

Lake Lanao: Its Past and Present Status

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Abstract

Geographically located in Central Mindanao, Lake Lanao is the second largest lake in the Philippines. The lake is famous locally for its various uses and internationally for its endemic cyprinids. This paper intends to inform the local leaders and the national planners about Lake Lanao's dwindling fisheries resources, the extinction of some endemic cyprinids, and the current interventions as well as suggested action plans to increase fish production and to conserve the remaining species in the lake. The past and present studies on the lake are also reviewed. Early and latest statistics on the lake's fisheries production are presented to invite the interest of all sectors in coming up with the integrated approach to protect, conserve and increase its fisheries production. Local and national interventions to conserve and increase fisheries production are discussed. These include the setting up of BFAR Fisheries Station in Kialdan, Marantao; the establishment of a fish hatchery in Poona, Marantao by Southern Philippines Development Authority; the formation of Save Lake Lanao Movement by the local leaders; the creation of Lake Lanao Research and Development Council; the current concern of Philippine Council for Aquatic and Marine Research and Development-DOST; and the extension and research and development thrusts of the Mindanao State University, College of Fisheries in Marawi City.

Introduction

Lake Lanao, the second largest lake in the Philippines, is geographically located in the province of Lanao del Sur, Central Mindanao. It lies between 8° N. Latitude and 124° E. Longitude (Lewis 1978). Frey (1969) considered its basin to be volcanic due to its collapse associated with the 1955 earthquake. Frey's study also revealed several morphometric data (Table 1). Lake Lanao has a vast watershed of approximately 147,460 ha (Table 2). It exerts considerable influence over the local climate, making Marawi City the summer capital of Southern Philippines.

The water of Lake Lanao comes from five major river tributaries: Ragain, Taraka, Gata, Masiu and Bacayawan Rivers (Fig. 1). Lake Lanao has only one outlet, the Agus River located at the north. The Agus River is presently tapped by the National Power Corporation (NAPOCOR) to generate electricity. Water flows northward until it drops as the famous Maria Cristina Falls from a vertical height of about 58 m (Villaluz 1966) to mix with the saline water of Iligan Bay.

Table 1. Morphometric and other relevant data on Lake Lanao (After Frey 1969; Villaluz 1966; 1974-1980; Escudero 1994; and Macawaris 1981)

Parameters	Data
Area	357 sq km (34, 700 ha)
Lake basin/origin	volcanic/tectonic
Age	10,000 yrs (late tertiary)
Minimum depth	10 m (north)
Maximum depth	112 m (south)
Mean depth	63.3 m
Water replacement time	6.5 yrs
Average transparency	12 m @ 1% incident light
Lake bottom	bedrocks, sediments, coarse sand (magnetite & garnet), pebbles
Mean discharge	107.71 cu m/sec at 701.89 mean level
Elevation	710 m above sea level
Type	warm monomictic
Primary productivity	highly productive
Planktonic autotrophs	70 species, six families
Zooplankton	calanoid & cyclopeid copepods, cladocerans and chaoborus
Endemic cyprinids	18 species
Watershed	approx. 147, 460 ha
Major river tributaries	Ramain, Taraka, Gata, Masiu and Bacayawan Rivers
Outlet	Agus River (north)
Temperature	@ Surface water 28°C 30 m 26.5°C 40 m below 24.3°C
Oxygen concentration	@ 12 m 7.3-8.5 mg/l 20 m 4.3-5.3 mg/l 90 m 2 mg/l
pH	@ 10 m 8.2-8.9 15 m 7.6 45 m 7.2

Table 2. Basic information on Lake Lanao watershed (95% in Lanao del Sur and 5% in Maguindanao)

Total area	147, 460 ha
Disposable/alienable	45, 460 ha
Timber/forest land	67, 242 ha
For urban development	20, 982 ha
Planted to rice	18, 432 ha
Planted to corn and other crops	37, 307 ha
Mean monthly temperature	23°C
Mean annual rainfall	27.2 mm (evenly distributed throughout the year)

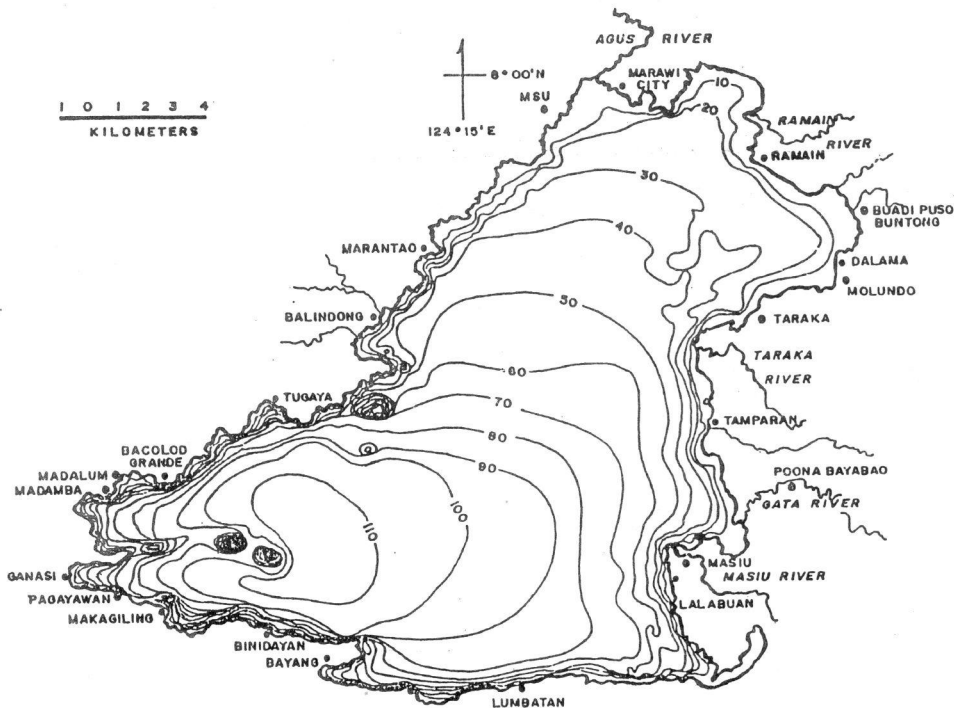


Fig. 1. Topographical map of Lake Lanao showing river tributaries (from Escudero 1995, with permission from the publisher)

Bordering the lake's shores are 17 municipalities and a city, Marawi City (Fig.1) with a total of 390,036 inhabitants and 59,258 households as of 1995. Compared with the other lakes in the country, Lake Lanao is relatively pristine and free from industrial effluents. Ever since, the lake plays vital roles in socio-economic and religious lives of the Maranaos (lake dwellers). Lake Lanao serves as source of water for ablution and domestic use, as transport route and, most importantly, as source of freshwater fishes and shellfishes for local consumption. The general importance of the lake to the Maranaos is best described by Lanao del Sur Governor, Dr. Mahid M. Mutilan, in 1992 when he said, "The value of Lake Lanao to us is certainly immeasurable. Perhaps it is only next to Islam as our most cherished treasure in life. We have survived as a people with distinct civilization mainly because of God's bounties found in the lake. It is because of Lake Lanao that we have sustained human habitation in this part of the country, enjoying a decent livelihood. To say that the lake is a source of life for Maranaos is not an exaggeration. This is because of our peculiar heritage as a distinct people in the Philippine society".

The main objective of this paper is to bring to the attention of the national planners and scientists the current problems faced by the Maranaos and the need for an integrated and/or multi-disciplinary approach to protect, conserve and manage the lake's fisheries resources and its watershed. Past and current studies and concerns on the lake are briefly reviewed. Emphasis is on fisheries production data and suggested action plans.

Studies on the lake

Lake Lanao had attracted the attention of scientists world-wide for a number of reasons. The few accumulated literature on the lake reveal that studies in the past are varied yet limited to few disciplines. Herre (1933) studied the taxonomy of the 18 cyprinids endemic in the lake (Table 3). CE Wood and C Wood wrote in 1963 (unpubl.) a monograph of Lake Lanao fishes based on his collections.

Table 3. Eighteen endemic Lake Lanao cyprinids established by Herre under five genera (after Villaluz 1966)

Scientific name	Local (Maranao) name
<i>Mandibularca resinus</i> Herre*	bagangan sa erungan
<i>Cephalacamsus pachyichilus</i> Herre	bitungu
<i>Ospafulus palaemophagus</i> Herre	bitungu
<i>Ospafulus truncatulus</i> Herre	bitungu
<i>Puntius baolan</i> Herre**	baolan
<i>Puntius amarus</i> Herre	pait; dipura
<i>Puntius binotatus</i> Cuvier & Valenciennes	pait
<i>Puntius clemensi</i> Herre	bagangan
<i>Puntius flavifuscus</i> Herre	tumba
<i>Puntius katolo</i> Herre	katolo
<i>Puntius lanaoensis</i> Herre	kundur
<i>Puntius lindog</i> Herre**	lindog
<i>Puntius manalak</i> Herre**	manalak
<i>Puntius sirang</i> Herre	sirang; tumaginting
<i>Puntius tras</i> Herre	tras
<i>Puntius tumba</i>	tumba
<i>Puntius diza</i> Herre**	diza
<i>Spratillicypris palata</i> Herre**	palata

*Largest of all Lake Lanao cyprinids.

**Species of high commercial value.

Villaluz (1966) attempted to identify and conserve the lake's major fisheries. From August 1967 to June 1968, Frey (1974) conducted a limnological study that described the lake's bathymetry, hydrology and primary productivity. Lewis (1974 and 1978) described 70 planktonic autotrophs and the thermal regime of Lake Lanao. Kornfield and Carpenter (1984) presented systematic and zoogeographic conclusions based on comparative electrophoresis and offered speculations on some of the evolutionary problems that may be irresolvable due to various faunal perturbations. Escudero (1980) investigated the biology of 'kadurog' *Glossogobius giurus* and of the 'tumaginting' *Puntius sirang* Herre, an endemic fish in Lake Lanao. This was followed by the biology and fishery of *Hypseleotris agilis* Herre (Escudero 1983), an accidentally introduced species now abundant in the lake (Escudero 1994). A market survey was conducted which serves as basis for comparison of the lake's fisheries production. The biology of *Puntius tumba* Herre and other endangered native cyprinids and the bathymetry of Lake Lanao are being studied by the Mindanao State University (MSU) in collaboration with the National Mapping and Resources Information Authority (NAMRIA).

Lake Lanao Fisheries Production

Due to limited data, the comparative fisheries production presented herein is confined to the market surveys conducted by Villaluz (1966) in 1963-1964 and by Escudero (1994) in 1990-1991 (Table 4). It is evident that all the endemic and introduced species in Lake Lanao are in a precarious situation. Within the time span of 27 years, the lake's cyprinids suffered a decline of 958,384 kg

Table 4. Comparative fisheries production in Lake Lanao based on market surveys conducted in 1963-1964 (Villaluz 1966) and in 1990-1991 (Escudero 1994)

Species	1963-1964		1990-1991		Decrease	
	kg	%	kg	%	kg	%
Cyprinids*	981,120	49.4	22,736	9.1	958,384	97.7
Mudfish (aruan)	237,250	11.9	9,562	3.8	227,688	96.0
Catfish (katipa)	20,075	1.0	104	0.1	19,971	99.5
Eel (kasili)	2,920	0.2	—	—	2,920	100.0
Popoyo (climbing perch)	9,125	0.5	74	0.03	9,051	99.2
Shrimps (odong)	56,575	2.9	14,530	5.8	42,045	74.3
Shells (soso, etc.)	200,750	10.1	50,886	20.3	149,864	74.6
Common carp	237,250	11.9	176	0.1	237,074	99.9
Tilapia	109,500	5.5	71,056	28.4	38,444	35.1
White goby (kadurog)	127,750	6.4	2,308	0.9	125,442	98.2
Gourami	2,920	0.2	20	0.01	2,900	99.3
Tamban (black bass)	1,095	0.1	—	—	1,095	100.0
Eleotrid (katolong**)	—	—	78,950	31.5	—	—

* Cyprinids comprised only *Puntius sirang*, *P. tumba* and *P. lindog* in 1990-1991

** First noticed in 1997

or about 97.7%. Only three endemic cyprinids (*Puntius sirang*, *P. tumba* and *P. lindog*) remained out of the 18 species reported by Herre (1933). The rest are no longer seen in the Marawi City market today. Other indigenous species like the mudfish *Ophicephalus striatus*, catfish *Clarias macrocephalus*, climbing perch *Anabas testudineus*, and gourami *Trichogaster pectoralis* had also shown tremendous decline ranging from about 96-99.5%. The eel 'kasili' is already extinct.

Among the introduced species, the common carp *Cyprinus carpio* exhibited a very deplorable decrease of 99.3%. This is followed by the white goby *Glossogobius giurus*, locally known as 'kadurog', at 98.2%. Nile tilapia *Oreochromis niloticus*, locally called 'mampawi', has suffered relatively less but alarming decrease of 35.11%.

Past and Present Concerns

The concerns of Lake Lanao are diverse and aimed at increasing fisheries production, utilization of the lake water for various purposes, and conservation/preservation of its commercial endemic finfishes and watershed. Except for the second, the other concerns had been pursued at snail pace which led to the disappearance of 15 endemic cyprinids.

Fish production

The aim of increasing fish production of the lake through the introduction of other fish species (Table 5) had been vividly described by Villaluz (1966). In 1915, common carp *Cyprinus carpio* L. from Hongkong and Canton, China were stocked in Lake Lanao. In the

Table 5. Introduction of fish species into Lake Lanao *

Species	Year	Responsible Agency/Person	Status
<i>Cyprinus carpio</i> Linn.	1915	Seale and Herre	endangered
	1926	H.R. Montalban	
<i>Micropterus salmoides</i> Lacepede	1945	Alvin Seale	extinct
<i>Trichogaster pectoralis</i> Pallas	—	—	endangered
<i>Tilapia mossambica</i> Peters	1955	Accidental	endangered
<i>Chanos chanos</i> Forskal	1955	Bureau of Fisheries**	extinct
	1962		
	1963		
	1964		
<i>Glossogobius giurus</i> Ham. & Buch.	1960	Accidental by PFC	endangered
<i>Hypseleotris agilis</i> Herre	1977	unknown	abundant

*Sources: Villaluz (1966) and Escudero (1994)

**Later known as Philippine Fisheries Commission (PFC) and now Bureau of Fisheries and Aquatic Resources (BFAR)

same year, black bass *Micropterus salmoides* locally called 'tamban' was also stocked. In 1926, the lake was restocked with common carp from Formosa (Taiwan). The gourami *Trichogaster pectoralis* was brought into the Philippines in 1938 from Bangkok, Thailand and was later stocked into the lake. *Tilapia mossambica* was likewise brought into the country from Bangkok and later found its way into the lake when an earthquake destroyed the surrounding tilapia ponds in 1955. The white goby *Glossogobius giurus* Hamilton and Buchanan was noticed sometime in 1960. It is believed that the species was accidentally stocked when the Bureau of Fisheries, later known as the Philippine Fisheries Commission (PFP), released milkfish *Chanos chanos* fry into the lake. The eleotrid *Hypseleotris agilis*, locally called 'katolong', was first noticed in 1977 (Escudero 1994). Like the white goby, *H. agilis* is believed to have been accidentally stocked into the lake. The species is a native and an important fishery in Lake Mainit, bounded by Agusan del Norte and Surigao. Today *H. agilis* is an important fishery in Lake Lanao. What is presently alarming is the presence of the Taiwanese catfish in the lake. Nobody knows who introduced the catfish and when it got into Lake Lanao.

Lake conservation

Owing to the need of conserving and protecting the lake's resources, the College of Fisheries of Mindanao State University (MSU) in Marawi City was established in 1963. The College was mandated to train skilled manpower in aquaculture, to do research, and extend free services to local fish farmers. Deeply concerned with the continued decline of the lake's important fisheries, the College thought of enhancing the fish stocks through seed dispersal and lake stocking. The job is enormous and needs external assistance. In August 1994, the President of the MSU and the Governor of the Province of Lanao del Sur signed a Memorandum of Agreement (MOA). As agreed upon, the

provincial government provides an annual budget of one-half million pesos while MSU takes care of carp and tilapia fingerling production for lake stocking. Facilities are under construction and, once completed, about a million fingerlings shall be produced monthly for lake stocking and dispersal to local fish farmers.

Again, deeply concerned with the deplorable status of the lake's major fisheries, the MSU through its College of Fisheries and in collaboration with the Philippine Council for Aquatic and Marine Research and Development of the Department of Science and Technology (PCAMRD-DOST) sponsored Lake Lanao R&D Planning Workshop at the MSU campus on November 21-23, 1996. The forum was well attended by representatives from both government agencies and non-government organizations. The planning workshop came up with research and development (R&D) plans. Some of the proposals had been packaged for implementation in 1998. PCAMRD-DOST also extended funding for *in situ* training of local fish farmers by the College and for the studies on the biology of the remaining endemic cyprinids.

Aquaculture projects

To complement its classroom instruction and role in research and development, the MSU College of Fisheries is doing community service that include technical assessment and trouble shooting of prospective and existing aquaculture projects around the lake. In 1996 and 1997, the College had served 10 clients and distributed carp and tilapia fingerlings and breeders for free.

In addition to the establishment of the MSU-College of Fisheries, the government thru the former Philippine Fisheries Commission (now Bureau of Fisheries and Aquatic Resources, BFAR) established a Demonstration Farm Station at Kialdan, Marantao in 1963. The station has 5 ha of freshwater fishpond and a hatchery for carp and other freshwater fishes. Since its establishment, the station had served a number of clients through seed dispersal and had stocked the lake with carp and tilapia fingerlings.

The Southern Philippines Development Authority (SPDA), a government corporation, established an 18-ha freshwater fishpond and a freshwater hatchery in 1980. As conceived, the fishpond was designed to produce 3,000–5,000 kg of carp and tilapia/hectare/cropping to augment the lake's dwindling fish production. The hatchery, on the other hand, was programmed to produce monthly 1-1.5M carp and tilapia fingerlings. In addition, SPDA had also put up fish cages and fish pens in some strategic areas in the lake for demonstration and production purposes. The SPDA project was profit-oriented so that all its produce had been sold to the local consumers. For some reasons, the project stopped operations.

Hydroelectric power plants at the lake's outlet

Due to the energy crises confronting the country in the 1970's, the National Power Corporation (NPC), a government corporation which develops and operates power plants in the Philippines, conceptualized the development of hydroelectric power plants along Agus River. The River has a total drop of about 702 m on 36.5 km from Lake Lanao to Iligan Bay (Macawaris 1981). Because of the topographical constraint, 687.1 m (about 98%) of the total gross head could only be utilized for electrical power generation along the river. As planned in 1975, NPC shall establish seven hydroelectric power plants designed with individual capacities as follows:

Agus I	100,000 kw
Agus II	180,000 kw
Agus III	150,000 kw

Agus IV	150,000 kw
Agus V	150,000 kw
Agus VI	200,000 kw
Agus VII	<u>45,000 kw</u>
Total	975,000 kw

The establishment of these series of hydroelectric power plants was based on the idea that water used by the upstream power plant will be reused by the downstream power plants. There are currently six hydroelectric power plants with a total capacity of 719 MW that supply 57.07% of the projected 70% of the power needs in Mindanao by year 2000.

Due to the reported illegal logging in the area and the observations that the lake and its watershed will be unable to cope with the planned series of hydroelectric power plants of NPC, the late President Marcos issued in 1976 an order banning all forms of forest exploitation at the lake's watershed. Consequently, big logging firms which extracted millions of cubic meters of timber in the late 50's until mid 70's had closed shop. However, illegal cutting of trees has remained.

The construction of a 25-m wide Regulatory Dam by the National Power Corporation (NPC) at the mouth of Agus River spawned wide spread unrest among the Maranaos. This led to the birth of Save Lake Lanao Movement (SALAM) in the late 80's. The movement contends that when Agus I hydroelectric plant (HEP) located near the mouth of Agus River is fully operational, the lake level will fluctuate from an elevation of 702 m to 698.15 m above sea level (MSL) or a drop of about 4 m. Lakewater level fluctuations may have adverse effects which include the following:

- Exposure of 23 sq km littoral zone, causing serious damage to fish and their habitat;
- Planting rice in the lowland ricefields in the municipalities of Ragain, Ditsaan, Tamparan, Mulondo, Masiu, and Taraka will no longer be feasible;
- Rain-fed areas are no longer suited to rice farming from January to May. Farmers have to shift to corn during those months and plant rice in June to November;
- Ragain, Taraka, Gata and Masiu Rivers may no longer be efficient for navigation due to the shallowing of their entrances, which may increase passengers' fare and the cost of transporting goods;
- Maranaos have to walk up to 200 m to fetch water for domestic use; and
- Exposure of lake beds fronting the piers of mosques around the lake pose ablution problem among the Maranaos who pray five times a day.

The creation of Lake Lanao Watershed Protection and Development Council

Due to the adverse effects of hydroelectric power plants, controversy between SALAM and NPC heightened and became a national issue in the early 1990's. In response, the national government, through the Senate Committee on Mindanao Affairs (chaired by Senator Aquilino Pimentel, Jr.), conducted a series of public hearings with the Maranaos. As a result, President Corazon C. Aquino issued a Memo Order No. 421 dated 25 March 1992 creating the Lake Lanao Watershed Protection and Development Council with the following composition: DENR Secretary, Chairman; NPC President, Vice Chairman; and AFP Chief of Staff, SALAM Chairman, MSU President, PCCI Representative, MAEC Representative, ARMM Governor as members.

Sensing the urgency in resolving the issue, President Fidel V. Ramos operationalized and strengthened the council by issuing a Memo Order No. 30 dated 14 August 1992, Prescribing Measures to Protect Lake Lanao and Its Watershed Environs. The Memo Order specified the Council's functions

to prepare and implement the watershed protection plan; procure and install hydraulic monitoring devices; establish watershed databank; conduct watershed studies; and prepare and submit policy recommendations to the President.

As an initial step, the council members agreed to create a research unit known as Lake Lanao Environmental Studies and Natural Resources Management and Development Center (LLESNRMD). Pursuant to the council's desire to operationalize the center during its meeting in April 1994, the MSU Board of Regents approved BOR Resolution No. 99 Series of 1994 formalizing the Center's existence. As an implementing arm of the council, the Center is mandated to:

- Conduct relevant research in agriculture, fisheries, forestry, engineering, and socio-economics;
- Establish institutional data bank useful for policy formulation geared towards the protection and management of Lake Lanao;
- Prepare and assist in the implementation of the watershed protection and development plan;
- Acquire and install equipment and instruments for research and monitoring purposes;
- Assist in the implementation of appropriate technology transfer to the affected inhabitants in the watershed areas;
- Coordinate with government and private institutions engaged in watershed development and protection; and
- Prepare and submit policy recommendations to the Philippine President.

As with the other agencies, the Center's difficulty in pursuing its goals is due to financial constraint.

Initiatives of NPC regarding Lake Lanao

The National Power Corporation (NPC), in its desire to resolve the issue, had outlined a number of R&D programs as embodied in its vision and mission. It operationalized its Watershed and Environmental Management Division (WEMD) under the Power Generation Group on July 6, 1994. For a start, WEMD is engaged in a collaborative study with PAGASA on climate change at Lake Lanao watershed. NPC has supported financially and cooperated with the programs and activities of the Center (LLESNRMD) as discussed earlier. It had also extended cooperation in the manner of representation in the activities of NGOs such as the Mindanao Green Alert Coalition (MIGACO) which formed a study group on November 30, 1996. For the management of Lake Lanao-Agus River watershed, NPC commissioned PICOP to prepare the Lake Lanao-Lanao Agus River Watershed 10-year Comprehensive Development Plan in 1992. The Watershed Management Department Head Office, thru its Resource Development Division, prepared a feasibility study for agroforestry development in the idle areas of Agus II HEP compound in June 1994 per request of Agus II HEP management.

Problems and Suggested Action Plans

Judging from the past fisheries statistics and present observations, the decline of the lake's important fisheries and the possible extinction of the remaining endemic cyprinids are quite alarming. These problems may be caused by the proliferation of a predatory eleotrid, indiscriminate harvesting of gravid fish, and use of illegal fishing methods (Escudero 1994). The decline of the lake's indigenous and introduced species has caused tremendous increase in prices of the locally caught fishes. A kilo of carp or tilapia now sells at P120.00–P200.00/kg or even higher during the month of Ramadan. Unlike in the early 60s when harvests from the lake were bountiful, the Maranaos today have no other recourse but to buy carp, mudfish and tilapia from Butuan, Surigao, Cotabato and Zamboanga.

What is deplorable is that the Marawi City wet market is flooded with marine fishes (which the Maranaos do not prefer to eat) coming from Iligan City.

By looking deeply into the problems of Lake Lanao and its watershed, one can discern a more serious problem that needs urgent solution, i.e., alleviation of the adversely affected fishermen and farmers around the lake. Illegal logging and illegal fishing will remain unabated if these segments of Lake Lanao watershed inhabitants would not find alternative livelihood. They would not appreciate any R&D projects if they remain poor. They would not cooperate with any scientist if they do not understand the value of their work. History tells us that any intrusion to Lake Lanao spawns suspicions and animosities.

The following action plans are hereby advanced:

- Conduct socio-economic studies around the lake in preparation for R&D programs;
- Zoning of Lake Lanao's immediate watershed and shallow/protected areas for fishponds and fish pens/cages purposes;
- Promotion/establishment of barangay type freshwater fish hatcheries for carp/tilapia fingerling production;
- Extension of supervised credits/loans to fishpond, fish pen, fish cage and fish hatchery operators by Land Bank, Development Bank of the Philippines, and other lending institutions;
- Information drive in lake fisheries management by academic and research institutions;
- Stock enhancement by the stakeholders or fish hatchery operators;
- *In situ* training of local fish farmers on hatchery and fishpond management;
- Establishment of a feed mill to meet the feed requirements of the local fish farmers at reasonable cost;
- Conduct biological/ecological studies of endangered species;
- Conduct studies on the effects of NPC dams along Agus River on the downstream and upstream migration of fishes;
- Establishment of orchards around Lake Lanao watershed or planting of crops that do not need intensive soil tilling to prevent lake siltation;
- Screening of species to be stocked/introduced into Lake Lanao;
- Interdisciplinary/integrated/holistic approach of R&D Programs; and
- Integration into the elementary and secondary curricula the essentials of environmental management and conservation of natural resources.

There may be other solutions to the problems in Lake Lanao and its watershed, but what is more important is the unselfish commitment and dedication of the stakeholders, researchers, and concerned government institutions in implementing the plans.

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