*Water Quality Report on*

# MOHICAP LAKE


LAGUNA LAKE DEVELOPMENT AUTHORITY

*Environmental Quality Management Division*

# WATER QUALITY REPORT ON MOHICAP LAKE
## 1996 – 2005

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# MOHICAP LAKE

## LAKE FEATURES

Mohicap Lake is located in Brgy. Sta. Catalina, San Pablo City. It is the smallest among the Seven Crater Lakes. It has an area of 22.89 hectares (228,900 sq. m.) and a maximum depth of 30 meters.

According to the actual inventory of aquastructures conducted in 2004, there were eighty (80) fish pen/ fish cage operators in the lake occupying an area of 36,000 sq. m.

## WATER QUALITY MONITORING PROGRAM

The Laguna Lake Development Authority (LLDA), by virtue of RA 4850, as amended, has the primary responsibility to promote the development of the Laguna de Bay region, while providing for environmental management and control, preservation of the quality of life and ecological systems, and the prevention of undue ecological disturbance, deterioration and pollution.

Since the 1970's, the LLDA has been conducting regular water quality monitoring with the following objectives:

- To accurately assess the suitability of the lake for all its present and intended beneficial uses;

- To evaluate the impacts of development activities on the lake's water quality that will serve as important criteria for environmental planning and management; and

- To provide sound technical basis for water resources management policies and programs for the lake.

Routine monitoring programs conducted by LLDA cover the Laguna de Bay and its tributaries as well as the Seven Lakes of San Pablo City and Tadlac Lake in Los Banos.

One water quality monitoring station was established for Mohicap Lake. During the conduct of the sampling activity, water temperature and dissolved oxygen concentration are measured at the surface (s) and at 2,4,6,10,15,20, and 25 meters depth. A composite water sample from the aforementioned depths is taken for water quality analysis. The chemical parameters analyzed at the laboratory include pH, total suspended solids (TSS), total dissolved solids (TDS), turbidity, chloride, nitrate, ammonia, inorganic phosphate, biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Zooplankton sample is collected by passing five pails of surface lakewater through a 35-micron mesh-sized plankton net. Zooplankton sample is preserved in a 10% formalin solution. On the other hand, phytoplankton sample is taken from a gallon of composite sample, placed in small plastic container and preserved with Lugol's solution. Water transparency is likewise measured and all the physical observations including weather condition are noted and recorded.

At present, monitoring is conducted during the first (January, February, March) and last quarters (October, November and December), as well as in June and September.

## EVALUATION OF RESULTS

Although monitoring of Mohicap Lake was conducted since the 1980s, some problems were encountered, such as equipment breakdown, power interruptions and lack of chemicals, such that analyses of some parameters were not completed.

This report presents the water quality monitoring data from 1996 to 2005 since this period represented a more complete set of data. Data for 2001 were incomplete due to the laboratory repair at that time, hence, they were not included in the statistical analysis.

Monthly data and annual averages are presented in Table 1. The variations of key parameters for the past ten years from 1996 to 2005 are depicted in the figures using a three-year moving trend analysis based on annual means.

Assessment of the water quality was based on the criteria for key parameters for Class C Waters as provided in the DENR Administrative Order No. 34.

Table 1. Water Quality Monitoring Data of Mohicap Lake from 1996 to 2005

| | pH | COD | BOD | NH3 | NO3 | IPO4 | TDS | TSS | Cl |
|---|---|---|---|---|---|---|---|---|---|
| DATE | units | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 1996 | | | | | | | | | |
| 15-Jan-96 | 7.1 | 8 | 1 | 0.8040 | 0.1080 | 0.1706 | 276 | 4 | 19 |
| 7-Feb-96 | 7.0 | 44 | 7 | 0.3500 | 0.0850 | 0.1290 | 261 | 18 | 15 |
| 25-Mar-96 | 7.6 | 56 | 7 | 1.1260 | 0.0590 | 0.0970 | 528 | 1 | 15 |
| 17-Jun-96 | 7.5 | 8 | 4 | 0.8540 | 0.0020 | 0.0780 | 266 | 2 | 19 |
| 2-Sep-96 | 7.9 | 16 | 2 | 0.4840 | 0.0780 | 0.0640 | 234 | 6 | 11 |
| 20-Nov-96 | 7.5 | 24 | 2 | 0.5960 | 0.0180 | 0.0570 | 234 | 12 | 15 |
| 9-Dec-96 | 7.5 | 20 | 7 | 0.4160 | 0.0020 | 0.0480 | 196 | 28 | 11 |
| *Average:* | 7.4 | 25 | 4 | 0.6614 | 0.0503 | 0.0919 | 285 | 10 | 15 |
| *Std.Dev.* | 0.3 | 18 | 3 | 0.2788 | 0.0430 | 0.0442 | 110 | 10 | 3 |
| 1997 | | | | | | | | | |
| 13-Jan-97 | 7.2 | 12 | 4 | 0.7758 | 0.0020 | 0.1041 | 256 | 5 | 19 |
| 10-Feb-97 | 7.9 | 24 | 4 | 0.2163 | 0.0156 | 0.0429 | 259 | 2 | 15 |
| 5-Mar-97 | 8.0 | 24 | 9 | 0.3083 | 0.0069 | 0.3364 | 401 | 61 | 15 |
| 6-May-97 | 8.0 | 20 | 5 | 0.2474 | 0.0162 | 0.4417 | 246 | 4 | 11 |
| 7-Jul-97 | 7.1 | 18 | 3 | 0.0707 | 0.2862 | 0.2396 | 228 | 4 | 15 |
| 8-Oct-97 | 7.1 | 18 | 3 | 0.0707 | 0.2862 | 0.2396 | 228 | 4 | 15 |
| 5-Nov-97 | 8.0 | 24 | 4 | 0.0100 | 0.0142 | 0.0184 | 250 | 2 | 15 |
| 3-Dec-97 | 7.5 | 20 | 3 | 0.2046 | 0.0012 | 0.0110 | 240 | 2 | 11 |
| Average: | 7.6 | 20 | 4 | 0.2380 | 0.0786 | 0.1792 | 264 | 11 | 14 |
| Std.Dev. | 0.4 | 4 | 2 | 0.2402 | 0.1283 | 0.1600 | 57 | 20 | 2 |
| 1998 | | | | | | | | | |
| 7-Jan-98 | 7.2 | 20 | 4 | 0.3490 | 0.3045 | 0.0195 | 235 | 2 | 15 |
| 4-Feb-98 | 7.3 | 20 | 8 | 0.2035 | 1.4326 | 0.0669 | 257 | 2 | 15 |
| 17-Mar-98 | 7.6 | 12 | 5 | 0.5051 | 0.0156 | 0.0182 | 276 | 4 | 11 |
| 20-May-98 | 7.2 | 8 | 8 | 0.8072 | 0.0082 | 0.1170 | 320 | 15 | 15 |
| 6-Jul-98 | 7.3 | 20 | 11 | 0.7240 | 0.0100 | 0.0034 | 275 | 4 | 22 |
| 14-Sep-98 | 7.2 | 4 | 4 | 0.3330 | 0.0060 | 0.0500 | 241 | 4 | 22 |
| 20-Oct-98 | 7.0 | <4 | 4 | 1.0320 | 0.01 | 0.0740 | 272 | 17 | 19 |
| 23-Nov-98 | 6.8 | 4 | 12 | 0.4258 | 0.0060 | 0.0686 | 353 | 8 | 11 |
| 3-Dec-98 | 7.0 | 84 | 12 | 0.6630 | 0.0080 | 0.0610 | 218 | 105 | 7 |
| Average: | 7.2 | 22 | 8 | 0.5603 | 0.1997 | 0.0532 | 272 | 18 | 15 |
| Std.Dev. | 0.2 | 26 | 3 | 0.2659 | 0.4726 | 0.0351 | 42 | 33 | 5 |

0 Noncompliance with DAO 34 Water Quality Criteria

Class C Waters

| | pH | COD | BOD | NH3 | NO3 | IPO4 | TDS | TSS | Cl |
|---|---|---|---|---|---|---|---|---|---|
| DATE | units | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 1999 | | | | | | | | | |
| 25-Jan-99 | 6.8 | 12 | 8 | 1.6530 | 0.0020 | 0.0990 | 259 | 1 | 11 |
| 24-Feb-99 | 7.0 | 24 | 6 | 0.2093 | 0.1270 | 0.0176 | 253 | 7 | 11 |
| 15-Mar-99 | 6.9 | 102 | 14 | 3.3400 | 0.0020 | 0.1090 | 237 | 75 | 11 |
| 10-May-99 | 6.8 | 24 | 5 | 0.0041 | 0.0324 | 0.1349 | 243 | 15 | 11 |
| 15-Jul-99 | 7.4 | 118 | 2 | 0.6068 | 0.0095 | 0.0609 | 234 | 1 | 11 |
| 20-Sep-99 | 7.2 | 10 | 5 | 1.0059 | 0.0027 | 0.0481 | 225 | 1 | 11 |
| 13-Oct-99 | 6.9 | 8 | 6 | 1.1538 | 0.0426 | 0.0861 | 250 | 1 | 22 |
| 10-Nov-99 | 6.9 | 18 | 10 | 2.2064 | 0.0060 | 0.0800 | 243 | 5 | 11 |
| 8-Dec-99 | 6.9 | 72 | 4 | 0.6464 | 0.0068 | 0.0020 | 242 | 1 | 15 |
| Average: | 7.0 | 43 | 7 | 1.2029 | 0.0257 | 0.0708 | 243 | 12 | 13 |
| Std.Dev. | 0.2 | 43 | 4 | 1.0552 | 0.0407 | 0.0431 | 10 | 24 | 4 |
| 2000 | | | | | | | | | |
| 20-Jan-00 | 7.0 | 198 | 5 | 0.4287 | 0.7566 | 0.0501 | 258 | 8 | |
| 9-Feb-00 | 6.9 | 6 | 7 | 1.5516 | 0.0341 | 0.0951 | 252 | 1 | 15 |
| 15-Mar-00 | 7.2 | 20 | 6 | 1.7218 | 0.0020 | 0.1361 | 254 | 4 | 9 |
| 8-May-00 | 7.2 | 12 | 7 | 2.1164 | 0.0020 | 0.1174 | 263 | 3 | 60 |
| 11-Jul-00 | 7.3 | 12 | 4 | 1.6032 | 0.0328 | 0.1123 | 264 | 10 | 15 |
| 25-Sep-00 | 7.0 | 64 | 9 | 1.0524 | 0.0271 | 0.0417 | 227 | 1 | 7 |
| 19-Oct-00 | * | 4 | * | * | * | * | 244 | 2 | 11 |
| 9-Nov-00 | 7.1 | 34 | 11 | 0.7924 | 0.0446 | 0.1464 | 241 | 21 | 7 |
| 7-Dec-00 | 7.0 | 4 | 8 | 0.7578 | 0.0020 | 0.0125 | 250 | 8 | 7 |
| Average: | 7.1 | 39 | 7 | 1.2530 | 0.1127 | 0.0890 | 250 | 6 | 16 |
| Std.Dev. | 0.1 | 63 | 2 | 0.5799 | 0.2607 | 0.0486 | 12 | 6 | 18 |
| 2002 | | | | | | | | | |
| 14-Jan-02 | 6.6 | 32 | 10 | 3.6216 | 0.0297 | 0.2204 | 256 | 3 | 9 |
| 11-Feb-02 | 7.1 | 20 | 4 | 1.9858 | 0.1233 | 0.0659 | 253 | 63 | 9 |
| 2-Mar-02 | 7.2 | 2 | 4 | 1.8523 | 0.0526 | 0.2088 | 273 | 10 | 11 |
| 5-Jun-02 | 7.4 | 6 | 3 | 1.1386 | 0.0010 | 0.1272 | 246 | 2 | 13 |
| 16-Sept-02 | 7 | 36 | 14 | 1.3456 | 0.0309 | 0.0010 | 209 | 3 | 20 |
| 14-Oct-02 | 7.0 | 2 | 10 | 1.5850 | 0.0788 | 0.0392 | 249 | 4 | 19 |
| 18-Nov-02 | 7.2 | 26 | 10 | 0.8591 | 0.0823 | 0.0843 | 249 | 50 | 15 |
| 12-Dec-02 | 7.1 | 16 | 5 | 1.4831 | 0.0455 | 0.1172 | 280 | 3 | 15 |
| Average: | 7.1 | 18 | 8 | 1.7339 | 0.0555 | 0.1080 | 252 | 17 | 14 |
| Std.Dev. | 0.2 | 13 | 4 | 0.8448 | 0.0382 | 0.0772 | 21 | 25 | 4 |

0 Non-compliance with DAO 34 Water Quality Criteria

| | pH | COD | BOD | NH3 | NO3 | IPO4 | TDS | TSS | Cl |
|---|---|---|---|---|---|---|---|---|---|
| DATE | units | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 2003 | | | | | | | | | |
| 20-Jan-03 | 7.2 | 16 | 11 | 1.9352 | 0.0098 | 0.1555 | 251 | 0.5 | 11 |
| 17-Feb-03 | 7.1 | 2 | 9 | 2.1892 | 0.7574 | 0.1267 | 267 | 38 | 9 |
| 17-Mar-03 | 7.2 | 23 | 9 | 2.8026 | 0.2730 | 0.1586 | 266 | 1 | 9 |
| 16-Jun-03 | 6.8 | 2 | 9 | 1.1816 | 0.0383 | 0.1001 | 273 | 26 | 7 |
| 15-Sept-03 | 7.1 | 2 | 4 | 1.2539 | 0.4475 | 0.0727 | 247 | 16 | 22 |
| 20-Oct-03 | 7.1 | 16 | 9 | 1.1319 | 0.0920 | 0.0894 | 243 | 18 | 11 |
| 17-Nov-03 | 6.8 | 4 | 14 | 1.7340 | 0.0470 | 0.0960 | 245 | 18 | 26 |
| 15-Dec-03 | 7 | 2 | | 1.4058 | 0.0010 | 0.1252 | 276 | 2 | 30 |
| Average: | 7.0 | 8 | 9 | 1.7043 | 0.2083 | 0.1155 | 259 | 15 | 16 |
| Std.Dev. | 0.2 | 9 | 3 | 0.5841 | 0.2709 | 0.0312 | 13 | 13 | 9 |
| 2004 | | | | | | | | | |
| 19-Jan-04 | 6.9 | 27 | 12 | 1.5181 | 0.0400 | 0.1895 | 255 | 5.0 | 37 |
| 17-Feb-04 | 7 | 12 | 7 | 2.3794 | 0.0944 | 0.0010 | 260 | 7 | 30 |
| 15-Mar-04 | 6.8 | 54 | 6 | 1.2637 | 0.1677 | 0.1513 | 251 | 9 | 41 |
| 21-Jun-04 | 6.9 | 96 | 11 | 3.3550 | 0.0550 | 0.0635 | 234 | 40 | 11 |
| 20-Sep-04 | 7 | 12 | 14 | 3.1098 | 0.1335 | 0.2539 | 247 | 1 | 15 |
| 18-Oct-04 | 7 | 4 | 15 | 2.7436 | 0.0122 | 0.1248 | 285 | 7 | 19 |
| 22-Nov-04 | 7.2 | 23 | 11 | 2.5079 | 0.0397 | 0.1266 | 251 | 15 | 15 |
| 15-Dec-04 | 7.2 | 8 | 8 | 1.2939 | 0.1643 | 0.0994 | 237 | 5 | 15 |
| Average: | 7.0 | 30 | 11 | 2.2714 | 0.0884 | 0.1263 | 253 | 11 | 23 |
| Std.Dev. | 0.1 | 31 | 3 | 0.8199 | 0.0607 | 0.0768 | 16 | 12 | 11 |
| 2005 | | | | | | | | | |
| 17-Jan-05 | 7 | 12 | 4 | 1.2666 | 0.0305 | 0.0469 | 240 | 5 | 11 |
| 21-Feb-05 | 6.8 | 18 | 10 | 1.5212 | 0.0042 | 0.0803 | 224 | 26 | 15 |
| 14-Mar-05 | 7 | 2 | 8 | 2.2376 | 0.0265 | 0.1743 | 250 | 11 | 15 |
| 20-Jun-05 | 7.1 | 8 | 5 | 1.4031 | 0.0568 | 0.1114 | 1833 | 5 | 15 |
| 15-Sep-05 | 6.7 | 12 | 10 | 1.3008 | 0.0662 | 0.2479 | 229 | 16 | 11 |
| 25-Oct-05 | 7 | 23 | 7 | 0.8619 | 0.0185 | 0.0568 | 231 | 1 | 15 |
| 21-Nov-o5 | 6.9 | 16 | 11 | 1.2204 | 0.0396 | 0.0814 | 253 | 6 | 11 |
| 15-Dec-05 | 6.9 | 4 | 9 | 1.4422 | 0.0010 | 0.1002 | 236 | 10 | 4 |
| Average: | 6.9 | 12 | 8 | 1.4067 | 0.0304 | 0.1124 | 437 | 10 | 12 |
| Std.Dev. | 0.1 | 7 | 3 | 0.3904 | 0.0232 | 0.0673 | 564 | 8 | 4 |

0 Non-compliance with DAO 34 Water Quality Criteria

## pH

pH is an indication of the degree of acidity or alkalinity of a substance.

Most biological and chemical processes in water can be affected by pH. In most natural waters, pH ranges from 6.0 to 8.5. A deviation from this range, therefore, could indicate the presence of pollutants like industrial effluents.

As can be seen from Table 1 and Figure 1, the pH levels for Mohicap Lake were consistently within the desired range of 6.5 to 8.5 as provided in DAO 34.

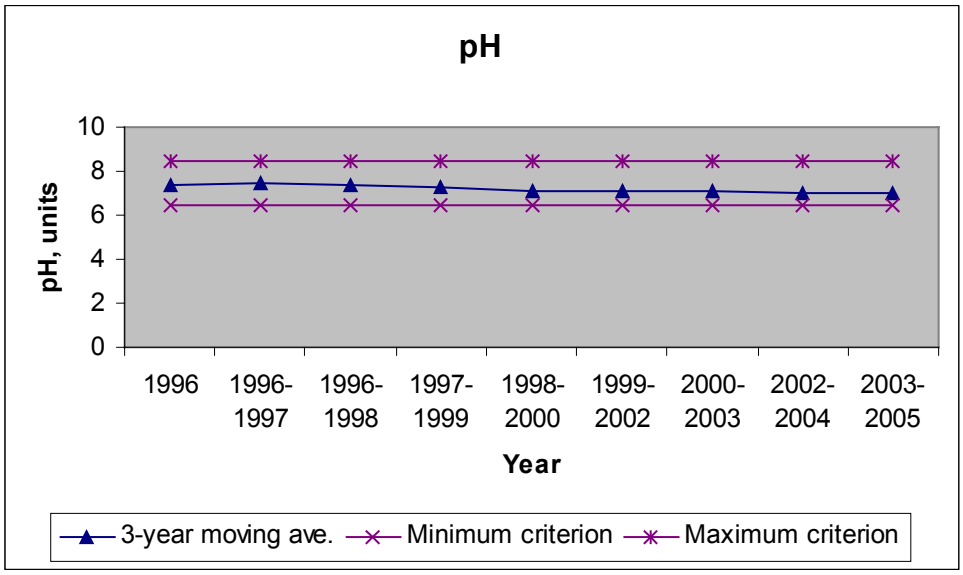


Figure 1. Three-year trend of pH values in Mohicap Lake

## Nitrate (NO3)

Nitrate is the most highly oxidized form of nitrogen found in wastewaters and in trace quantities in surface waters, but may be of high levels in some groundwaters. Nitrate is an important nutrient for many photosynthetic autotrophs and, in some cases, acts as the growth-limiting nutrient.

Among the nutrients that the LLDA regularly monitors in Mohicap Lake, nitrate remained the single least problematic because it never exceeded the 10 mg/L criterion for Class C Waters.

Although there were slight fluctuations in the values of nitrate, it has remained at levels around 0.1 mg/L which is considered as the natural concentration of nitrate in water.

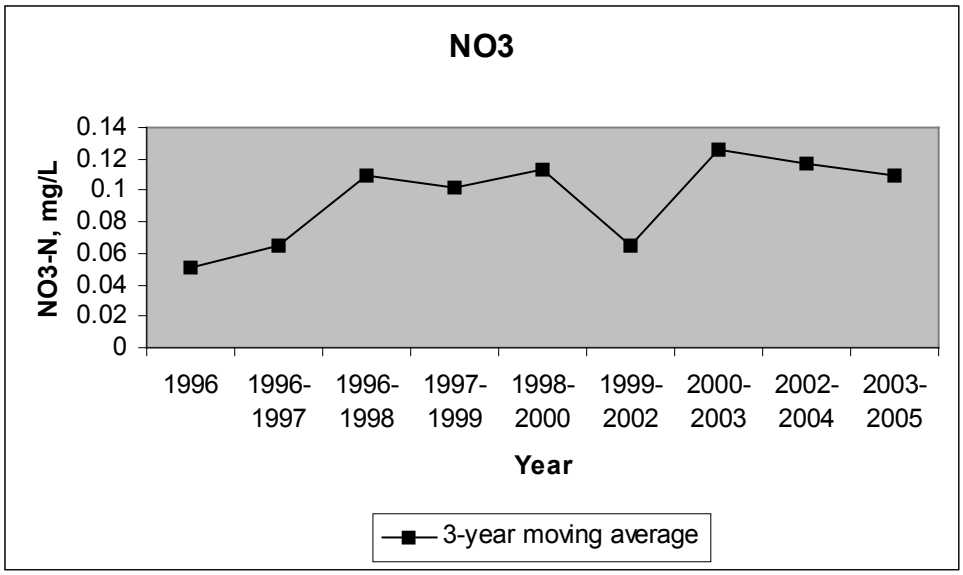


Figure 2. Three-year trend of nitrate levels in Mohicap Lake

## Ammonia (NH3)

Ammonia naturally arises from the breakdown of nitrogenous organic and inorganic matter in soil and water, among others. Ammonia in water may exist either as $NH_4^+$ or $NH_3$. The latter form is considered toxic. Given the pH of natural water (i.e., as in Mohicap Lake), it can be generalized that the measured ammonia largely exist as $NH_4^+$. Hence, we evaluate the result in Figure 3 in terms of $NH_4^+$ concentration.

For lack of a local water quality criterion for ammonium, however, the values within the range of 0.04 – 1.0 mg/L are used. This is set by the European Union as the allowable concentration range for fisheries and aquatic life.

Ammonia concentrations had been almost consistent in its increase starting from 0.5mg/L up to about 2.0mg/L. Based on EU criterion, Mohicap Lake exceeded the allowable level, particularly during the second half of the monitoring period.

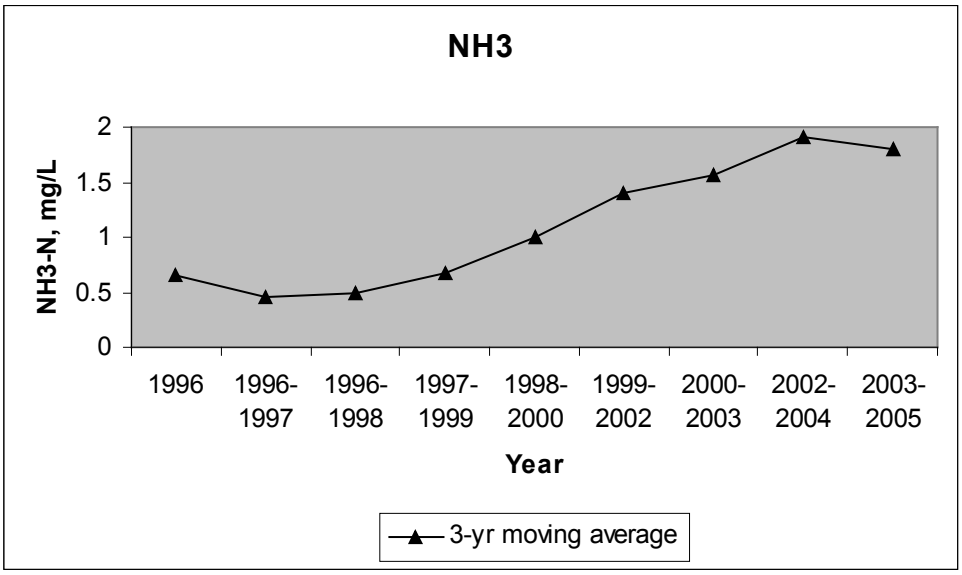


Figure 3. Three-year trend of ammonia levels in Mohicap Lake

## Inorganic Phosphate (IPO4)

Phosphorus, an essential nutrient, may exist in water either in dissolved or in particulate form. In most cases, it is the limiting nutrient for algal growth. Thus, it is important that phosphorus be maintained at safe levels to retard the process of eutrophication.

For Class "C" waters, the allowable phosphate concentration is set by DAO 34 at 0.4 mg/L When applied to lakes and reservoir, the phosphate concentration should not exceed an average of 0.05 mg/L nor a maximum of 0.1 mg/L.

As can be seen in Figure 4, the phosphate levels in Mohicap Lake has consistently exceeded the allowed average of 0.05 mg/L.

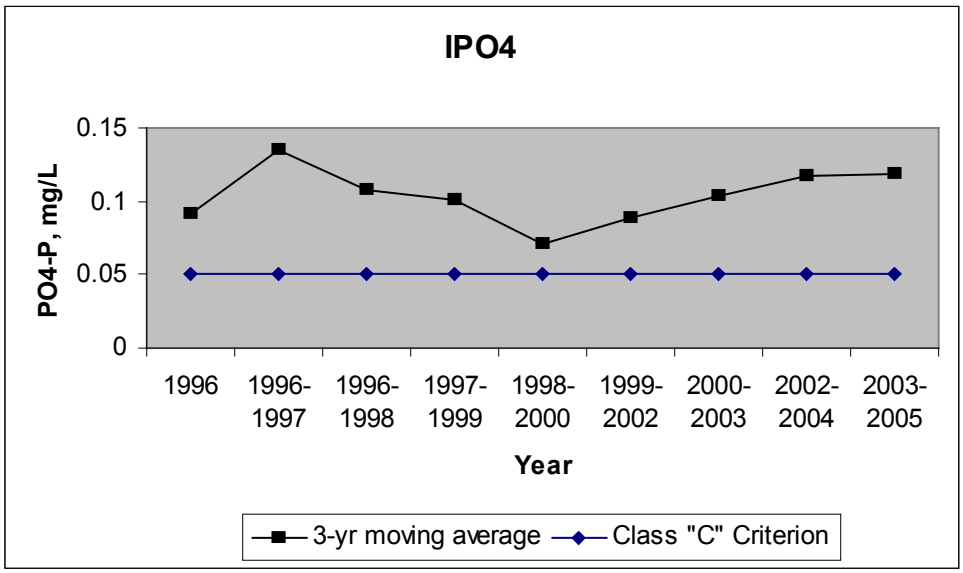


Figure 4. Three-year trend of phosphate levels in Mohicap Lake

## Total Dissolved Solids (TDS)

Dissolved inorganic materials include calcium, bicarbonate, nitrogen, phosphorus, iron, sulfur and other ions found in a water body. Typical concentrations of these materials are essential for the maintenance of a healthy aquatic life. Also, many dissolved ions such as nitrogen, phosphorus and sulfur are building blocks of molecules necessary for life. High concentrations of total dissolved solids limit the suitability of water for drinking and irrigation.

DAO 34 sets the water quality criterion for TDS at 1000 mg/L for Class A waters and 500 mg/L for Class AA waters. The readings for Mohicap lake were even within the Class AA level.

For the 10-year monitoring period, average values for TDS were almost uniform but with a slight increase in 2005.

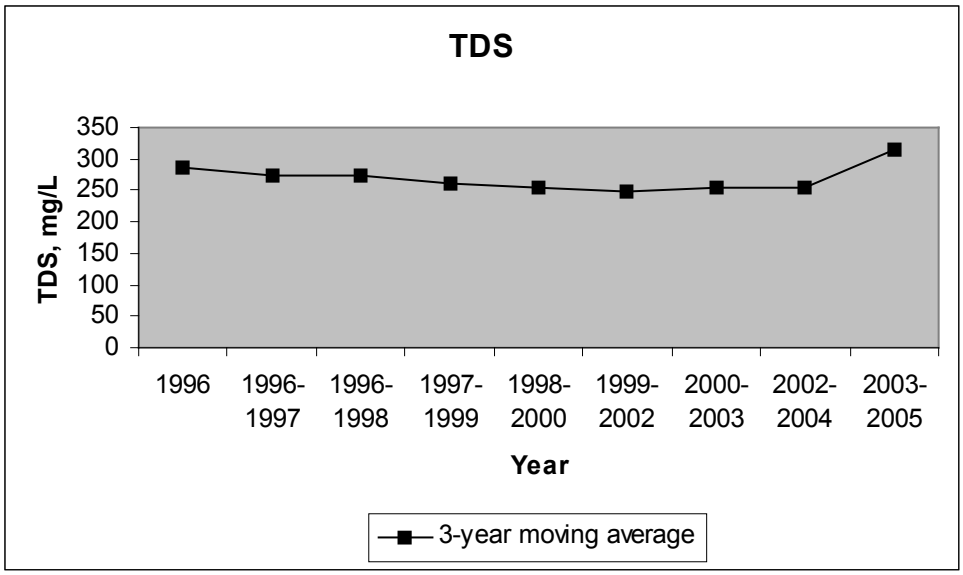


Figure 5. Three-year trend of TDS levels in Mohicap Lake

## Total Suspended Solids (TSS)

The suspended solid content or filter residue of water quantifies the amount of particulate materials in a water sample. This includes both organic and inorganic matters such as plankton, clay and silt.

High concentration of suspended solid reduces water clarity and results to lower photosynthetic activity. The suspended particles can also bind with toxic compounds and heavy metals.

From Figure 6, TSS values remained low for Mohicap Lake, although with slight fluctuations over the ten-year period.

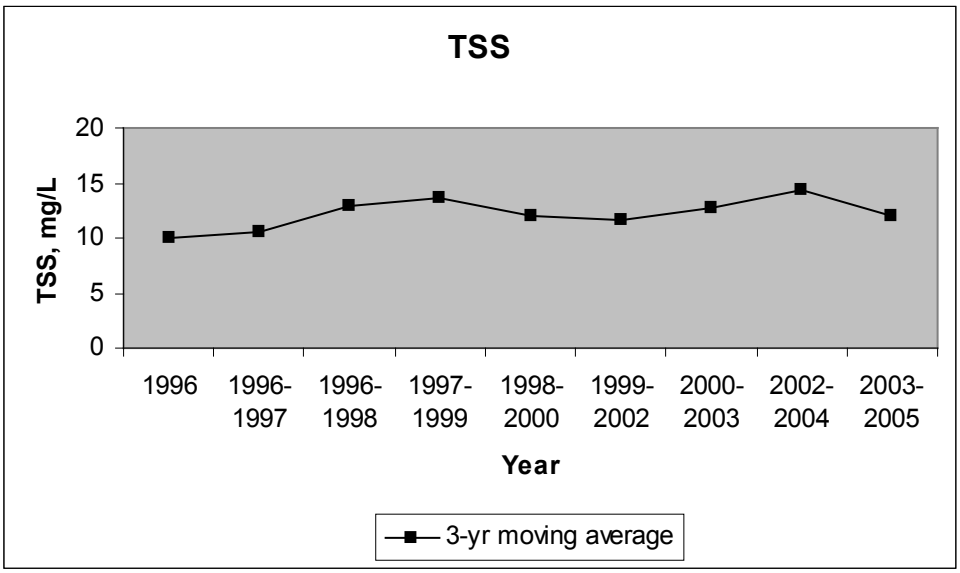


Figure 6. Three-year trend of TSS levels in Mohicap Lake

## Chloride

Chloride may enter surface waters via atmospheric deposition of oceanic aerosols, weathering of rock salt deposits, and pollution from industrial and sewage effluents. The normal level of chloride in freshwater is usually less than 10mg/L. Higher levels of chloride would indicate that "unnatural" sources (e.g., sewage discharges) have entered the water body, the occurrence of which is often associated with possible fecal contamination.

For Class C water, chloride level as high as 350mg/L is allowed. Mohicap Lake never exceeded this criterion.

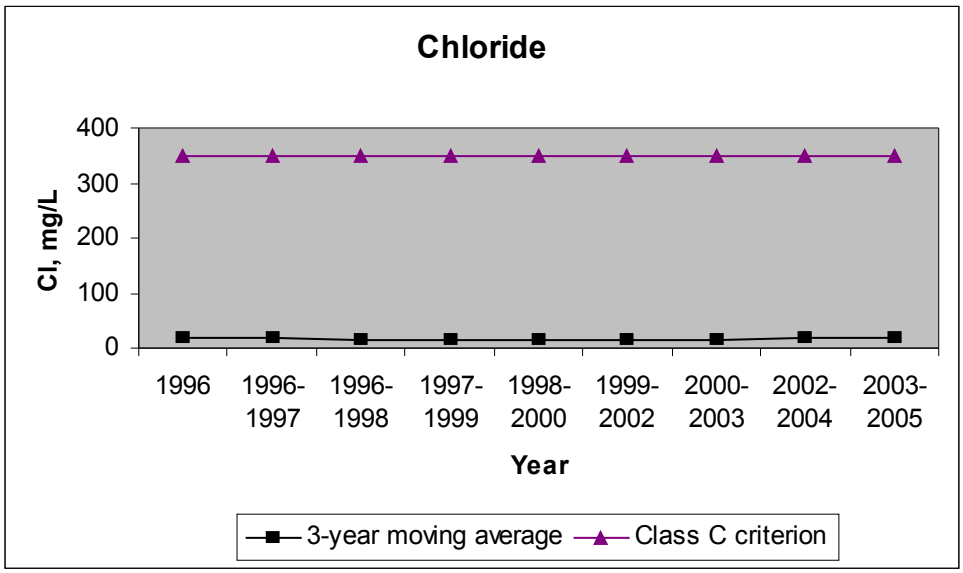


Figure 7. Three-year trend of chloride levels in Mohicap Lake

## Biochemical Oxygen Demand (BOD)

BOD gives an estimate of the biochemically degradable organic matter in a water sample. It is defined as the oxygen required by micro-organisms to stabilize organic matter.

A maximum level of 10mg/L, which Mohicap Lake seldom exceeded (Table 1), is suitable for Class C water. Higher values would indicate the presence of wastewater discharges.

The BOD concentration in Mohicap Lake showed an increasing trend such that the level at 2005 was already almost within the maximum limit.

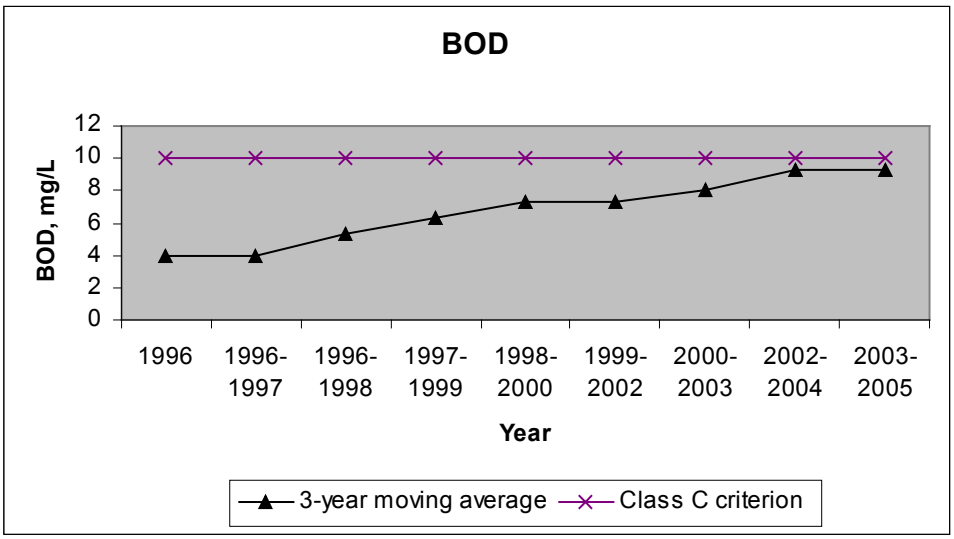


Figure 8. Three-year trend for BOD levels in Mohicap Lake

## Chemical Oxygen Demand (COD)

COD is used to measure the amount of chemically oxidizable matter in a water sample. Normally, COD of unpolluted water is 20mg/L, while polluted water usually has COD greater than 200mg/L.

Figure 9 shows that Mohicap Lake continued to hold low levels of COD.

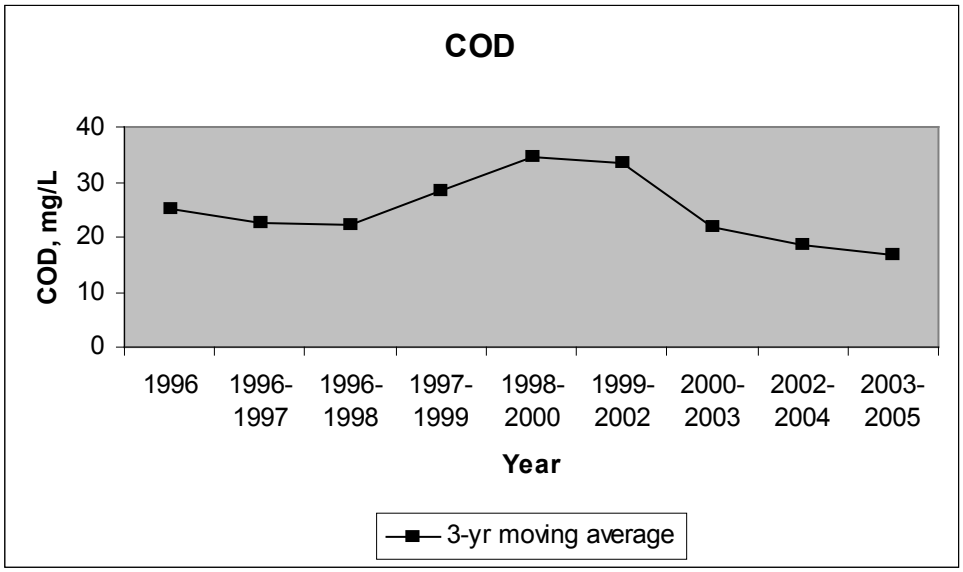


Figure 9. Three-year trend of COD levels in Mohicap Lake

## Dissolved Oxygen (DO)

The importance of oxygen in all forms of life cannot be ignored. For aquatic life, oxygen must be available in readily usable form, i.e., as dissolved oxygen (DO). Micro-organisms use DO in purifying natural water. DO is also essential for the survival and growth of fish and other life forms. DO is affected by many factors such as temperature, salinity, turbulence, photosynthetic activity of algae and plants, and atmospheric pressure. For monitoring purposes, the criterion of 5 mg/L for Class C Waters is used.

Among the many factors that affect DO, those that are brought about by human activities have the greatest effect. Dumping of untreated wastewater into lakes, overuse of fertilizers (and feeds) and other practices that introduce organic matters and nutrients all result to higher biological respiration rates for micro-organisms. This translates to lower DO since it is consumed in the process of respiration.

Excessive nutrient loading as discussed earlier could be the cause of the apparently decreasing levels of dissolved oxygen in Mohicap Lake. Table 2 and Figure 10 show that the desirable DO level of 5 mg/L was attained only at the surface of the lake for the months of January, February, and July. DO levels met the set criterion up to 2 meters for March, May, September and November, and up to 4 meters for June and October. Deeper into the lake, the DO levels ranged from 3 mg/L to 4 mg/L, which is considered slightly alarming. Although fish could still survive with this amount of DO, this scarcity might affect its growth.

Table 2. Ten-year monthly average of DO at different depths

| **Depth, meters** | **D.O. (mg/L)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Jan* | *Feb* | *Mar* | *May* | *Jun* | *Jul* | *Sep* | *Oct* | *Nov* | *Dec* |
| 0 | 5.5 | 8.1 | 10.1 | 7.4 | 9.6 | 7.7 | 6.4 | 8.3 | 7.1 | 4.2 |
| 2 | 4.2 | 4.1 | 6.4 | 7.3 | 8.3 | 4.8 | 6.0 | 8.1 | 5.1 | 3.9 |
| 4 | 3.2 | 3.1 | 4.0 | 4.6 | 5.9 | 3.9 | 4.9 | 5.7 | 4.1 | 3.8 |
| 6 | 3.0 | 3.1 | 3.7 | 3.6 | 4.5 | 3.6 | 4.1 | 4.7 | 3.7 | 3.9 |
| 10 | 2.9 | 3.0 | 3.6 | 3.7 | 3.7 | 3.7 | 3.7 | 4.4 | 3.6 | 3.5 |
| 15 | 2.8 | 2.9 | 3.7 | 4.2 | 3.9 | 4.3 | 3.9 | 4.2 | 3.6 | 3.2 |
| 20 | 2.9 | 3.1 | 3.6 | 3.7 | 3.3 | 3.8 | 3.4 | 3.6 | 3.4 | 3.1 |
| 25 | 2.7 | 2.7 | 2.9 | 2.9 | 3.4 | 4.1 | 3.3 | 2.9 | 2.3 | 2.6 |

0 Compliance to DAO Water Quality Criterion

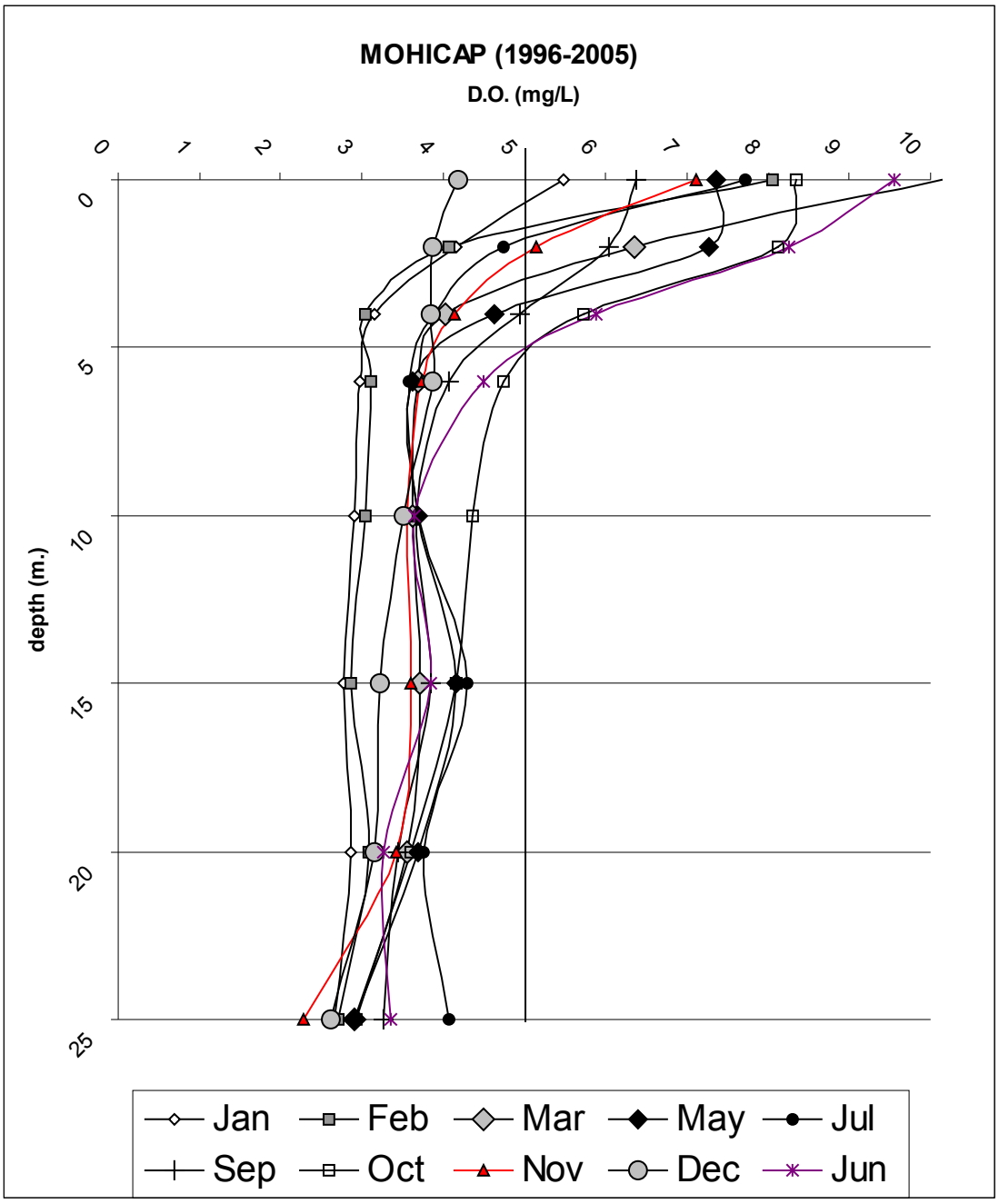


Figure 10. Ten-year monthly DO average at different depths

## Phytoplankton

Phytoplankton refers to microscopic aquatic plants commonly found in flowing and standing bodies of water. It is also referred to as algae. Phytoplankton has a very significant role in aquatic productivity because it provides food and oxygen necessary for the survival of aquatic animals. Phytoplankton occupies the first link in the food chain and as a primary producer, it constitutes the base of the trophic level.

About 21 genera of algae were identified in Mohicap lake from 1996 to 2005. Algal population was low from 1996 to 2001. There was an abrupt increase in algal counts in 2002 with an annual average of 55867 cells/ml due to the predominance of *Microcystis sp*. which contributed about 99.9 % (416625 cells/ml) to the total algal population. The highest algal production in 2002 was observed in March. Aside from *Microcystis sp., Crucigenia sp*., a green algae, contributed about 29.01 % in September of 2002. *Microcystis sp*. was also recorded as the dominant species in 2003 with percentage contribution of 98% to the total algal counts.

Algal population decreased in 2003 and 2004 with an average value of 4111 and 3663 cells/ml, respectively. A slight increase was observed in 2005 with an average value of 11147 cells/ml.

Table 3. Phytoplankton Counts by Group, 1996 - 2005

| Year | Bluegreen | Green | Diatoms | Dinoflagellates | Total |
|---|---|---|---|---|---|
| **1996** | 610 | 708 | 97 | 9 | 1424 |
| **1997** | 477 | 228 | 156 | 4 | 865 |
| **1998** | 91 | 226 | 646 | 2 | 965 |
| **1999** | 785 | 464 | 523 | 38 | 1811 |
| **2000** | 481 | 263 | 90 | 6 | 840 |
| **2001** | 335 | 243 | 891 | 4 | 1472 |
| **2002** | 54359 | 751 | 755 | 3 | 55867 |
| **2003'** | 2855 | 256 | 997 | 3 | 4111 |
| **2004** | 681 | 1866 | 1116 | 3 | 3663 |
| **2005** | 10327 | 255 | 540 | 25 | 11147 |

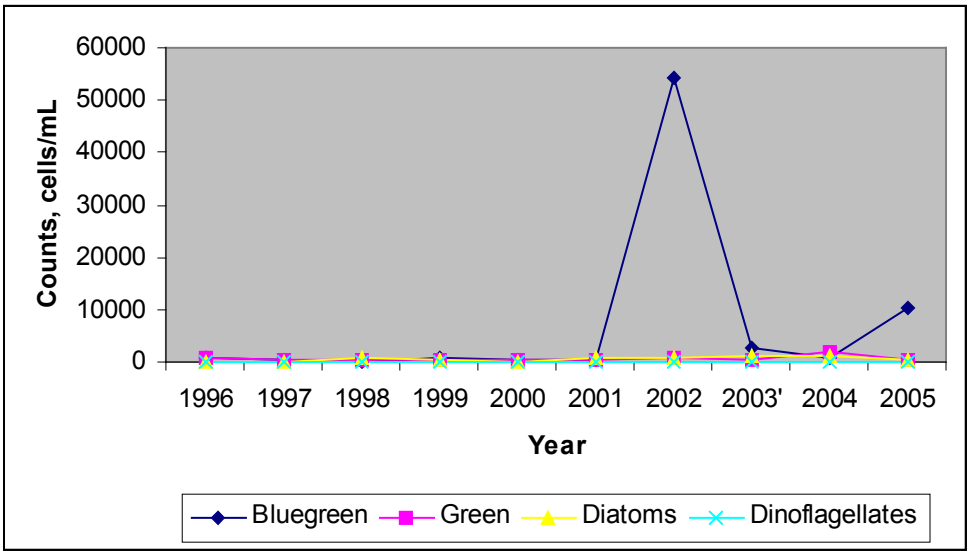


Figure 11. Phytoplankton Counts by Group

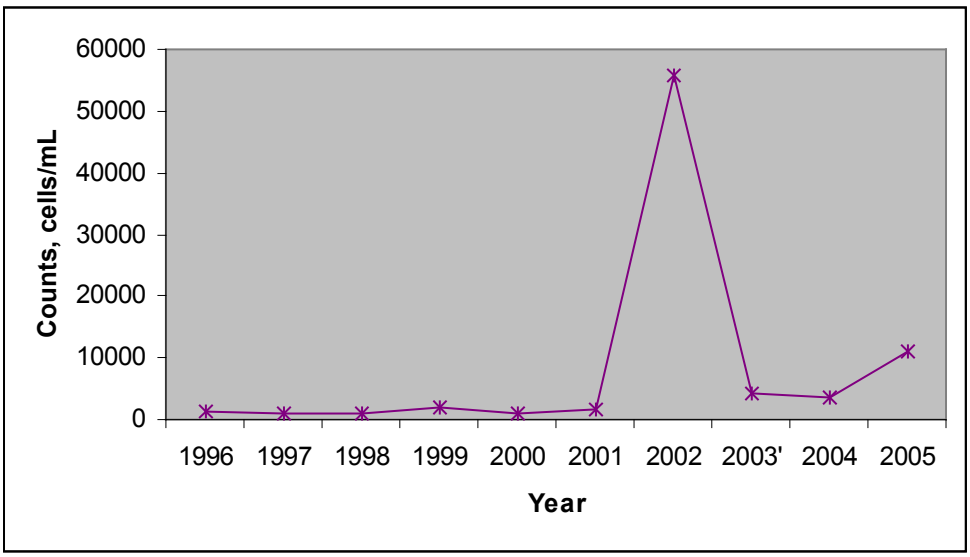


Figure 12. Total Phytoplankton Counts

Fishkills due to oxygen depletion in Mohicap Lake were usually associated with cold weather and/or the occurrence of algal bloom. The bloom usually occurs when the water is calm, weather is hot and the nutrient levels are present in sufficient amounts.

## Zooplankton

The zooplankton as consumer occupies the second ($2^{nd}$) trophic level in the food chain. These life forms feed on phytoplankton or algae that are available in the water.

From 1997 to 2005, 71 zooplankton samples were collected and analyzed. There were 19 species of zooplankton identified in the lake with 13 species of rotifers, 3 species of cladocerans and 3 species of copepods. Also seen in the samples analyzed were juveniles of copepods known as nauplius and copepodids. At this stage, the taxonomic basis for species identification was not discernable yet. Hence, the organisms were just counted and included in the lists.

*Copepoda* had the highest counts followed by *Rotifera,* and then by *Cladocera* throughout the study period.

Annual averages ranged from 2 to 25 ind. / liter. The highest count of 100 ind./ liter was noted in January 1999. Most peaks were generally observed during the cold months of January to March. Except in 1997 and 1999, counts of 0 ind. / liter were recorded at different months. Higher averages were recorded during the dry season.

Figure 13 below presents the percentage contribution of the different zooplankton groups from 1997-2005.

Except in 1997, 1999 and 2000, copepods maintained competitive advantage among other groups. Annual estimates revealed an erratic trend. The species composition remained the same.

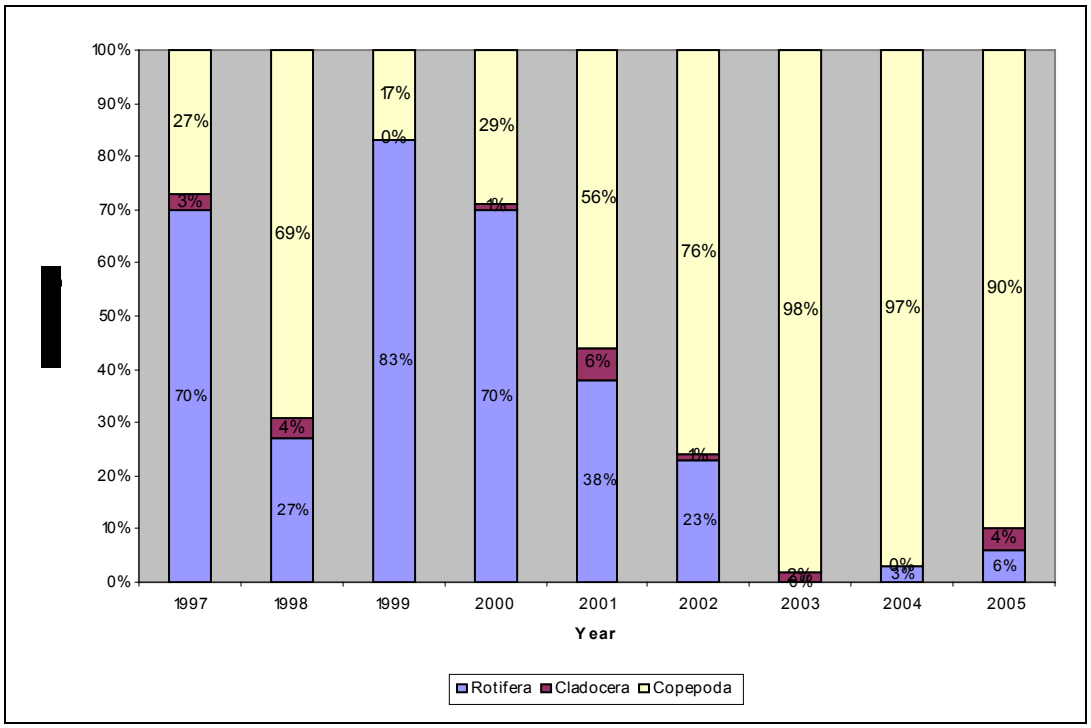


Figure 13. Percentage of Zooplankton by Group

The zooplankton community in Mohicap Lake in 1997 to 2005 consisted of the following:

**Phylum : Rotifera**

**Rotifera**

***Asplanchna sieboldi***
***Brachionus angularis***
***Brachionus calyciflorus***
***Brachionus diversicornis***
***Brachionus forficula***
***Brachionus falcatus***
***Brachionus urceolaris***
***Filinia longiseta***
***Filinia opoliensis***
***Hexarthra fennica***
***Keratella sp.***
***Lecane sp.***
***Trichocerca sp.***

**Phylum : Arthropoda**
**Class : Crustacea**

**Cladocera**

***Bosmina longirostris***
***Ceriodaphnia cornuta***
***Diaphanosoma excisum***

**Copepoda**

***Diaptomus sp.***
***Mesocyclops sp.***
***Thermocyclops crassus***
copepodid stage
copepodid stage (calanoid)
nauplius stage

## Chlorophyll -a

Chlorophyll-a is measured as an indication of phytoplankton biomass. Phytoplankton biomass is largely influenced by the availability of nutrients, light and optimal (warm) water temperature. Under certain environmental conditions, in particular elevated light and high nutrients, phytoplankton blooms can result. When phytoplankton blooms decay, the resulting bacterial activity can reduce dissolved oxygen concentrations in the water column, possibly leading to fish kills.

Among the crater lakes in San Pablo City, Mohicap Lake ranked third in terms of chlorophyll-a measurement for the period 1996 to 2005. The highest annual average was recorded in 1997 at 49.96 μg/L, while the lowest was in 1999 at 21.24 μg/L.

The chlorophyll-a in Mohicap Lake for the past ten years was still within the eutrophic level of 9.75 to 65.58 μg/L. (Ref.: Eutrophication of Lakes in China, 1990)


Figure 14. Annual average of Chlorophyll-a

## CONCLUSIONS AND RECOMMENDATIONS

Mohicap Lake is in a critical state in terms of water quality.

Though the BOD level for the past ten years met the criteria, BOD had been increasing. Measures must be undertaken to prevent further increase.

The desirable DO level of 5 mg/L was virtually attained only at the surface of the lake. Such condition could have been partly due to the excessive nutrient loading in the lake.

The phosphate level in Mohicap Lake had consistently exceeded the allowed average of 0.05 mg/L. Ammonia concentration had been almost consistent in its increase, exceeding the allowable level for fisheries and aquatic life from 1999 to 2005.

The degrading water quality of the lake may be attributed to the discharge of domestic wastes from the surrounding community and to the inappropriate feeding practices in the aqua structures.

Pursuant to RA 8550, Fisheries Code, the maximum limit for aquaculture is 10% of the lake area but at present, fish pen and fish cages occupy a total area of 36,000 sq. m. This matter comes within the realms of the regulatory functions of the LLDA, and therefore, it has to be adequately addressed such that the carrying capacity of the lake is not exceeded.

The Laguna Lake Development Authority (LLDA), through its Lake Management Division (LMD), has been implementing several programs to protect the lake. Lake seeding and water lily clearing are done on a regular basis.

To characterize the quality of the lake in terms of health aspects, total coliform and fecal coliform counts have already been included in the water quality monitoring program of the LLDA starting 2006.

This report is intended to help the LLDA, the Local Government Units, the FARMCs, the NGOs and other stakeholders to formulate and implement appropriate environmental and fishery/aquatic resources management programs for Mohicap Lake.

The upgrading of the water quality of the lake could not be achieved by the LLDA alone. All stakeholders must work hand in hand to attain such goal.