1997 was observed at 80 - 85 mm (Galicia and Lopez 2000).

Table 12. Sex Ratios at different gonadal stages of *H. agilis* catch from Lake Mainit on August to November 2007.

GONADAL STAGE	SEX RATIO			
	August	September	October	November
Immature			1:6	
Maturing	1:0.71	1:0.88	1:1.54	1:0.65
Mature	1:1.18	1:0.86	1:1.56	1:0.59
Gravid	1:9	0:5	1:0.6	1:4.75
Spent	1:4.6	0:8	1:8	1:1.25

Table 13. Monthly length frequency data on *H. agilis* catches from Lake Mainit between August and November, 2007.

SIZE RANGE (mm)	MONTHLY LENGTH FREQUENCY (%)			
	Aug-07	Sep-07	Oct-07	Nov-07
51-60			5.41	
61-70	0.91		5.41	
71-80	12.73		6.76	
81-90	**34.55**		2.70	
91-100	22.73	30.00	31.08	1.90
101-110	17.27	**51.67**	**36.49**	29.52
111-120	9.09	16.67	12.16	**51.43**
121-130	1.82	1.67		16.19
131-140	0.91			0.95
141-150				

Note: Values in boldface indicate modes or highest frequencies.

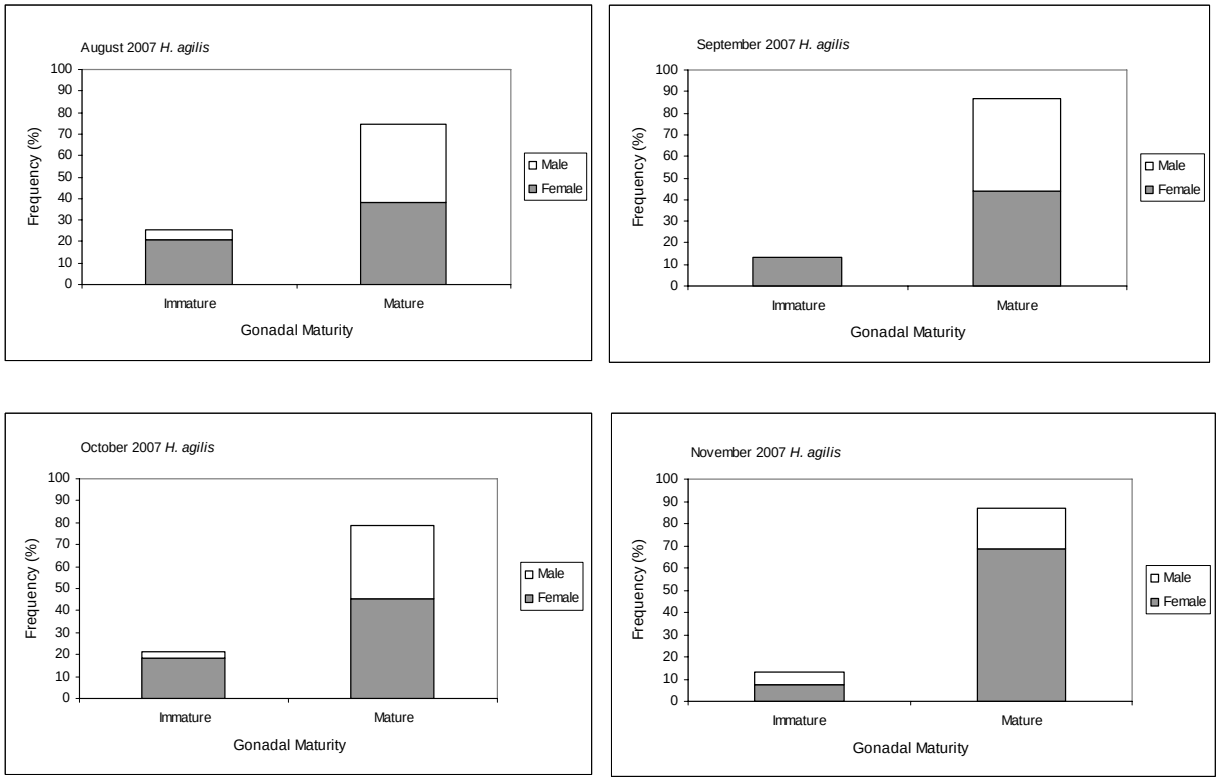


Figure 23. Comparison of monthly gonadal maturity frequency distribution of *H. agilis* catches from Lake Mainit (August to November 2007).

The White Goby (*Glossogobius giuris*)

The white goby (*Glossogobius giuris*) locally known as *pijanga* (Fig. 24) belongs to Family Gobiidae. It is characterized by having fused ventral fins which is used functionally to anchor on substrates. The *pijanga* from Lake Mainit are found in littoral and limnetic zones and support a major fishery in Lake Mainit. The *G. giuris* catches from Lake Mainit during August to November 2007 range in size between 57 – 242 mm, which are smaller than the size range of 25 to 305 mm reported by Galicia and Lopez (2000). Monthly size ranges of gonadal stages in both males and females are also presented in Table 14.

Figure 24. The white goby *Glossogobius giuris.*

Table 14. Monthly catches of *G. giuris* from Lake Mainit showing size ranges in male and female gonadal stages.

SEX	GONADAL STAGE	SIZE RANGE (mm)			
		August	September	October	November
Female	Immature	64 - 155		60 - 140	
	Maturing	57 - 162	117 - 190	81 - 151	123 - 150
	Mature	80 - 155	132 - 141	74 - 136	130 - 145
	Gravid	116 -145	116 - 141	77 - 242	130 - 148
	Spent	89 - 176	122 - 145	87 - 211	128 - 158
Male	Immature	83 - 105	-	67 - 110	
	Maturing	67 - 186	120 - 142	65 - 212	127 - 154
	Mature	148	139	126 - 128	130 - 152
	Gravid	-	-	-	153
	Spent	87 - 191	121 - 170	99 - 220	132 - 184

The length – frequency distribution of *G. giuris* catches from Lake Mainit in the month of August 2007 shows two peaks (Fig. 25) at 81 - 90 mm and 131 – 140 mm, followed by a single peak in September at 121 – 130 mm (Fig. 26) and two peaks again on October 2007 (Fig. 27) at 91 – 100 mm and 121 – 130 mm and followed by a single peak at 131 – 140 mm on November (Fig. 28). The frequency distribution of sexes in all class sizes (Figs. 25-28) is observed to be composed largely of females.

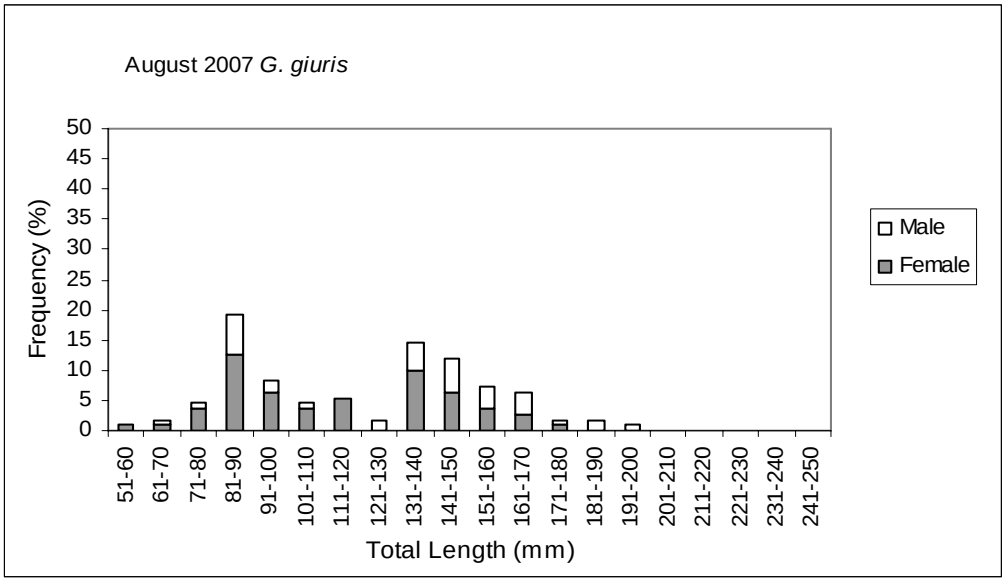


Figure 25. Length – frequency and sex distribution of *G. giuris* catches from Lake Mainit in August 2007.

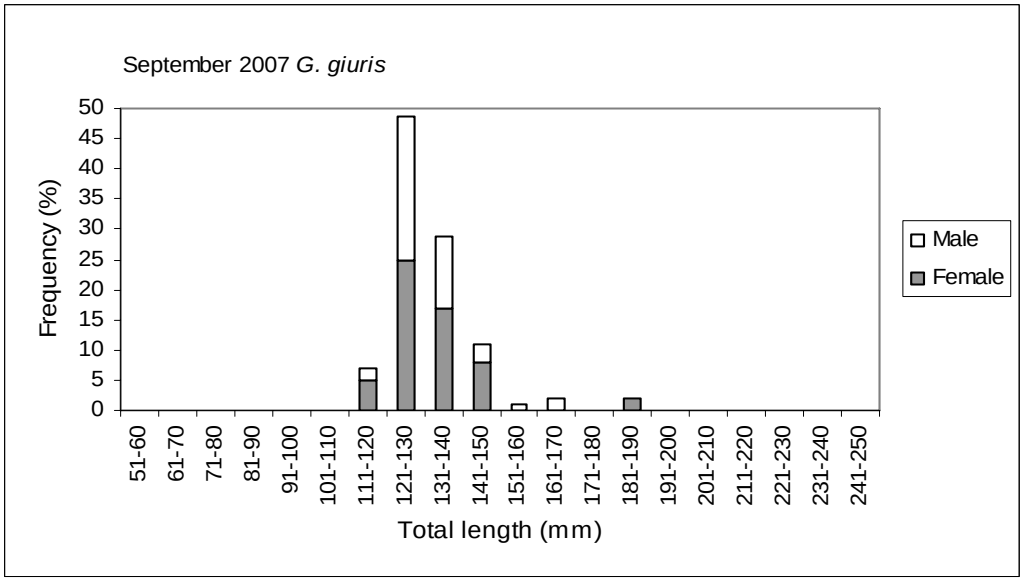


Figure 26. Length – frequency and sex distribution of *G. giuris* catch from Lake Mainit in September 2007.

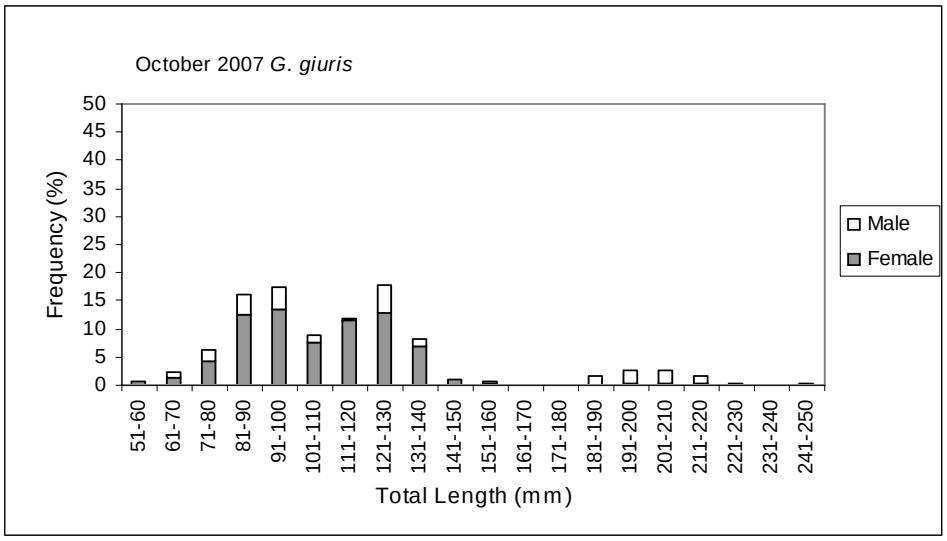


Figure 27. Length – frequency and sex distribution of *G. giuris* catches from Lake Mainit in October 2007.

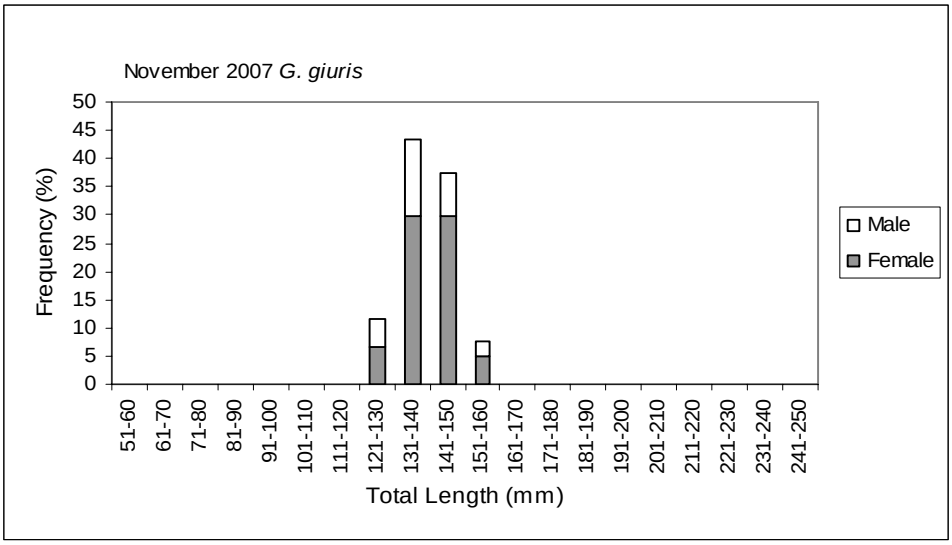


Figure 28. Length –frequency and sex distribution of G. giuris catches from Lake Mainit in November 2007.

Monthly gonadal stage frequency distributions show variation of peaks and sex ratios. In the month of August (Fig. 29) the *G. giuris* catch was dominated by maturing individuals and spent or resting individuals. The spent individuals are biased towards the males while the rest of the other stages are dominated by females. In September (Fig. 30), nearly equal peaks were observed in maturing and spent individuals with ratios biased towards females. Catches of *G. giuris* in October (Fig. 31) were dominated by immature and spent individuals with more females dominating the catches.

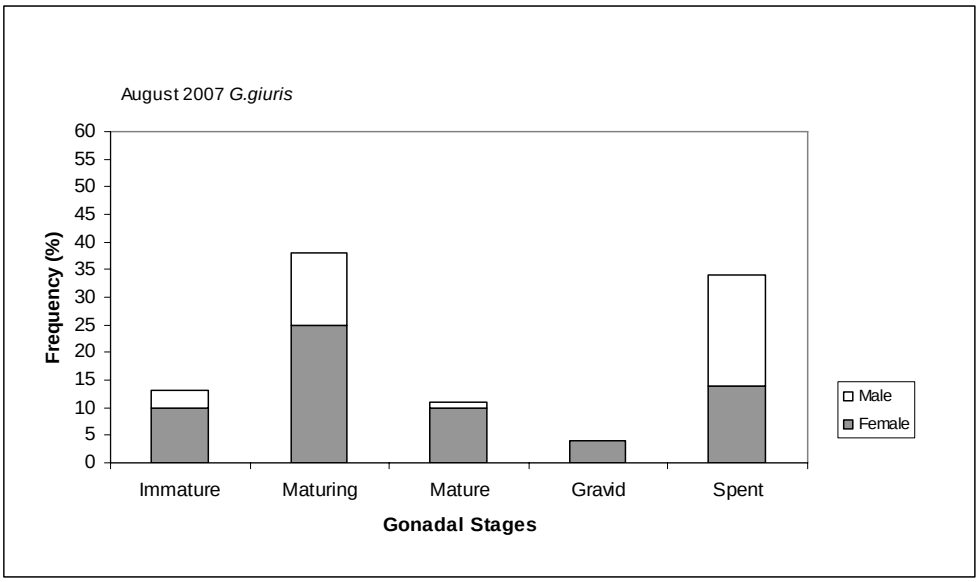


Figure 29. Gonadal stage frequency distribution of *G. giuris* catches from Lake Mainit in August 2007.

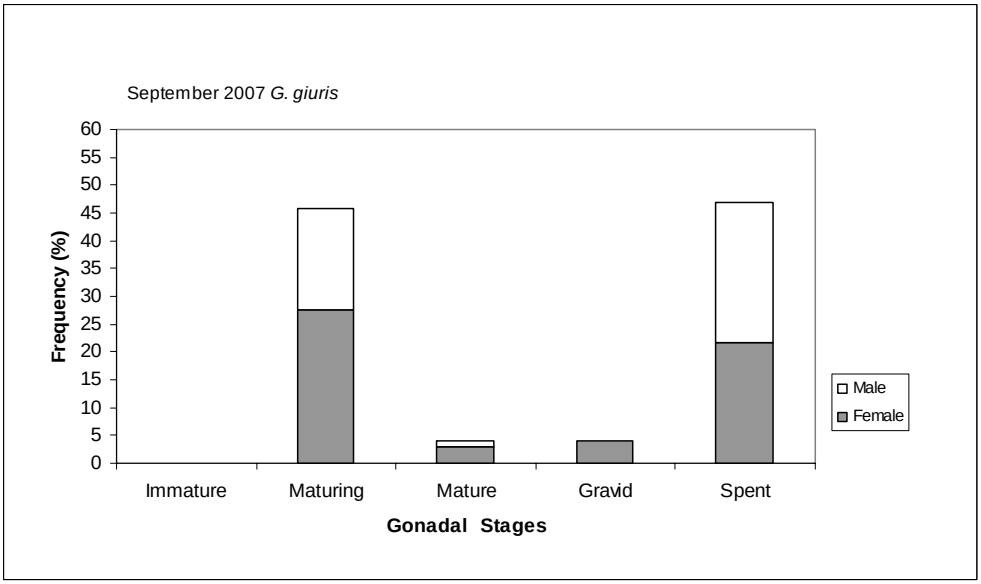


Figure 30. Gonadal stage frequency distribution of *G. giuris* catches from Lake Mainit in September 2007.

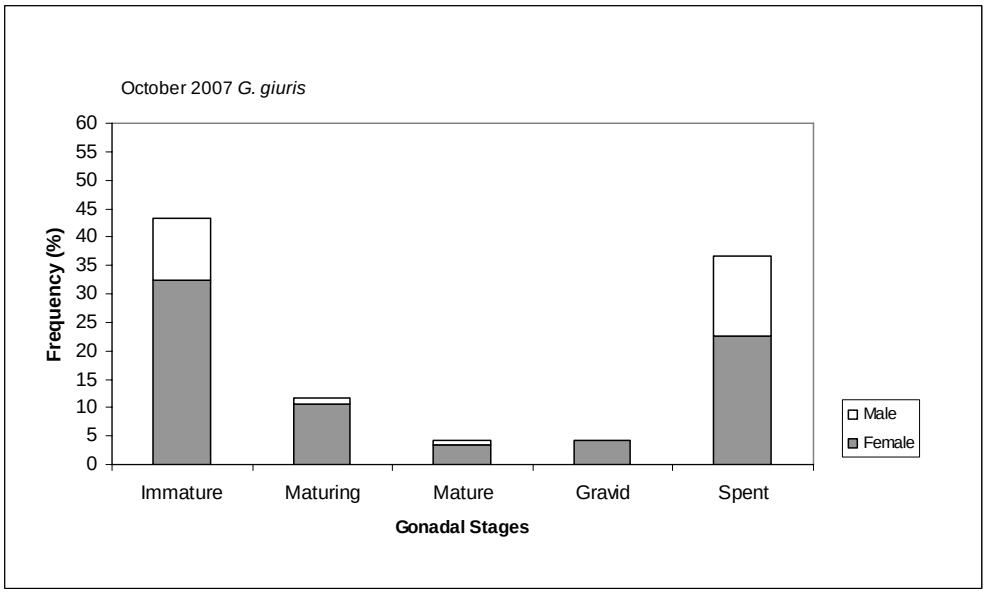


Figure 31. Gonadal stage frequency distribution of *G. giuris* catches from Lake Mainit on October 2007.

The *G. giuris* catch in November 2007 (Fig. 32) showed a peak frequency of spent individuals with a sex ratio biased towards the females. Monthly gonadal maturity data showed that August and September have more mature individuals with sex ratio dominated by female while the immature individuals have almost equal sex ratios.

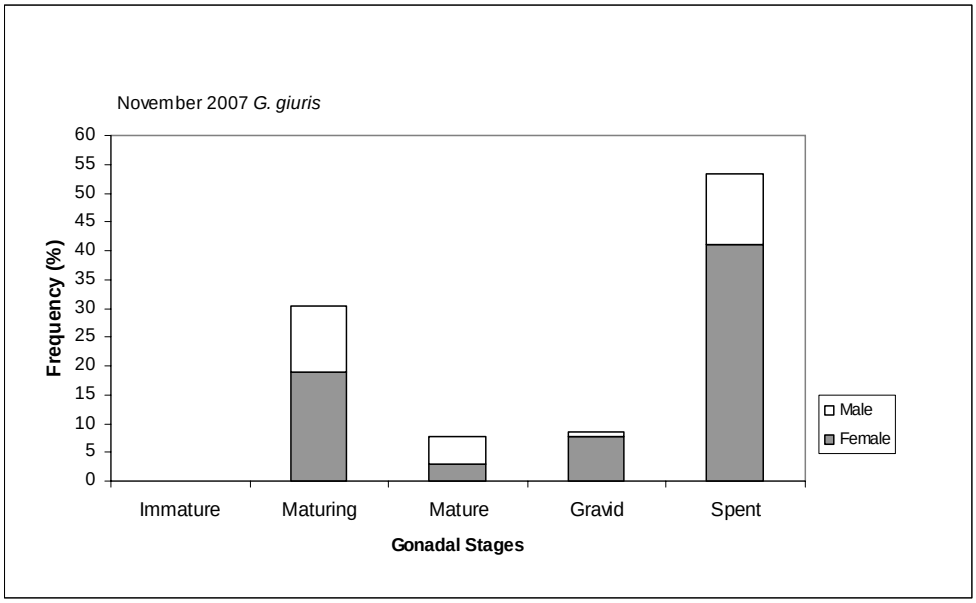


Figure 32. Gonadal stage frequency distribution of *G. giuris* catches from Lake Mainit in November 2007.

Monthly frequency distributions on gonadal maturity (Fig. 33) of *G. giuris* catches from Lake Mainit showed that October and November are dominated by immature individuals with sex ratios favoring the females (Table 15). The occurrence of more females in the catches suggests that potential recruitment of *pijanga* is still high, as long as overfishing is avoided and the ecological condition is maintained.

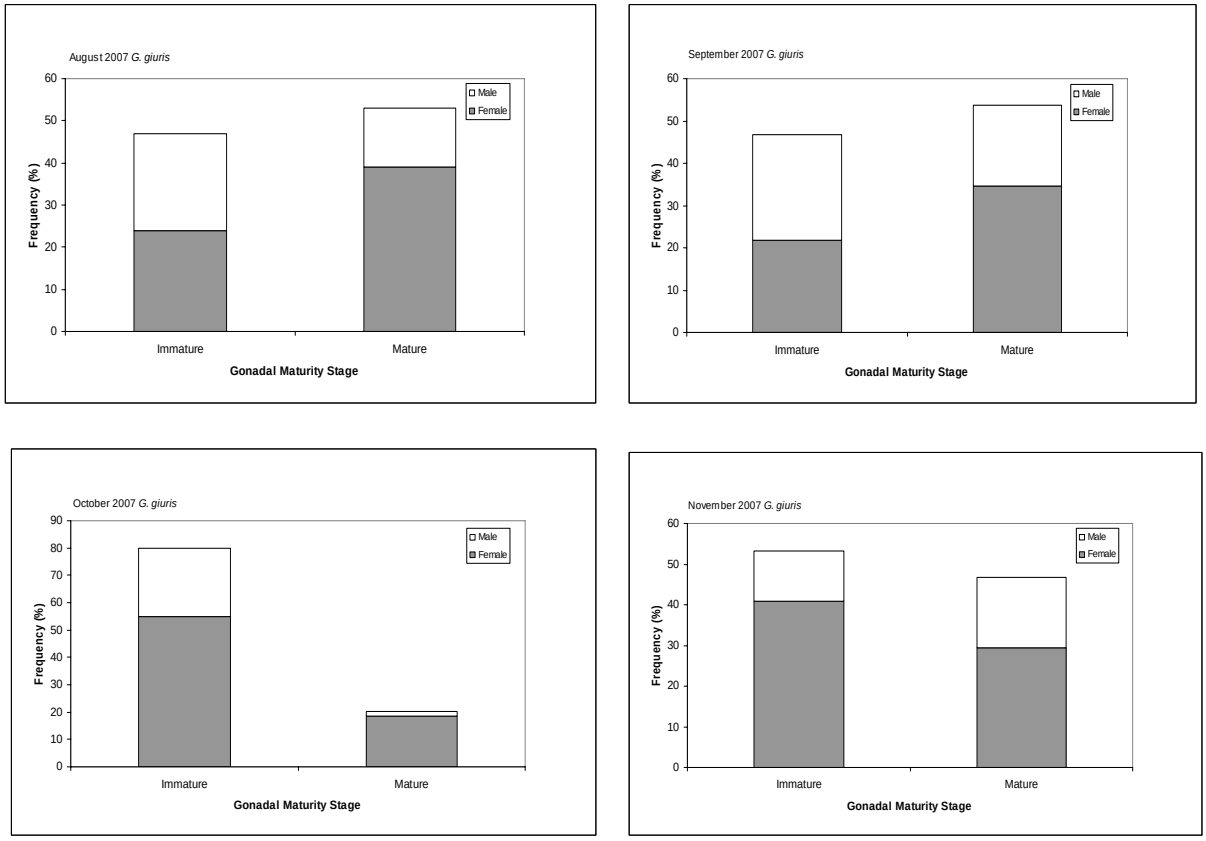


Figure 33. Monthly gonadal maturity frequency distributions of *G. giuris* catches from Lake Mainit in November 2007.

Table 15. Sex Ratios at different gonadal stages of *G. giuris* catch from Lake Mainit on August to November 2007.

GONADAL STAGE	SEX RATIO			
	August	September	October	November
Immature	1:3.3		1:2.95	
Maturing	1:1.92	1:1.56	1:9.75	1:1.67
Mature	1:10	1:3	1:6.5	1:0.6
Gravid	0:4	0:4	0:15	1:8
Spent	0.7:1	1:0.88	1:1.61	1:3.3

The monthly length frequency of *G. giuris* catches from Lake Mainit (Table 16) showed a shift of modes from August to November 2007. The mode in August can be observed between 81-90 mm size range while in September and October the mode can be observed at 121-130 mm size range. The mode in November can be observed at 131-140 mm size range. This progression of the monthly modes or size range of highest frequencies is reflective of the growth of *G. giuris* in Lake Mainit. The report of Galicia and Lopez (2000) showed a different monthly mode of the size frequency distribution of *G. giuris*. This difference in size mode can be attributed to the fishing gear monitored, which in the case of Galicia and Lopez (2000) which was only *baling* while in the present study bith *baling* and *pukot* were used. The size classes with the highest frequencies in the 1997 assessment were 60-70 mm in August and September, 70–80 mm in October and 80–90 mm in November.

Table 16. Monthly length frequency data on *G. giuris* catches from Lake Mainit between August and November, 2007.

SIZE RANGE	MONTHLY LENGTH FREQUENCY (%)			
(mm)	Aug-07	Sep-07	Oct-07	Nov-07
51-60	1.00		0.55	
61-70	2.00		2.20	
71-80	5.00		6.34	
81-90	**21.00**		16.25	
91-100	9.00		17.36	
101-110	5.00		8.82	
111-120	6.00	6.93	11.85	
121-130	2.00	**48.51**	**17.63**	11.54
131-140	16.00	28.71	8.26	**43.27**
141-150	13.00	10.89	1.10	37.50
151-160	8.00	0.99	0.55	7.69
161-170	7.00	1.98		
171-180	2.00			
181-190	2.00	1.98	1.65	
191-200	1.00		2.75	
201-210			2.48	
211-220			1.65	
221-230			0.28	
231-240				
241-250			0.28	

Note: Values in boldface indicate modes or highest frequencies.

3.3 Participatory Socio-Economic Assessment

The bulk of the data on fisheries socio-economics was obtained from focus group discussions (FGDs) and key informant interviews in the coastal barangays around Lake Mainit and Kalinawan River. A total of 46 barangays covering six municipalities under two provinces around the lake were grouped into 13 FGD clusters (2-7 barangays/cluster) based on their proximity to each other (*see Appendix Tables 1&2)*. A total of 228 residents around the lake attended the FGD clusters, comprising of local/barangay officials, LGU staff of the municipal agriculture office (MAO), municipal environment and natural resource office (MENRO), fishermen, womenfolk, youth representatives, and members of people's organizations and local NGOs (Fig. 34).

Each FGD session was conducted by dividing the participants into the fisheries and socio-economic groups and information was gathered simultaneously using prepared table formats and maps. The number of participants of each FGD varied from one barangay cluster to the next, which ranged from 15 to 24. Each session ran from two and a half to three hours, depending on the enthusiasm and speed of the participants in providing information. Attendant problems and issues related to fishing and livelihood, environment, political, and other community concerns were also raised by the participants during the FGD. This participatory and rapid method of gathering information provided a preliminary set of data on total fishing effort in the lake, estimates of revenues and net incomes from fishing, and an array of fisheries-related and other management issues around Lake Mainit that are vital to formulating a comprehensive and issue-based management program for the sustainable use of the lake's resources.

3.3.1 Fishing Effort

The lakeshore and riverbank communities in Lake Mainit and Kalinawan River are largely dependent on the lake's resources for food and livelihood. The Lake Mainit fishery can be categorized as traditional or municipal. As the fourth largest lake in the country, Lake Mainit sustains high fishing effort and is showing signs of overexploitation. A survey of the fishing effort made through FGDs in 46 barangays across six municipalities around Lake Mainit (Mainit, Alegria, Kitcharao and Jabonga) and along Kalinawan River (Santiago and Tubay) showed that some 4,063 fishers and 2,776 fishing boats are involved in Lake Mainit fisheries (Table 17). Most of the fishers come from Jabonga and Santiago where many of them engage in fishing on a full-time basis, while Alegria has the smallest number of fishers (Fig. 35). The number of fishers, however, increases dramatically during the North-East Monsoon or amihan, especially in Alegria where an increase from 78 to 500 fishers, including part-time fishers, can be observed. The farmers are attracted to fishing during '*ting-guob*' or flood season when the shallow portions are inundated and teeming with fish. The region belongs to Climatic Type II with maximum rainfall occurring from November to February. Flooding is eminent during this period because the shallow mouth of Kalinawan River, the only outlet, prevents rapid exit of the water. Majority of the fishing boats are non-motorized *bancas* or *bandong* (72%), because most fishing grounds are just within the littoral zone, while motorized boats are fewer (28%).

San Pedro, Alegria, SDN

Quezon, Mainit, SDN San Pedro,

Bangayan, Kitcharao, ADN

Bunga, Jabonga, ADN

Lapaz, Santiago, ADN

Poblacion, Tubay, ADN

Figure 34. A series of focus group discussions was conducted in the six municipalities around Lake Mainit and Kalinawan River.

Table 17. Estimated number of fishers and fishing boats in Lake Mainit and Kalinawan River.

Municipality	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	TOTAL
No. of Barangays	11	7	6	8	7	7	46
No. of Fishers	440	78	880	1,135	1,028	502	4,063
No. of Fishing Boats:	318	56	844	1,033	113	412	2,776
Motorized	152	3	293	180	88	50	766
Non-Motorized	166	53	551	853	25	362	2,010

Note: Above values are based on upper limits of mean estimates provided by FGD participants.

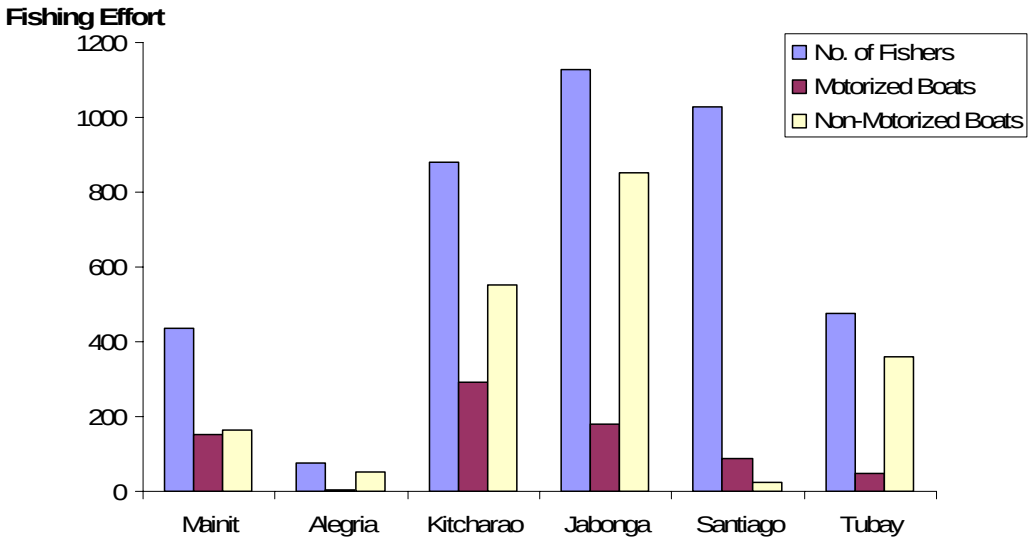


Figure 35. Comparison of fishing effort (fishers and boats) in lake and riverine fisheries around Lake Mainit.

A total of 36 kinds of fishing gears and methods are being used by fishermen in Lake Mainit and along Kalinawan River, with Mainit and Jabonga having the most diversified fishing activities (Table 18). Alegria has the least variety of fishing gears as it also has the fewest number of fishers. This number was generated from FGDs and includes the many modifications of standard gears and non-gear fishing methods such as gleaning for fish and invertebrates (*e.g. panginhas, panulo, pang-ige, tubli,* etc.). Only 18 gear types were reported by the Fisheries Assessment component which obtained their data from actual site survey and inventory in the lake during the period August-October 2007 and do not include non-gear fishing activities.

Table 18. Estimated number of types of fishing gears or methods per municipality**.**

Municipality		Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay	Total
No. of fishing gear types or fishing method		21	8	12	20	19	12	36
Popular Gears:								
Seine	*Baling*	x						
Shrimp Trap	*Bantak*		x	x	x			
Hook & Line	*Bingwit**	x	x	x	x	x	x	
Fish Corral	*Bungsod*			x	x			
Net	*Lambat*					x		
Cast Net	*Modified Laya*	x		x	x	x		
Barrier Net	*Palaksuhan*					x		
Spear	*Pana*		x	x	x	x	x	
Net	*Pante*						x	
Gill Net	*Pukot*	x	x	x	x	x		
Fish Trap	*Timing/screen*	x	x	x	x	x		
Net	*Sinsin*						x	
Net	*Surit*						x	

** Other variations: taan, buldos, palangre,pasol*

Fishing gears used in Lake Mainit and Kalinawan River are quite diverse: including simple to multiple handlines, longlines, gill nets, push nets, modified cast nets, drag seines, barriers, fish corrals and traps, spears, and even fish shelters and snail dredges and many others ingenious implements of simple construction. 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*. Table 19 shows the details of fishing operations of the most popular gears used around Lake Mainit based on information provided by fishers during FGDs. Most of these gears are operated using either motorized or non-motorized boats with crew size of 1-2 fishers, except for beach seine (*baling*) which requires at least seven fishers to operate.

Based on the number of users, the most popular gear is *timing* (1,472 fishers), a fish trap fashioned out of nylon or steel screen and deployed in shallow waters for 6-24 hours. This gear is operated everyday and year-round but most popular from November to March during the *guob* season when fish catches tend to shoot up. Gill net (*pukot*) ranks second in popularity and used by about 567 fishers. Several variations in gillnet occurs, such as *pang-higad* (shallow), *pang-lawod* (deep) and *pang-carpa* (carp fishing). The species caught are similar to those of *timing*, however, the *pang-carpa* are operated at the edge of the littoral zone where large fish are often schooling. Other popular gears around the lake are hook & line (*bingwit*), spear (*pana*), fish corral (*bungsod*), modified cast net (*laya* with lamp) and drag seine (*baling*). Most gears are operated daily the whole year but the time spent on fishing varies widely, from only one hour in the case of collecting catch of *bungsod*, to 12-24 hours for *taan* and the shrimp trap called *bantak*. Spearfishing, on the other hand, is efficient only during clear water conditions and thus, is used during calmer seasons.

Table 19. Details of fishing activities of popular fishing gears in Lake Mainit and Kalinawan River.

Gears	Baling	Bantak	Bingwit*	Taan	Bungsod	Laya	Pana	Pukot**	Timing/ Screen
Boat type	M & NM	M & NM	M & NM	M & NM	M & NM	M	NM	M & NM	M & NM
Crew Size	7	1 or 2	2	1-2	2	2	1	1 or 2	1-2
No. of fishers	16-23	88-93	320-420	112	95	188	262	567	1,472
Months used	Jan-Dec	Jan – Dec	Jan – Dec	Jan – Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Nov-Mar
Hours fishing	4-11	24	4	12-24	1	8-10	1-4 ; 8	4– 12	6 - 24
No. of trips / mo.	Daily	Daily	Daily	Daily	Daily	Daily	Daily	Daily	Daily

Note: M, NM-= motorized and non-motorized boats;
**Variations: buldos, pasol, palangre; ** Variations: higad, lawod, pang-carpa*

3.3.2 Estimates of Fish Production

Volume and Composition of Landed Catch

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 many fishers declare such a large catch is quite rare. In fact, catches more than 30 kg/trip are considered "jackpot" catch seldom experienced by most fishers (Fig. 36). Fishing operations of *baling* had been rendered illegal in most municipalities around the lake (with the exception of Mainit municipality) because of the potentially destructive impacts of using fine mesh nets. Dragging this net across the lake bottom can also destroy benthic vegetation and habitats of fish and invertebrates. 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 *timing* reaches up to 100 kg during *guob* although normally the catch ranges from less than 5kg to 20 kg.

Common catch of *timing* comprise *tilapia*, *pijanga*, *banak, hayuan, kasili*, and the Thai catfish locally called *bangkok* (Table 20). Freshwater shrimps 'uwang' are commonly caught by shrimp trap *bantak*. Among the mollusk resources the most abundant is the gastropod *ige* which are commonly collected by hand picking or using a snail dredge. Modified operation of the cast net or *laya* has increased its efficiency in catching mainly *pijanga* in the deeper waters of the lake.

Marketing of Fish Products

Majority of the catch is sold in local markets around the lake, except for large catches of carps which are sold as far as Iligan City and Marawi City where this fish fetch remarkably higher prices among the Muslim communities. Fishers also declared that *pijanga* are often sold in nearby urban markets such in the cities of Butuan, Surigao, and Cabadbaran.

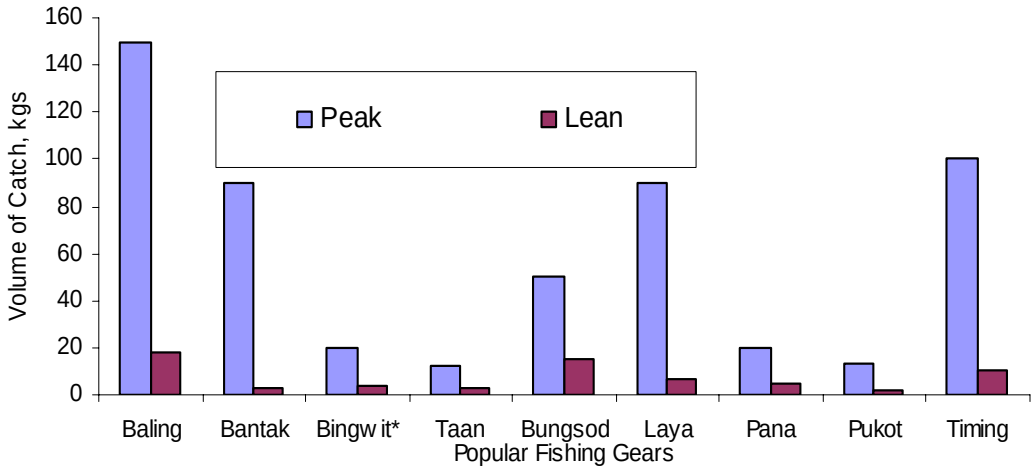


Figure 36. Volume of catch (kgs) of the popular fishing gears during peak and lean season.

Table 20. Common kinds of fish caught by popular fishing gears in Lake Mainit and in Kalinawan River and their current selling prices.

Common Fish Species Caught	Gear Types									Price Range (Pesos/kg)
	Baling	Bantak	Bingwit	Taan	Bungsod	Laya	Pana	Pukot	Timing/ Screen	
Bakoko							x			100
Banak					x	x	x	x	x	80-100
Bangkok	x			x	x		x	x	x	35-50
Bugwan	x	x	x		x	x		x		12-30
Carpa	x				x	x	x	x		40-120
Durod			x							50
Gingaw	x					x				120-300
Hayu-an	x			x	x	x	x	x	x	40-80
Kagang		x								*For bait*
Kasili	x	x		x	x	x	x		x	150-350
Kikilo			x							70-100
Laya	x									80-120
Luyab		x								25-30
Pantat				x						30-60
Pijanga	x	x	x	x	x	x	x	x	x	30-60
Tilapia	x		x	x	x	x	x	x	x	25-60
Uwang		**x**								35-60

Certain kinds of fish, such as *kasili* (eels), *gingaw*, *carpa* and *banak* (mullet) command high prices even in local markets. Normally, if the catch is low (e.g. 3-5kg), about 85-90% of this is peddled in the neighborhood. For large catches of high-priced fish such as *pijanga* or carp, the entire catch is disposed of to middlemen or fish buyers in identified fish landing sites. Export of good quality fish to markets in urban centers may explain why large-sized *pijanga* are seldom seen in the local markets of Mainit and Kitcharao.

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.

Income from fishing

The income 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 21). 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 21. Derived estimates of gross sales and net income of fishers during lean and peak fishing seasons in different fishing gears.

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**					**1,537**	**223**

Traps such as *timing* and *bantak* are popularly used by most number of fishers in Lake Mainit and Kalinawan River because of lower fishing costs while obtaining large gross sales (Fig. 37), resulting in larger net incomes between Php2,700-3,000. Traps are also simple to operate – fishers simply deploy them in strategic locations and retrieved them after 4-12 hours. The more number of traps the higher is the volume of catch. 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 (Table 20) 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.

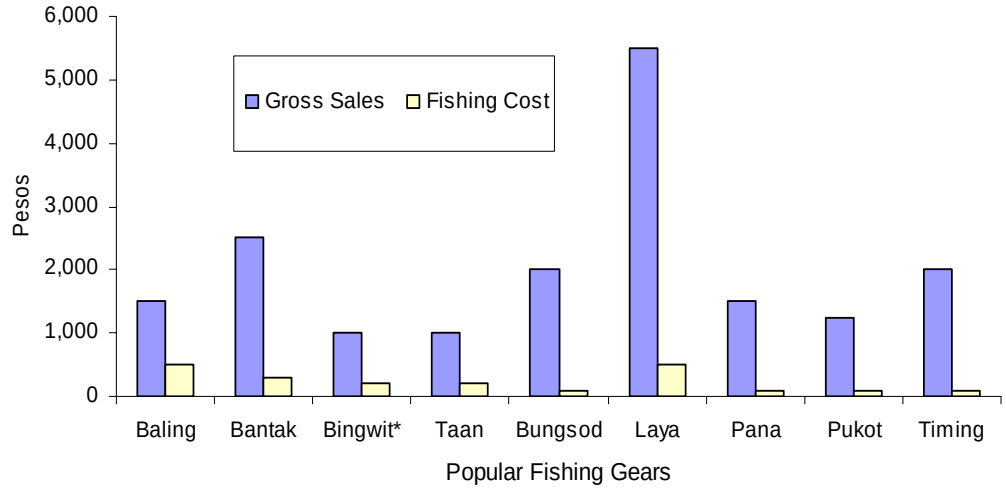


Figure 37. Gross sales and fishing cost of the popular gears.

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 (Table 22; Fig. 38).

Table 22. Daily household expenses of the average fishing family in Lake Mainit communities.

Expense Item	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
Food & Groceries	190.00	130.00	180.00	215.00	200.00	205.00
Education	90.75	30.00	27.00	80.00	53.00	52.50
Basic Amenities	23.00	13.00	8.30	8.30	7.30	6.30
Miscellaneous	30.00	55.00	50.00	50.00	30.00	40.00
Total Expenses	**333.75**	**228.00**	**265.30**	**353.30**	**290.30**	**303.80**

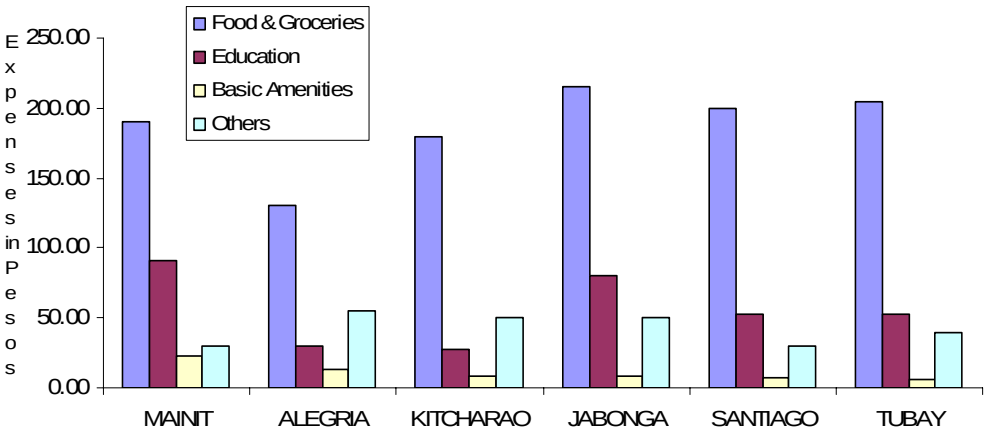


Figure 38. Comparative distribution of average daily expenditures per municipality.

Results show that the average household around Lake Mainit needs Php228-353 to cover their basic daily requirements. Participants of FGDs in Tubay, Santiago and Jabonga declared higher daily budget for food (Php200-215) while residents of Mainit spend more on children's daily school allowance (Php90.75) than in other municipalities. Overall, lakeshore residents of Mainit, Jabonga, and Tubay have the largest daily expenditures (Table 22). 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.

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. Most families send their children to government elementary and high schools within their barangay or municipality, while a few can afford to send them to private schools and college, often with the financial support from benevolent relatives or scholarship programs sponsored by NGOs and POs. Basic amenities such as potable water is available in most barangays for free or with minimal monthly bill of Php10-12. Expenses for electricity is at a minimum in most households, used only for lighting and power for the radio or television sets. Other families, however, can afford to have refrigerators and cassette players, and thus, incur higher electricity costs from P300-500/month. 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.

Based on daily income from fishing of Php223, monthly income of the average fisher during lean months is only about Php6,700 and surely not enough to meet monthly expenses even in Alegria. 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* (Table 23; Fig. 39) which could reach Php1,500-3,900. 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.

Table 23. Estimates of monthly household expenses of the average fishing family in lakeshore municipalities of Lake Mainit and Kalinawan River.

Expense Item	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
Food & Groceries	5,700	3,900	5,400	6,450	6,000	6,150
Education	2,165	995	1,170	2,230	1,690	1,680
Basic Amenities	690	390	249	249	219	189
Miscellaneous	1,830	2,985	3,090	3,900	1,500	1,710
Total Expenses	**10,385**	**8,270**	**9,909**	**12,829**	**9,409**	**9,729**

Legends: *includes medicine, electricity and water;
**includes cigarettes, cellphone load, snacks/light & hard drinks, bets for numbers game

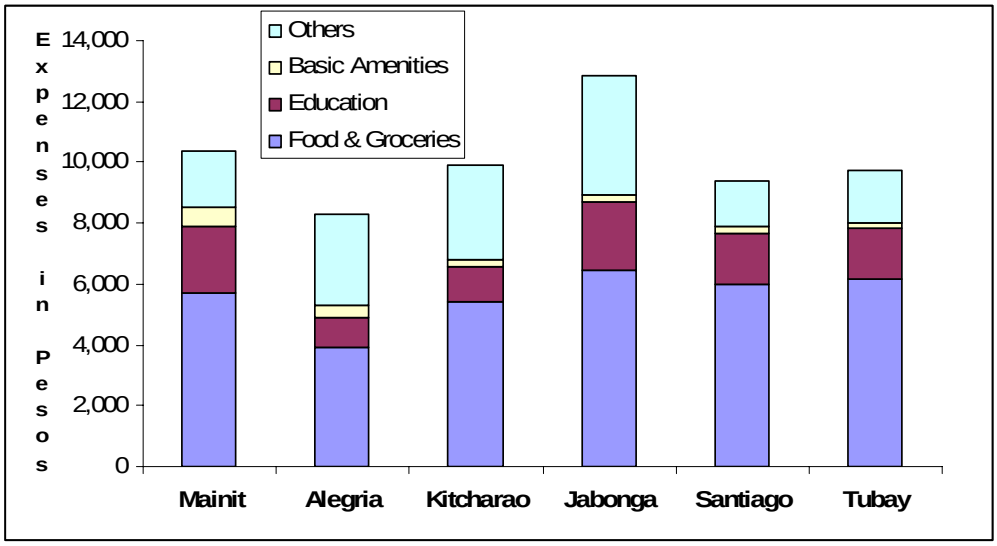


Figure 39. Average monthly household expenses of fishers in Lake Mainit and Kalinawan River.

Other sources of income

Fishers around Lake Mainit recognize that their daily income from fishing can hardly meet the basic family expenditures, unless they are lucky to make a "jackpot" catch. Such large catches, however, are extremely rare and higher net income fishers obtain from them are easily offset by days of poor catch. Many fishers 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 (Table 24).

Owing to lack of data, estimates of the additional income from these various economic activities are rough, but can range from about Php1,000 to even Php4,000-5,000 monthly. Many of these livelihood options are either seasonal or involve only a few fishers at a time. In order to supplement their income from fishing many fishers often engage in farming, get employed as farm labor force during planting and harvesting, or drive passenger motorcycles or *habal-habal*. Fishers' wives often vend fish caught by their husbands and other food items such as viand and native snacks. Other fishers have special skills as barbers and carpenters, while some women are skilled at manicure, pedicure, hair cutting, and dressmaking. Raising livestock like hogs/pigs, goats, carabao or cow and poultry is common in all municipalities. These are sponsored or initially funded by NGOs, POs, or government programs (Table 25). Some families maintain backyard vegetable gardens, operate *sari-sari* stores, and employ other ingenious ways to supplement income from lake and river fisheries.

Table 24. Non-fishing income-generating activities of the fisherfolk around Lake Mainit.

	Mainit	**Alegria**	**Kitcharao**	**Jabonga**	**Santiago**	**Tubay**
1. Farming:						
Rice	x	x	x	x		
Corn	x	x	x	x	x	
Coconut	x	x	x	x	x	
Banana	x	x	x	x	x	
Cassava	x		x	x	x	
Camote	x		x	x	x	
Gabi				x	x	
Vegetables	x	x		x	x	
2. Labor: domestic helper, farm worker; Carpentry; labada	x	x	x	x	x	x
3. Food / fish vending	x	x	x	x	x	x
4. Beauty Parlor/service	x	x	x	x	x	x
5. Sarisari Store	x	x	x	x	x	
6. Driver: motorbike or motorela	x	x	x	x		
7. Dressmaking/sastre	x	x		x		
8. Livestock: ducks, hogs,goats, chicken		x	x	x	x	
9. Others: hollow-block making	x					
Hilot					x	
Gold panning/mining		x			x	
Daycare worker/employment				x		x

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. Gold panning is either small-scale, using simple ingenious methods involving entire the family (Fig. 40), or medium-scale employing a bull mill to grind the sediment and hence, increasing efficiency and amount of gold extraction. Gold panners along Kalinawan River declared that each family group normally collects 0.5-1.0 gram of fine gold in a day's panning. At the current buying rate of gold at Php750/gram that would earn them a daily income of Php375-750. Presumably mechanized extraction using bull mill can collect much more than that, although employees were reluctant to part with that information.

Figure 40. Family-based (left) and mechanized (right) gold panning operations along Kalinawan River.

Temporal patterns of economic activities

Fishing and other economic activities in Lake Mainit and surrounding areas follow a certain annual periodicity. The seasonal calendars generated from FGDs in each municipality (Tables 25-29) show fishing with major gear types is affected by season or prevailing wind patterns, *i.e.* the *habagat* (southwest monsoon) and *amihan* (northeast monsoon). Most fishers have more than one gear that can be used in different seasons to assure daily income. Generally the peak of fishing by most gears (*e.g. timing, pukot, laya*) occurs during *habagat* when water in lake is relatively calm, although certain gears (*surit, sinsin*) operate best during *amihan*. Many fishers compensate for poor catches in these seasons by engaging in vegetable farming and other land-based activities.

3.3.4 Intervention programs

Lake Mainit and its surrounding municipalities have attracted the attention of various programs and projects introduced to the communities. The list of intervention programs in Table 31 is categorized into the following: livelihood options, credit facilities for financial assistance, health care, infrastructure, and environmental programs, based on accounts of FGD participants and barangay officials. 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. 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 (Table 31), while Tubay has the least number of support programs. It is possible, however, that the enumeration from the FGDs is incomplete.

Table 25. Seasonal calendar of economic activities of fishers and other community events in Mainit, Surigao del Norte.

Events	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weather Pattern	amihan	amihan	amihan	amihan	amihan	habagat	habagat	habagat	habagat	habagat	habagat	amihan
Major Fishing Gears												
Baling												
Timing												
Pukot												
Laya w/ suga												
Bingwit-Taan												
Crop/Rice Production	(Kamote, cassava, gabi & vegetables)*			rice						rice		
Community Events				Fiesta Magpa-yang	Fiesta Mabini, Tapian, Tagbu-yawan	Fiesta Matinao	Fiesta San Fran-cisco		Fiesta Mainit	Araw ng Mabini	All Saints/ Souls' Day	Araw ng Mainit; Fiesta in Tolingon
Diseases	(Schistosomiasis and respiratory diseases in all of Mainit)* ; Amoebiasis in Mabini											

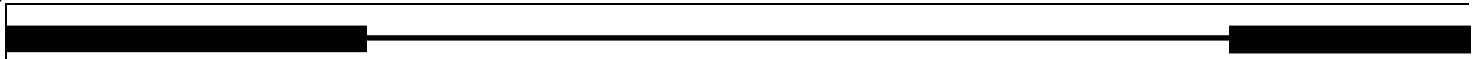
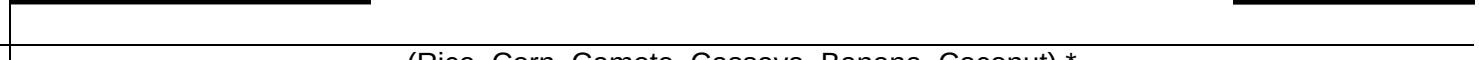
* Throughout the year; Fine lines mean low catch while thick lines mean abundant catch/harvest.

Table 26. Seasonal calendar of economic activities of fishers and other community events in Alegria, Surigao del Norte.

Events	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weather Pattern	amihan	amihan	amihan	amihan	amihan	amihan	habagat	Habagat	habagat	habagat	amihan	amihan
Major Fishing Gears												
Bantak												
Pukot												
Pana												
Timing												
Taan												
Rice Production				rice						rice		
Community Events				Fiesta San Pedro	Fiesta Alegria	Fiesta Alipao		Fiesta	Fiesta		All Saints/ Souls' Day	
Diseases	(Schistosomiasis			Respiratory Diseases: Cold/cough				Diarrhea		Dengue		Arthritis)*

* Throughout the year; Fine lines mean low catch while thick lines mean abundant catch/ harvest

Table 27. Seasonal calendar of economic activities of fishers and other community events in Kitcharao, Agusan del Norte.

Events	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weather Pattern	amihan	amihan	amihan	amihan	amihan	habagat	habagat	habagat	habagat	amihan	amihan	amihan
Major Fishing Gears												
Bantak & Timing												
Pukot												
Pana												
Laya												
Bingwit												
Bunsod												
Farm/Crop Production	(Rice, Corn Camote, Cassava, Banana, Coconut) *											
Community Events					Fiesta			Araw ng Bangunay Fiesta Poblacion; San Roque	Fiesta Canaway		All Saints/ Souls' Day	
Diseases	(Schistosomiasis)** Hilanat, Ubo, Sore Eyes*											

* Throughout the year; fine lines mean low catch while thick lines mean abundant catch.

Table 28. Seasonal calendar of economic activities of fishers and other community events in Jabonga, Agusan del Norte.

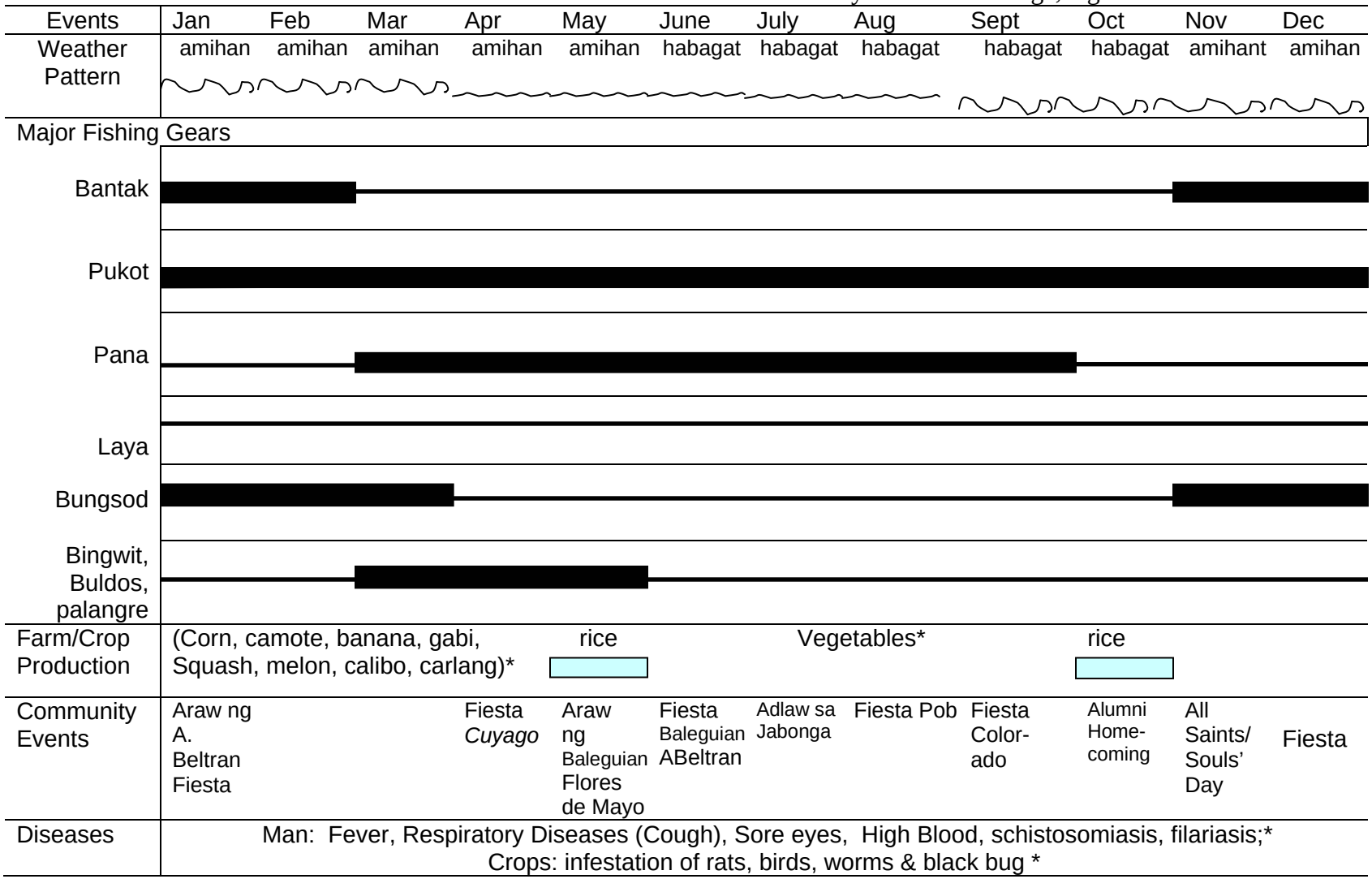


Table 29. Seasonal calendar of economic activities of fishers and other community events in Santiago, Agusan del Norte.

Events	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weather Pattern												
Major Fishing Gears												
Lambat												
Pukot												
Screen												
Pana												
Taan/ Palangre												
Farm/ crop Production				(Rice	Corn	Camote		Cassava		Vegetables) *		
Community Events	Fiesta				Fiesta						All Saints/ Souls' Day	
Diseases		(Schistosomiasis			Cold, cough		Malaria			Dengue	*Bagsa*)*	

* Throughout the year; Fine lines mean low catch while thick lines mean abundant catch

Table 30. Seasonal calendar of economic activities of fishers and other community events in Tubay, Aguan del Norte.

Events	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Weather Pattern	amihan	amihan	amihan				habagat	habagat	habagat	amihan	amihan	amihan
Major Fishing Gears												
Pante												
Surit												
Pasol												
Pana												
Sinsin												
Crop Production	Camote, Banana, Cassava, Copra *											
Community Events										Arawng Tubay	All Saints/ Souls' Day	
Diseases	Respiratory Diseases: (Colds, Cough, Fever)*											

* Throughout the year; Fine lines mean low catch while thick lines mean abundant catch/ harvest

Table 31. Intervention programs and projects introduced in Lake Mainit communities.

Programs/Projects	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
1. Livelihood:						x
Hog dispersal	x		x	x	x	
Goat dispersal	x	x		x	x	
Carabao dispersal		x	x	x	x	
Chicken dispersal		x				
Cow/cattle dispersal		x	x		x	
Power turtle farm machine					x	
Hunger Mitigation Program (Vegetable Gardening)			x			
Upland-Lowland farming				x	x	
Fish Cage culture					x	
2. Financial assistance:						
Lending	x	x	x	x	x	x
Vending: meat, food				x		x
Sari-sari Store						x
3. Health Care:						
Health Center	x	x			x	
Botica sa Barangay		x				
Birthing Clinic		x				
Disease Control/Treatment		x		x		
Daycare Center					x	
Senior Citizen Center					x	
4. Infrastructure:						
School Building	x					
Water System	x	x		x	x	
Solar Power				x		
River spillway				x		
Farm to market road	x	x	x	x		
5. Environmental rehabilitation						
Tree Planting	x		x			
Fish Sanctuary		x	x			
* Plan for 2007: Mini Nursery of fruit trees				x		
Total No. Programs/Projects	**9**	**12**	**8**	**12**	**12**	**4**

Several entities from local to international bodies had left their footprints in Lake Mainit to alleviate the living conditions of the fishing communities and to sustain the aquatic life in the lake (Table 32). Animal dispersal had been the most popular program, supported by 21 agencies and organizations since the 1980s but only a few has been sustained. The information obtained from focus group discussions, on the other hand, are quite limited. The comprehensive phase of the present project will address the need to evaluate the impacts of these intervention programs, particularly in alleviating the socio-economic situation of lakeshore communities.

Table 32. List of identified sponsors and sources of funds of the various intervention programs and projects in Lake Mainit.

Livelihood options	Credit Facilities	Health Services	School Bldg	Water system	Solar Power	Road	Tree Planting	Fish Sanctuary
Alterdev	AADC Alter Dev							
AUSAID	CIDSS	AUST-AID		ARCDP ARISP II	DAR IFAD	ARC DP		
CART Found.	DSWD	CDF						
CB-CRMP		CIDSS		CIDSS	NMCR EMP		CB-RMP	CB-RMP
CPROSE		DOH, RHU		CYM			GP, Inc.	
DA-BFAR	MED	KALAHI	KALAHI	HIKAH BAk			MRL	
DA-CIDP				ICHSP			PM Ltd	
DA-LGU						DA		DA-LGU
DOLE	MSWD			MSWD				
DSWD-LGU	PLABA							
FAO								
FOCAS	SEA K							
IFAD	SNPIDA			IFAD		IFAD		
INFRESJPPS								
OGMA	Green Bank			SK				
PACAP	Land Bank							
PODER	Rural Bank							
REACH		REACH						
RIVEMPCO								
TSARD								
UNESCO								
21	**12**	**6**	**1**	**9**	**3**	**3**	**4**	**2**

Remark: A complete list of names for the above agencies and organizations will be obtained within the project.

3.3.5 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 33, 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 33. Summary of fisheries-related issues and other problems and concerns in the municipalities around Lake Mainit.

Municipality	Mgt	Funds	Gear	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**

Declining Fish Catch

Fishers perceive that fish catch from the lake and rivers has declined over time. A review of the historical trends of fishing in the Lake Mainit shows that the lake fishery had been experiencing 'a fishing down' phenomenon (Fig. 41-42). Older fishers who participated in FGDs shared their observations on the declining volume of fish catch and decreasing sizes of fish commonly caught from the lake. Fishing using 'taan' (bottom-set longline) in Mainit and Jabonga used to catch as much as 40kg/day in the 1960s, but fish catch had steadily declined since the 1980s to the present. Increasing fishing pressure (too many fishers and fishing gears) and a host of environmental problems, such as pollution and its resulting degradation of water quality, accounted for this downtrend.

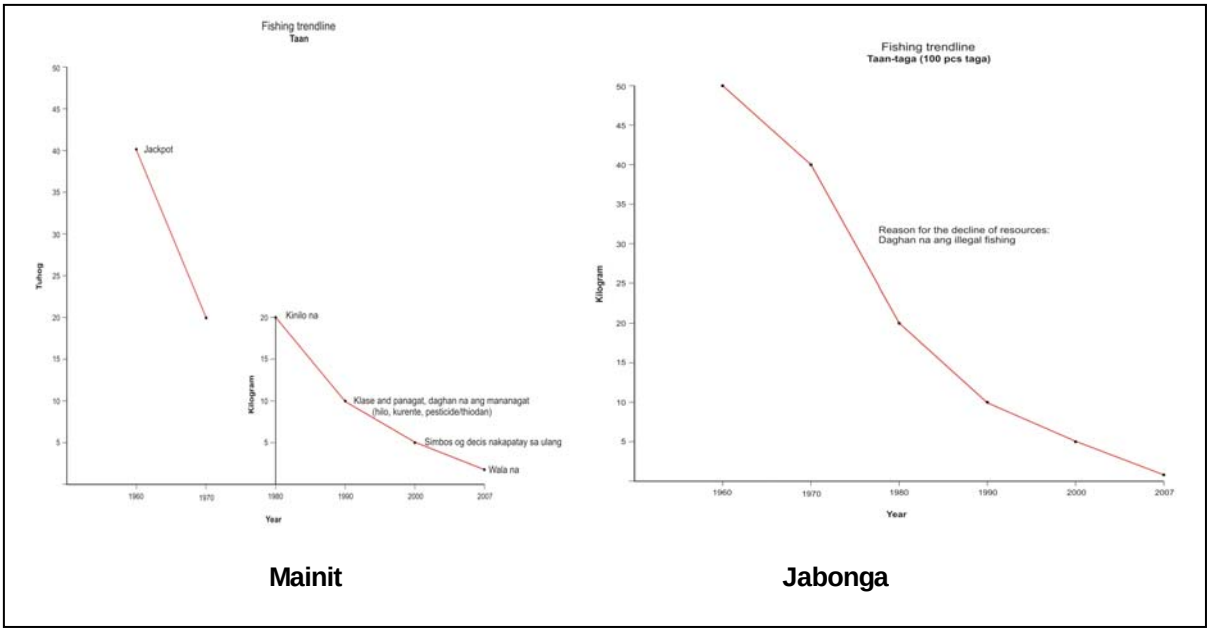


Figure 41. Historical trends in the catches of *taan* in Mainit, Surigao del Norte and Jabonga, Agusan del Norte.

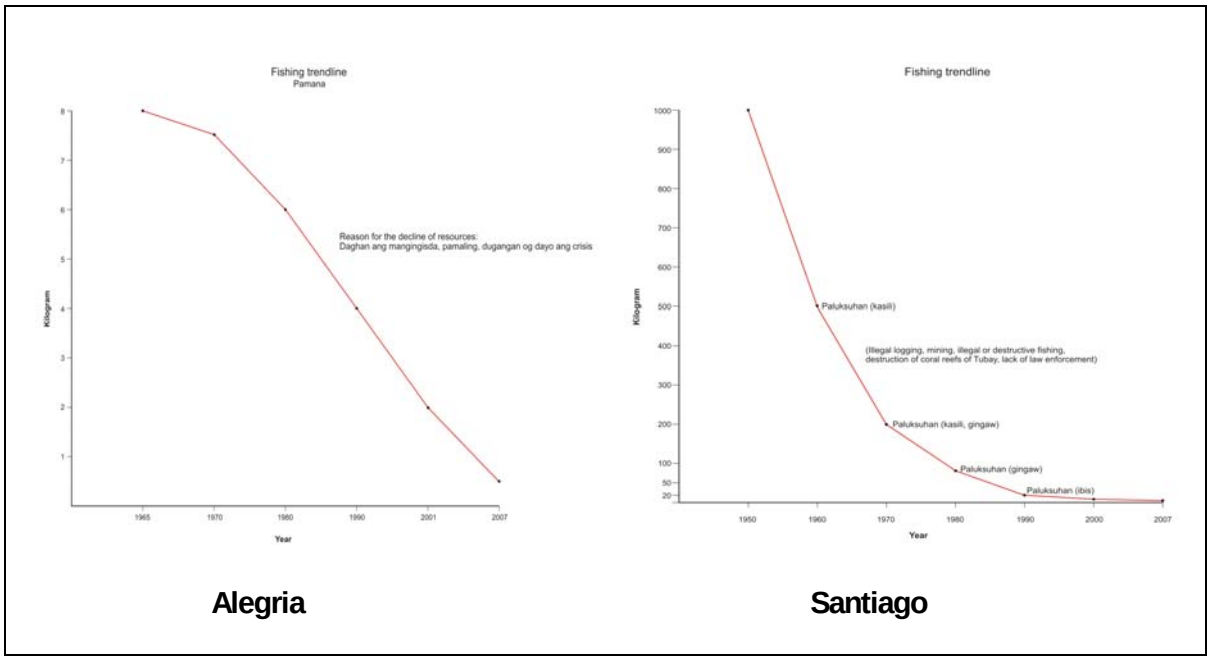


Figure 42. Historical trends in the catches of *pana* in Alegria, Surigao del Norte and of *palaksuhan* in Santiago, Agusan del Norte.

Perceptions of decreasing fish stocks in Lake Mainit can be substantiated by fisheries monitoring data (see Aquatic Inventory and Fisheries Assessment report) generated by this project. The monthly total recorded catch (mean of 17.89 tons) from six municipalities between August and October 2007 is far, far below the 1980-81 catches of 1,259 tons/month from the lake reported by Pauly et al. (1990). Decline in daily catch by fishers over the past decades may have discouraged some fishers from fishing who resorted instead to other livelihood options. Many FGD participants observed that there had been a reduction in the number of fishers in certain areas, such as in Kitcharao and Tubay when compared to 2004 levels (Provincial Fishery Profile). Alegria has only a few full time fishers, presumably because there are now other alternative forms of livelihood such as farming and mining. Yet the perceived decrease in fishers does not indicate lower fishing effort, as the number of fishing boats and variety of gear types continue to increase.

Poor or Ineffective Governance

The rapid decline of fish catch is attributed mainly to overfishing, a consequence of poor or ineffective fisheries management and environmental governance. Although most LGUs have recently enacted municipal fishery ordinances banning destructive or unsustainable fishing gears (such as *baling, sinsin, surit, palaksuhan*), no clear policies on regulating fishing effort are in place. Among the common complaints of lakeshore residents are the poor implementation of fisheries policies, lack of political will of leaders, and insufficient capital and technical support for alternative livelihood.

Degrading Water Quality

Lake Mainit was declared one of the cleanest lakes in the Philippines based on a 2003 report (Tumanda, et al. 2004). Residents, however, observe that pollution from agricultural and mining activities around the lake is degrading the water quality and habitat of fishes in Lake Mainit. Gold mining along the shores of the lake and Kalinawan River is destroying the littoral (or shore) area in many places, threatening the ecology of aquatic plants which are, in turn, natural habitats of fish and shellfish. Siltation especially in river mouths remains unabated, resulting in the shallowing of rivers and the consequent backflow of water during the flood season or *guob*. These distressing scenarios are also observed in other lake ecosystems in the Philippines (Juliano, 1996). There are 28 river tributaries in Lake Mainit coming from relatively denuded watershed areas. Timber and mining operations are considered threats to the fishery and to the fishing communities. Vehement reactions of the stakeholders prompted a halt for companies to engage in large-scale mining operations, and an introduction of tree planting program was initiated by the Gold Phils, Inc. to rehabilitate the area in Mainit (Table 31).

3.4 Management Implications and Recommendations

Statistics on inland capture fisheries and aquaculture production in the Philippines were officially recorded only during the mid-1970s. Thereafter, inland capture fisheries and aquaculture began to contribute to official production statistics (Barut *et al*., 2003). The most comprehensive data on inland fisheries of Lake Mainit were compiled by Pauly et al (1990) based on 1980-81 assessments. The present fisheries stock assessment project is therefore critical to the sustainable fisheries management of the lake. Since the health of Lake Mainit and Kalinawan River ecosystems is closely associated with the condition of the watershed, there is a need to integrate inland fisheries management with a sound watershed management program, aimed at curbing pollution and erosion of the watershed, and thus, protection of fish populations.

Sustainable fisheries management of Lake Mainit entails the development of holistic programs that encourage multi-agency, multisectoral participation. Improving fishery governance must recognize the role of local organizations such as *Bantay Dagat* and FARMCs. Many *Bantay Dagat* volunteers opined that they have been initially vigilant in fishery law enforcement, but were dismayed eventually because of political intervention as regards apprehended violators. Although several cases were filed in court resulting from the vigilance of fishery law enforcement teams, the intercession of local government authorities often ended in amicable settlements (Olifernes, *et al*, undated man.). Repeated violations of Fisheries Administrative Order (FAO) 155 or the prohibition on the use of fine mesh nets are common.

National policies (RA 7160 and RA 8550) placed the management of coastal or municipal waters under the local government. Jurisdictional policies therefore preclude the active participation of the Bureau of Fisheries and Aquatic Resources (BFAR-Caraga) in

fishery law enforcement in the lake. BFAR, however, has active aquaculture programs to enhance fisheries production in Lake Mainit. The municipalities around the lake, through the Lake Management Council, established Fisheries and Aquatic Resource Management Councils (FARMCs) based on Executive Order (EO) 240. The FARMC is an important arm of the LGU in planning and implementing fisheries policy and programs, particularly in regulating effort through issuance of fishing permits and collection of fees from fishermen.

Lake Mainit experiences the typical syndrome of a threatened fisheries: 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. 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. *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.

The LMDA should also address the issue of encroachment of fishing ground perceived by many fishers in the lake. 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.

Results of the rapid appraisal phase of this fisheries resource assessment project have indicated that fish production from the lake has been declining over the years, and that most fishers are earning marginal incomes barely enough to meet basic daily needs such as food, education of children, and health. 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.

The following are suggested activities for sustainable fishery production and improved living conditions of the fisherfolk in Lake Mainit, compiled from FGD participants, key informants in this project, and participants of the validation workshop:

1. Activation and strengthening of fishermen's associations and co-operatives to enable them to undertake resource management activities.
2. Establishment of land-based income-generating activities to alleviate fishers' income and reduce pressure on the lake's fishery resources.
3. Implement research and development (R&D) program to cover ecological monitoring to update limnological data, monitoring of water quality and primary productivity of the lake, fish stock assessment,
4. Technical assistance on sustainable methods of upland farming to protect the watershed areas.
5. Fish stock enhancement through seeding, fish pen/cage culture, establishment and maintenance of fish sanctuaries and other rehabilitation strategies. Introduction of aquaculture (fish pens and cages) in lake waters has significantly increased fish production in some lakes in Asia and the Philippines, provided that the prescribed limit of about 10% of the water area in the lake is strictly observed.
6. Capacity building of resource management bodies (FARMC, *Bantay Dagat*) and LGU staff through training in CRM, fisheries management, fish sanctuary monitoring and other technical skills development.

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. Given the complex and multisectoral character of fisheries management, the existence of a resource management alliance is probably the best hope for the provinces of Agusan del Norte and Surigao del Norte to sustain the aquatic resources of Lake Mainit and Kalinawan River for the present and future generations of fishers.

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Appendices

Appendix Table 1a. Clustered lakeshore barangays per municipality in Surigao del Norte.

Province		Surigao del Norte		
Municipality		Mainit		Alegria
Cluster		1	2	1
Barangay	1	Quezon	Mansayao	San Pedro
	2	Mabini	San Francisco	Alipao
	3	Magpayang	Tagbuyawan	Anahaw
	4	Matin-ao	Tapian	Gamuton
	5	Roxas	Tolingon	Poblacion
	6	San Isidro		Pungtod
	7			San Juan
Total No. of Participants		15	18	22

Note: FGD Venue in no. 1 barangay

Appendix Table 1b. Clustered lakeshore barangays per municipality in Agusan del Norte.

Province		Agusan del Norte					
Municipality		Kitcharao		Jabonga			
Cluster		1	2	1	2	3	4
Barangay	1	Bangayan	San Roque	A. Beltran	Cuyago	Poblacion	Bunga
	2	Jaliobong	Canaway	Baleguian	Magsaysay	Colorado	San Pablo
	3		Crossing				
	4		Sungkoy				
Total No. of Participants		15	18	19	19	23	17

Note: Venue in no. 1 barangay

Appendix Table 1c. Clustered riverbank barangays in Agusan del Norte.

Province		Agusan del Norte			
Municipality		Santiago		Tubay	
Cluster		1	2	1	2
Barangay	1	Poblacion II	Lapaz	Poblacion II	Doña Rosario
	2	Curva	E. Morgado	Poblacion I	Santa Ana
	3	Jagupit	Tagbuyacan	Cabayawa	Tagmamarkay
	4	San Isidro			Victory
Total No. of Participants		24	21	19	16

Appendix Table 2. Some economic parameters of fishing using the popular gears.

Gears	Baling	Bantak	Bingwit*	Taan	Bungsod	Laya	Pana	Pukot**	Timing or Screen
Catch Volume (kg /fishing operation)									
Peak	100-150	80-100 kgs (in 1,000 units)	20	10-15	50	80-100	20	3	100
Lean	18	1-3 kg (in 300-500 units)	3-5	2-3	10-20	3-10	5	1 -2	5-20
Percentage Sold, %	90-100	95-100	90	100	90	95-98	95-98	90	90
Gross Sales, (Pesos/ day)	400-600	200-600	100-200	100-200	300	300-600	100-200	175300	150-300
Fishing Cost, Pesos	200-300	150	50-100	100	100	200-300	75	100	100
Net Income	100-400	50-450	0-150	0-100	200	0-400	25-125	75-200	50-200

Appendix Table 3. Estimated daily expenses of fishing households around Lake Mainit.

Particulars	Unit of measure	Mainit	Alegria	Kitcharao	Jabonga	Santiago	Tubay
Average Family Size	Members	5-9	4-8	4-7	9-10	6-9	5-7
Household expenses:							
Food (rice, viand)	pesos/day	180.00	120.00	160.00	200.00	180.00	190.00
Groceries	pesos/day	10.00	10.00	20.00	15.00	20.00	15.00
Sub-total	pesos/day	**190.00**	**130.00**	**180.00**	**215.00**	**200.00**	**205.00**
Education:							
Tuition	pesos per mo.	75-625	40-750	10 -1,250	75-1500	75-1125	75-2250
Allowance/Baon							
Elementary	pesos/day	10.75	5.00	2.00	3.00	3.50	5.00
High School	pesos/day	20.00	5.00	15.00	17.00	37.50	17.50
College	pesos/day	60.00	20.00	10.00	60.00	12.00	30.00
Sub-total	pesos/day	**90.75**	**30.00**	**27.00**	**80.00**	**53.00**	**52.50**
Medicine and Health	pesos/day	5.00	1.00	1.00	4.00	3.00	3.00
Electricity/Light	pesos/day	17.00	11.00	7.00	4.00	4.00	3.00
Water	pesos/day	1.00	1.00	0.30	0.30	0.30	0.30
Sub-total	pesos/day	**23.00**	**13.00**	**8.30**	**8.30**	**7.30**	**6.30**
Others							
cigarettes	pesos/day	15.00	15.00	15.00	15.00	14.00	13.00
cellphone load	pesos/day	25.00	15.00	10.00	20.00	20.00	3.00
snacks	pesos/day	11.00	62.50	35.00	60.00	6.00	10.00
swertres	pesos/day	10.00	7.00	43.00	35.00	7.50	20.00
tong-its	pesos/day	-	-	-	-	2.50	11.00
Sub-total	pesos/day	**30.00**	**55.00**	**50.00**	**50.00**	**30.00**	**40.00**
Total Expenses	**pesos/day**	**333.75**	**228.00**	**265.30**	**353.30**	**290.30**	**303.80**

Remark: Total daily expenses do not include tuition which is calculated on a monthly basis.