

# Laguna de Bay

## 2013 Ecosystem Health Report Card

*Ibalik ang  
diwa ng lawa*

*Restore the ecological  
balance of the lake*






















# Laguna de Bay, a special ecosystem

Laguna de Bay is the largest inland water in the Philippines and the third largest in South East Asia. The lake has a surface area of 900 km<sup>2</sup>, with an average depth of about 2.5 meters and an elevation of about 1 meter above sea level. It is bordered by the province of Laguna in the east, west and southwest, the province of Rizal in the north to northeast, and Metro Manila in the northwest. The lake features three distinct bays, the West Bay, Central Bay and East Bay that converge at the South Bay. The West Bay watershed is the most populated and heavily developed, mainly because it includes part of Metro Manila, while the East Bay, the least. The West and Central Bay are separated by Talim Island, the biggest and most populated island within the Lake. The lake's only outlet is the Napindan Channel which is connected to Manila Bay via the Pasig River.

## Natural resource values and human activity threats



**VALUES:** Laguna de Bay is a multi-use water resource, supporting agriculture, livestock and poultry , and various industries . Local populations rely on both aquaculture in fish pens and cages  and traditional fishing  for commerce and food. Water extraction  provides drinking water, industrial cooling and hydroelectric power generation . The lake provides transportation  and recreational opportunities  for the general public. Laguna de Bay and its watershed are rich in biodiversity, serving as a flyway sanctuary for migratory birds .

**THREATS:** The impacts of rapid population growth  and urbanization  are causing severe stress to the lake environment and the watershed. Untreated domestic sewage (i.e., informal waterway settlements , sediment  and nutrients  from agricultural, industrial, and mining  activities flow into either the lake or its many tributaries, leading to poor water quality and ultimately, harmful algal blooms , and fish kills. Invasive species such as the clown knife fish  threaten native fish stocks. To attempt to regulate saltwater intrusion , flooding, and pollution flowing between the Pasig River and the lake, the Napindan Hydraulic Control Structure  was constructed in 1983. However, it was not operated to regulate saltwater intrusion due to strong protest from the Fisheries sector since periodic salt water intrusion is favorable to fisheries.

# How ecosystem health is measured

Recognizing the importance of Laguna de Bay, this first ecosystem health report card is designed to provide a better understanding of the current ecosystem health, particularly as water quality improvement strategies are developed.



View of the West Bay. Photo: Vanessa D. Vargas

Two workshops were conducted. The first workshop in December 2013 discussed the framework for the report card; identified the target audience and proposed indicators, sub-indicators and thresholds; and, determined the key messages.

During the second workshop in June 2015, the initial grades for the four sections of the bay were calculated and the report card framework was drafted. Indicators for **Water Quality** and **Fisheries** were selected to measure the ecosystem health of Laguna de Bay. Taken together, these indicators stand for the values of the lake and the threats that it is currently faced with.



Participants of the Second Laguna de Bay Report Card Workshop.

List of participants: Nancy Bermas and Daisy Padayao (Partnerships in Environmental Management for the Seas of East Asia); the Laguna Lake Development Authority Technical Working Group: Adelina Santos-Borja, Jocelyn Sta. Ana, Rose Bonifacio, Neil Varcas, Ireneo Bongco, Rosemary Cabrera, Gregory Ongjoco, and Marilyn Apacionado; Dr. Adelaida Palma (Bureau of Fisheries and Aquatic Resources); Dr. Gil Jacinto (University of the Philippines-Marine Science Institute); Dr. Macrina Zafaralla (University of the Philippines-Los Baños); Dr. Rey Papa and Millette Mendoza (University of Santo Tomas); and the Science communication team: Dave Nemazie, Dr. Simon Costanzo, and Vanessa Vargas (University of Maryland Center for Environmental Science).

## Water quality indicators

**NO<sub>3</sub><sup>-</sup>**

**Nitrates** in excess amounts cause dramatic increases in aquatic plant growth and changes in the types organisms that live in the lake. Sources include fertilizers, drainage from livestock feeds, as well as domestic and industrial discharges.

**PO<sub>4</sub><sup>-3</sup>**

**Phosphates** come from agricultural runoff, animal waste and sewage. Phosphorous is also one of the main component of synthetic detergents.



**Chlorophyll a** measures the amount of phytoplankton that can cause algal blooms. Algal blooms by blue-green algae are an indicator of deteriorating water quality and pollution.

**DO**

**Dissolved oxygen (DO)** is vital for the survival of fish and benthic organisms in the lake.

**BOD**

**Biological oxygen demand (BOD)** is the amount of oxygen required by microorganisms for stabilizing biologically decomposable organic matter in water under aerobic conditions. High BOD levels are associated with organic pollution, such as sewage.



**Total coliforms** is a measure of animal bacteria that enter the lake by direct deposition of waste in the water and runoff from areas with high concentrations of animals or humans.

## Fisheries Indicators



**Zooplankton** ratio can be used to indicate changes in the trophic state of the lake, level of eutrophication and warming history. Decreasing calanoid to cyclopoid ratio indicates deteriorating trophic state; the lower the calanoids, the higher the trophic state of the lake. In Laguna de Bay, the only remaining calanoid copepod is the invasive *Arctodiaptomus dorsalis*, which has already displaced previously recorded native calanoid species in the lake.



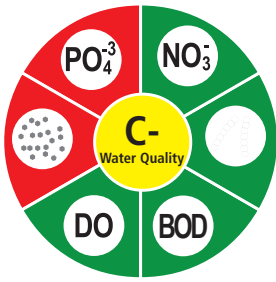
**Native fish species** composition measures the proportion of native against introduced/invasive species in major catch composition.



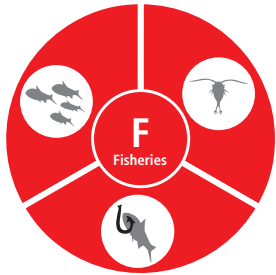
**Catch per unit effort** is computed from the average total daily catch and the total number of fishing hours.

# 2013 Laguna de Bay ecosystem

## LAGUNA DE BAY



Laguna de Bay scored a low passing mark, 76%, a C-, in water quality. The bay consistently is within the Department of Environment and Natural Resources (DENR) guidelines for class C waters in DO, BOD, Nitrate, and Total Coliforms. However, it scored 0% in Chlorophyll and 59% in Phosphate. Water quality was affected by high population and industrialization.



The lake received an F in Fisheries (48%), with a 53%, 68%, and 22% scores in fish native species composition, zooplankton ratio, and catch per unit effort (CPUE), respectively. Invasive fish species and competition among fisher

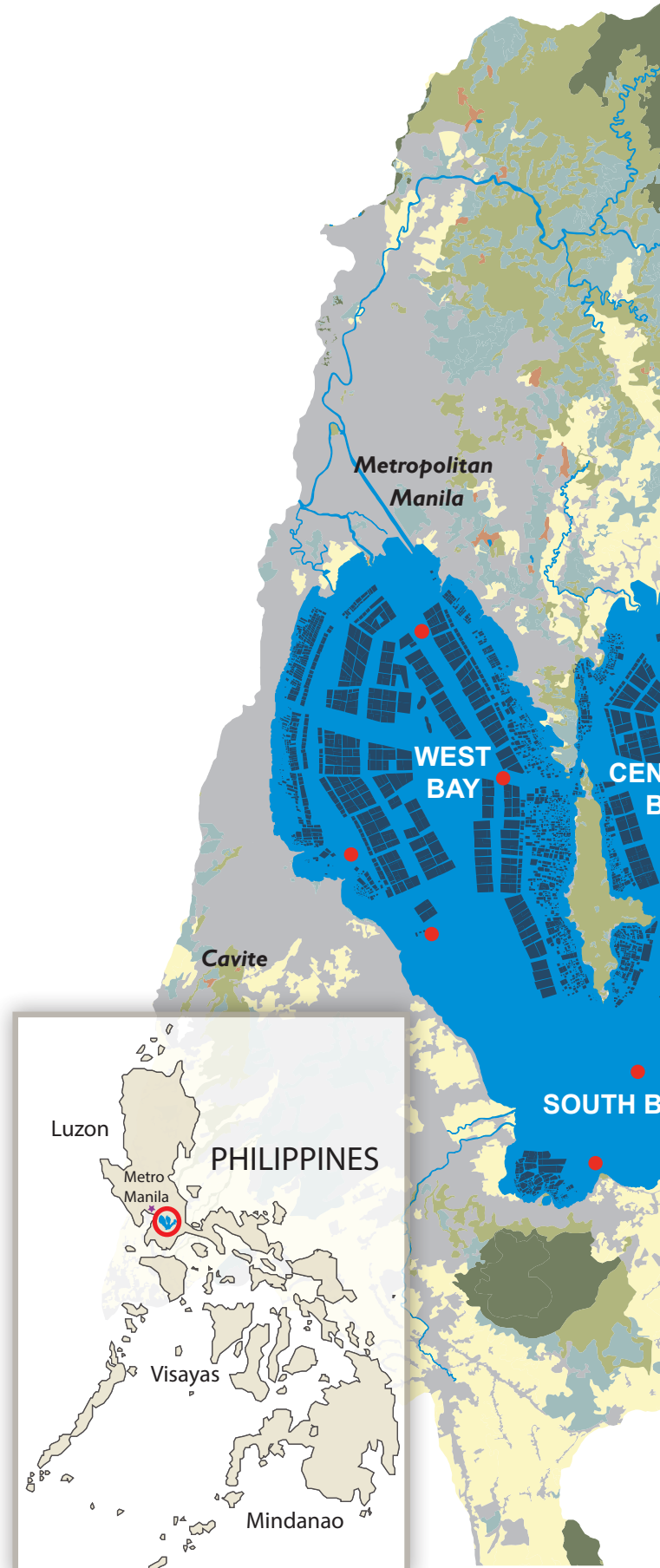
folks contributed to the low scores.

Even though the DENR guidelines are met in most water quality indicators, the chlorophyll a, phosphate, and zooplankton scores show that the lake is highly eutrophic. These results have a negative impact on the fisheries of Laguna de Bay. Overall, these scores are not only a cause of concern for fisheries, but the whole community and all the industries supported by the lake.

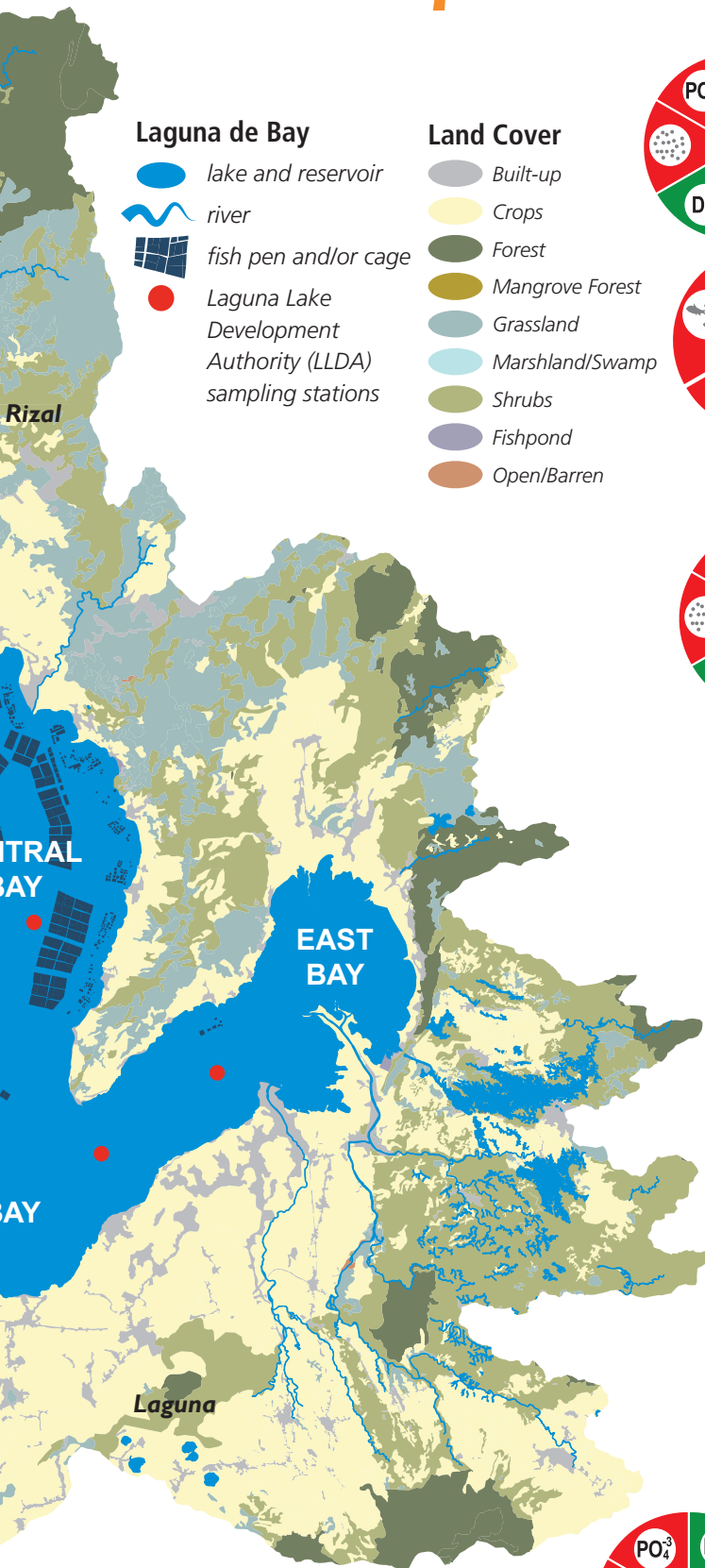
## How are the scores calculated and what do they mean?

The 2013 Laguna de Bay report card measured indicators for water quality and fisheries for the West, Central, East, and South bays. Six water quality indicators were compared to the Department of Environment and Natural Resources (DENR) guideline for class C (suitable for fisheries and recreation) waters which were then combined and then represented as a percent score for each bay. The three fisheries indicator were calculated as ratios or percentage that are then combined as a percent score for each bay. The grading scale follows the typical scale used in Philippine schools.

- A** 91–100%: All the indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to preferred habitat conditions for aquatic life.
- B** 83–91%: Most indicators meet desired levels. Quality of water in these locations tends to be good, often leading to acceptable habitat conditions for aquatic life.
- C** 75–83%: There is a mix of good and poor levels of indicators. Quality of water in these locations tends to be fair, leading to sufficient habitat conditions for aquatic life.
- D** 70–74%: Some or few indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to degraded habitat conditions for aquatic life.
- F** 0–70%: Very few or no indicators meet desired levels. Quality of water in these locations tends to be very poor, most often leading to unacceptable habitat conditions for aquatic life.



# Water health report card WEST BAY



## Laguna de Bay

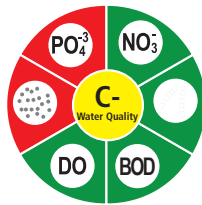
- lake and reservoir
- river
- fish pen and/or cage
- Laguna Lake Development Authority (LLDA) sampling stations

## Land Cover

- Built-up
- Crops
- Forest
- Mangrove Forest
- Grassland
- Marshland/Swamp
- Shrubs
- Fishpond
- Open/Barren

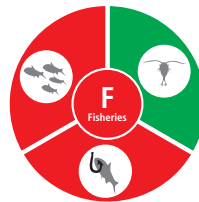
## WEST BAY

The West Bay has the second lowest water quality score (76%). It is the most heavily developed side of Laguna de Bay and most populated. For 2013, its DO, BOD and Nitrate were within DENR's guideline for class C waters (100%) and its total coliform at 98%. However it has the second lowest score in phosphate (56%) and like all the bays, received a 0% in chlorophyll. This scores reflect its high population density and the need to reduce phosphorus runoff into the lake..



The West Bay also has the second highest fisheries score of 55% (F), with a 62% score in zooplankton ratio, and CPUE (35%) and the second highest score in native fish species composition at 68%. This region has the highest concentration of commercial fish pens and cages, and an estimated fishing ground allocation of 1 fisher/101 ha.

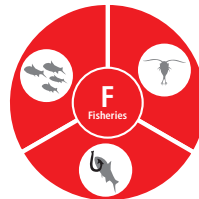
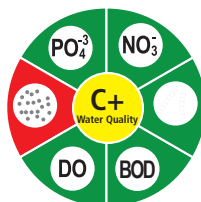
## CENTRAL BAY



The Central bay has the lowest water quality score at 71%, however, its 65% score in Fisheries is the highest. Although it scored 100% in nitrate, DO, BOD, and total coliform, it had the lowest score in phosphate with 25%, and a 0% in chlorophyll a.

The Central Bay has the highest in percentage of native fish in catch composition and zooplankton, with a score of 69% and 100%, respectively. It has approximately 1 fisher/110 ha of fishing ground allocation.

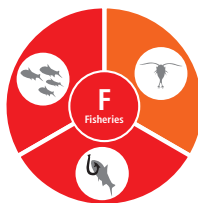
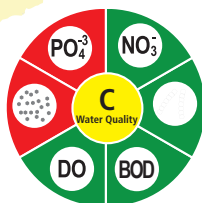
## EAST BAY



The East Bay has the highest water quality score at 81%. It received an A in all water quality indicators except for chlorophyll a (0%, an F). However, the East Bay scored the lowest in fisheries with 28% scoring a mere 3% in CPUE.

East Bay has a higher number of fishermen operating in a smaller fishing area with a fishing ground allocation of only 1 fisher/28 ha and the highest concentration of the invasive clown knife fish. This species was introduced in the lake through the East Bay and most likely propagated faster because of the East bay's water quality.

## SOUTH BAY



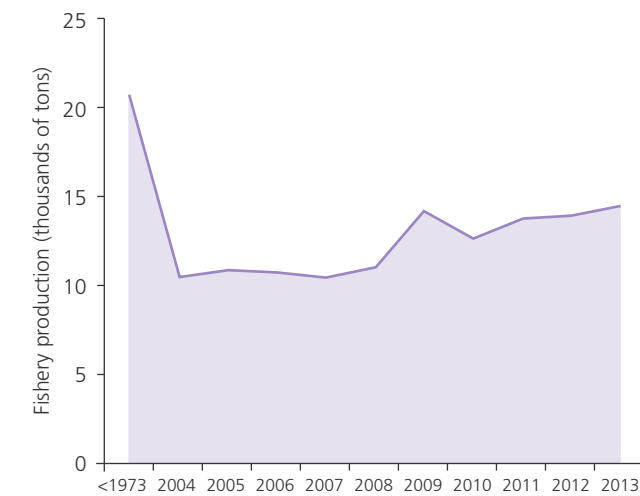
The South Bay has the second best score in water quality at 77%, with 100% in nitrate, DO, BOD, and total coliform. Like all the bays, it has a 0% in chlorophyll a and an F in phosphate at 63%. However, it had the second lowest score in fisheries, 43%, with the lowest score in native fish species composition at 37% even though a designated fish sanctuary is located within the South Bay.



# Fishery production is in trouble

In 2013, Laguna de Bay accounts for 3.1% of the national fisheries production, 2.5% of the national production for aquaculture, and 6.8% of the national production for municipal fisheries (BFAR). The major commercial species caught in the lake included milkfish (bangus), tilapia, bighead, silver perch, and goby (biya).

Fisheries production prior to the introduction of fish pens in 1973 was at 20,700 T/yr. Catch data in 1995 was at 8,146 T/yr before the reported sightings of invasive species. In 1996, catch was at 3,055 T/yr when there were two strong typhoons and catch data were most likely from natural recruitment.



Ten year production trend in Laguna de Bay. Data source: Bureau of Agricultural Statistics.

## Declining water quality and invasive species affect fisheries

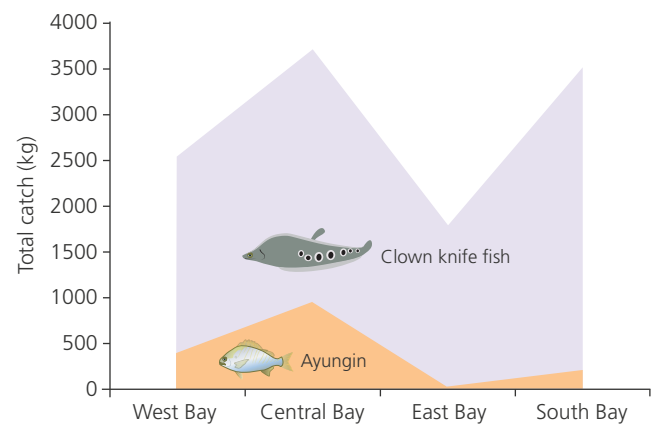
Both cultured and native fish species utilize the nutrients productivity of Laguna de Bay. However, lake water quality has been declining due to:

- land use change from agricultural to industrial and residential;
- industrial pollution, agricultural fertilizer run-off, siltation, and sedimentation; and,
- algal blooms and fish kill events in the Lake.

One of the most important native fishes in the Lake is the ayungin (*Leipotherapon plumbeus*). The highest total catch in 2013 is in the Central Bay, while the lowest is in the East Bay. This can be attributed to the high concentration of the invasive clown knife fish (*Notopterus chitala*) in the East Bay, which prey on ayungin. Clown knife fish eggs also attach to cultured fish cages and pens and once hatched, will feed on the fry and fingerlings of big head carp and bangus. The proliferation of knife fish has caused significant declines in cultured and native fish production.



Bighead carp (*Hypophthalmichthys nobilis*). Photo: Ramon F Velasquez.



Comparison of clown knife fish and ayungin catch from actual sampling in Laguna de Bay in 2013. Data source: Bureau of Fisheries and Aquatic Resources



Algal bloom in tilapia fish pens. Photo: Mark Anthony Salvador

# People can make a difference

## Youth education and involvement

The Laguna Lake Development Authority (LLDA) has a 14-year partnership with the Society for the Conservation of Philippine Wetlands, Inc. and Unilever Philippines called CLEAR (Conservation of Laguna de Bay's Environment and Resources). CLEAR was responsible for the acceptance of Laguna de Bay in the Living Lakes Network and aims to ensure the sustainability of initiatives towards a unified effort to conserve the Lake through awareness campaigns.

CLEAR and its various partners have conducted 16 ecological camps benefitting students from 100 high schools in 13 lakeshore municipalities. At these Eco-Camps, students are taught basic ecological principles and experienced actual rapid wetland assessment and water quality monitoring. To date, the network is composed of about a thousand youth members doing projects in their schools and communities that promote community resilience, climate change mitigation measures and climate change adaptability.

An annual CLEAR Youth Network Congress is being held for participants to report on their accomplishments and plan activities for the ensuing year. It has become a venue for the youth to exchange ideas and information on practices and activities on lake conservation.



Students learn to value Laguna de Bay. Photos: Conservation of Laguna de Bay's Environment and Resources

## Government agencies and local communities work together

An inter-agency technical working group (TWG) was formed to harmonize efforts for the implementation of projects and strategies for the containment of clown knife fish (*Notopterus chitala*) in Laguna de Bay and the preventive measures for further spread into other inland waters. With the theme "Panganib ng Knife Fish Sugpuin; Laguna de Bay Muling Pasiglahin" and "Mapanganib na Dayuhang Isda Pigilang Makawala sa mga Ilog at Lawa", the TWG:

- mobilized fishing communities to participate in the massive retrieval of knife fish;
- conducted experiments to intervene in the life cycle through salinity manipulation and electrocution of eggs;
- provided livelihood opportunities through development of value adding technology for the economic utilization of knife fish;
- conducted an extensive educational campaign; and,
- established and maintained a BFAR (Bureau of Fisheries and Aquatic Resources) interactive invasive fishes webpage for information dissemination and participatory citizen science.

Efforts are paying off—the 2013 fisheries survey showed that knife fish in the total catch was reduced to 10.53% compared to 40.34% in 2011!

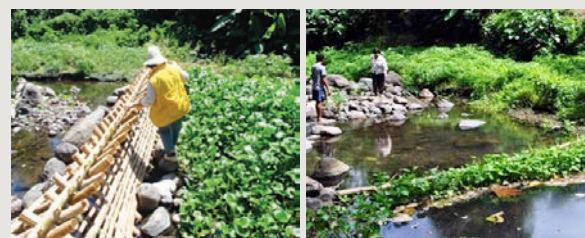


Knife fish collection and creating new knife fish products such as sausages and burger patties. Photos: Bureau of Fisheries and Aquatic Resources

## A new technology helps restore water quality

A simple, cost-effective filtration system is a promising solution to pollution, fish production, and biodiversity problems in Laguna de Bay. It is centered on the University of the Philippines (UPLB) Los Baños' phytoremediation system called the UPLB Aquatic Macrophyte Biosorption System (AMBS). It aims to restore degraded water quality of Laguna de Bay tributaries.

The AMBS system is made of bamboo and water hyacinth (*Eichhornia crassipes*) or kang kong (*Ipomoea aquatica*). Initial data showed visible evidence of habitat restoration, i.e., clearer water after filtration and robust populations of native fish fingerlings in 1–2 weeks. Stream cleanup before installation is needed, thus requiring community cooperation.



Molawin Creek is declared a biopark as water quality improves by the AMBS. Photos: Dr. Macrina Zafaralla (Los Baños Times)

# You can help save the Lake!



Photo: LLDA.

Youths participate in tree planting activity.

## Be conscientious

Properly dispose your household waste and maintain a clean surrounding. Organize and participate in community clean-up and tree planting activities.



Photo: sercul.org

Phosphate free detergents are now available.

## Be proactive

Support environmentally friendly products. Join the campaign to encourage the use of phosphate-free detergents and household cleaners.



Photo: BFAR

Invasive knife fish forum.

## Be informed

Learn about the status of the lake, and existing and future projects of governmental and non-governmental agencies that you can participate in.



Photo: LLDA.

Polluting industry is closed.

## Be vigilant

Report illegal activities and malpractices of the aquaculture, agricultural, and industrial sectors.

# Moving forward with LLDA

The Laguna Lake Development Authority faces a range of daunting challenges that go beyond land degradation, water pollution, and ecological degradation. The interlocking concerns- land use, water quality, reforestation, settlements and shorelines, regulation of fisheries and industries - run into the even larger imperatives of social and institutional reform.

The Lake basin of twenty four (24) sub-basins and river systems encompass close to a half-million hectares, which could not be effectively managed if stakeholders from all sectors - local governments, fisherfolk, the private sector, civil society - are not able to work together, with a shared vision of a re-imagined future for this most critical ecosystem of the country. For this to be sustained as a course of action, sound, science-based governance and new, innovative institutional arrangements - LLDA fully engaging with the widest array of interests and stakes - must be in place. In this day and age of climate change, we can do no less.

As we say, we cannot protect that which we do not value, we cannot value that which we first do not understand. This Ecosystem Health Report Card aids us all in the deeper appreciation of what ails the Laguna Lake - and more importantly, helps us understand how we can all the more value its beauty and bounties, and commit ourselves to restoring, enhancing, and protecting, its ecological wealth.

- HON. J.R. NEREUS O. ACOSTA, Ph.D., Secretary/Presidential Adviser for Environmental Protection, LLDA General Manager



The Laguna Lake Development Authority (LLDA), headed by Sec. Nereus Acosta, is tasked with managing the Laguna de Bay region. Photo: Mark Anthony Salvador

## About the report card

The development of the first ecosystem health report card for Laguna de Bay was jointly implemented by the Partnerships in Environmental Management for the Seas of East Asia Resource Facility and the Laguna Lake Development Authority (LLDA), under the UNEP/GEF Project on Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-based Pollution in Support of Global Nutrient Cycle.



### Key partners

Key partners include the LLDA Technical Working Group, the external experts from the University of the Philippines-Marine Science Institute (UPMSI), University of the Philippines-Los Baños (UPLB), University of Santo Tomas (UST), and the Bureau of Fisheries and Aquatic Resources (BFAR), and the Science communication team from the Integration and Application Network, University of Maryland Center for Environmental Science.



ian.umces.edu

Front cover: Local children playing when the lake overflowed in Wawa, Rizal. Photo: Jon Aguirre.

For more information, visit <http://llda.gov.ph>