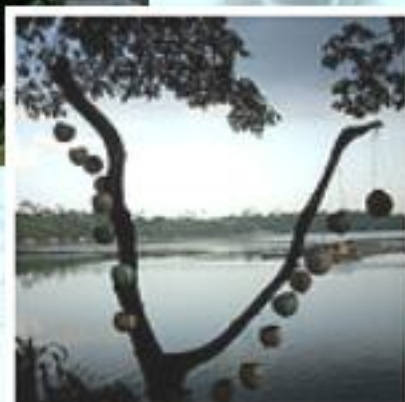


WATER QUALITY REPORT

on

SAMPALOC LAKE



LAGUNA LAKE DEVELOPMENT AUTHORITY

Environmental Quality Management Division

WATER QUALITY REPORT ON SAMPALOC LAKE 1996 – 2005

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SAMPALOC LAKE



THE LAKE AND ITS LEGEND

According to a legend (www.msc.net.ph/spc/7lakes/sampalok.html), the lake derived its name from a giant tamarind (sampalok) tree in the garden of a selfish couple who drove away a fairy disguised as a beggar asking for some fruit.

Hardly an hour after the old man left, there was a thundering noise followed by the cracking of the earth. The next instance, the entire orchard sank into a colossal pit which was eventually filled with water.

LAKE FEATURES

Sampaloc Lake, located within the city proper, is the biggest and premier lake of San Pablo City. It has an area of 1.04 sq. km. (104 hectares) and a maximum depth of 27 meters. Approximately 85% of its volume is of uniform depth. Sampaloc Lake is sunk in a shallow depression, revealing its volcanic origin.

The lake is considered as one of the prime tourist spots in the city. It was once dotted with floating restaurants along its shoreline. At present, the shoreline of Sampaloc Lake is being developed into ecology parks.

Through the years, aquaculture development in Sampaloc Lake has rapidly increased. Fish culture in floating cages has become a very popular and profitable business.

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.

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.

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

One sampling station was established in Sampaloc 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) and in June and September.

EVALUATION OF RESULTS

Although monitoring of Sampaloc 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 was incomplete due to the laboratory repair at that time. Hence, data for this period were not included in the statistical analysis.

Monthly data and annual averages are presented in Table 1, while the 3-year moving averages are presented in the figures.

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

DATE	pH units	COD mg/L	BOD mg/L	NH3 mg/L	NO3 mg/L	IPO4 mg/L	TDS mg/L	TSS mg/L	Cl mg/L
1996									
17-Jan-96	7.5	20	3.6	0.2880	0.0020	0.9060	186	27	22
21-Feb-96	7.9	52	5.3	1.0710	0.1770	0.4820	184	23	19
28-Mar-96	8.1	20	4.7	0.2340	0.3360	0.7650	211	4	22
18-Jun-96	8.8	4	2.5	0.4590	0.0020	0.7670	175	2	15
09-Sep-96	8.9	8	1.9	0.0020	0.0020	0.0470	170	24	19
28-Nov-96	8.6	4	1.3	0.3500	0.1130	0.3220	198	5	19
18-Dec-96	8.0	28	1.8	0.3720	0.1180	0.2930	171	8	15
<i>Average</i>	<i>8.3</i>	<i>19</i>	<i>3</i>	<i>0.3966</i>	<i>0.1071</i>	<i>0.5117</i>	<i>185</i>	<i>13</i>	<i>19</i>
<i>Std. Dev</i>	<i>0.5</i>	<i>17</i>	<i>2</i>	<i>0.3305</i>	<i>0.1229</i>	<i>0.3124</i>	<i>15</i>	<i>11</i>	<i>3</i>
1997									
09-Jan-97	7.4	32	5.7	0.3423	0.4006	0.9310	193	29	11
06-Feb-97	8.6	36	3.4	0.0100	0.4691	0.8775	187	10	19
03-Mar-97	8.0	64	3.8	0.1467	0.1204	0.8831	195	5	19
07-May-97	8.5	26	2.3	0.0750	0.0058	0.3518	167	2	13
21-Jul-97	7.5	<4	3.5	0.1390	0.0252	0.5580	173	2	26
27-Oct-97	7.6	24	3.0	0.0646	0.0165	0.5604	160	2	11
27-Nov-97	7.9	12	2.8	0.1983	0.0380	0.5501	190	2	15
15-Dec-97	7.3	4	9.0	2.2343	0.0366	0.9169	225	3	18
<i>Average</i>	<i>7.9</i>	<i>28</i>	<i>4</i>	<i>0.4013</i>	<i>0.1390</i>	<i>0.7036</i>	<i>186</i>	<i>7</i>	<i>16</i>
<i>Std. Dev</i>	<i>0.5</i>	<i>19</i>	<i>2</i>	<i>0.7475</i>	<i>0.1868</i>	<i>0.2232</i>	<i>20</i>	<i>9</i>	<i>5</i>
1998									
13-Jan-98	7.5	4	8	0.9781	0.0191	0.8392	190	10	15
17-Feb-98	7.3	20	5	0.8460	0.002	0.1328	183	4	26
19-Mar-98	7.6	52	7	0.9791	0.0038	0.1811	211	10	15
06-May-98	7.3	20	5	0.8841	0.0020	0.6305	198	2	15
08-Jul-98	7.4	12	7	0.3630	0.0060	0.5710	191	2	19
02-Sep-98	7.2	4	8	0.2980	0.0060	0.4100	178	2	11
07-Oct-98	7.1	16	8	0.6520	0.0060	0.5210	210	9	19
24-Nov-98	7.1	12	5	0.1935	0.0060	0.4118	157	22	11
15-Dec-98	6.8	56	5	0.8340	0.0080	0.5720	191	24	11
<i>Average</i>	<i>7.3</i>	<i>22</i>	<i>6</i>	<i>0.6698</i>	<i>0.0065</i>	<i>0.4744</i>	<i>190</i>	<i>9</i>	<i>16</i>
<i>Std. Dev</i>	<i>0.2</i>	<i>19</i>	<i>1</i>	<i>0.3070</i>	<i>0.0051</i>	<i>0.2206</i>	<i>17</i>	<i>8</i>	<i>5</i>

DATE	pH units	COD mg/L	BOD mg/L	NH3 mg/L	NO3 mg/L	IPO4 mg/L	TDS mg/L	TSS mg/L	Cl mg/L
1999									
27-Jan-99	7.0	44	20	2.0405	1.0233	0.0219	117	13	15
23-Feb-99	7.1	12	4	*	*	1.1780	174	4	11
19-Mar-99	7.7	18	6	0.8258	0.2440	1.1700	188	34	15
24-May-99	7.2	36	4	0.7177	0.0137	0.9104	188	1	17
14-Jul-99	7.3	12	6	0.6118	<0.0020	1.3270	192	1	15
27-Sep-99	7.1	16	7	0.9496	0.0164	1.0473	186	1	11
25-Oct-99	6.8	48	6	1.5010	0.0661	1.0881	176	11	15
11-Nov-99	6.9	32	5	0.7852	0.0379	1.0662	181	15	15
09-Dec-99	7.0	30	5	0.5434	0.0958	0.7259	179	12	13
<i>Average</i>	<i>7.1</i>	<i>28</i>	<i>7</i>	<i>0.9969</i>	<i>0.2139</i>	<i>0.9483</i>	<i>176</i>	<i>10</i>	<i>14</i>
<i>Std. Dev</i>	<i>0.3</i>	<i>14</i>	<i>5</i>	<i>0.5143</i>	<i>0.3656</i>	<i>0.3869</i>	<i>23</i>	<i>11</i>	<i>2</i>
2000									
13-Jan-00	7.0	4	4	0.0405	0.0002	0.5613	252	1	26
02-Feb-00	6.7	4	9	1.2642	0.0030	1.0151	287	4	15
02-Mar-00	7.1	12	4	1.1838	0.0020	0.6797	252	4	11
04-May-00	7.2	24	7	1.6238	0.0045	1.2050	224	3	11
17-Jul-00	7.2	4	6	1.0550	0.0626	1.3795	200	4	15
15-Aug-00	7.3	12	5	0.3315	0.0020	1.4200	205	3	*
14-Sep-00	7.1	12	10	0.6302	0.0020	1.2033	196	8	11
10-Oct-00	7.3	4	6	0.7510	0.0184	1.2185	181	5	*
16-Nov-00	7.0	16	6	1.2276	0.0268	1.4383	175	1	11
6-Dec-00	7.0	4	9	1.5605	0.1707	1.2903	182	1	11
<i>Average</i>	<i>7.1</i>	<i>10</i>	<i>7</i>	<i>0.9668</i>	<i>0.0292</i>	<i>1.1411</i>	<i>215</i>	<i>3</i>	<i>14</i>
<i>Std. Dev</i>	<i>0.2</i>	<i>7</i>	<i>2</i>	<i>0.5182</i>	<i>0.0534</i>	<i>0.3026</i>	<i>37.3</i>	<i>2</i>	<i>5</i>
2002									
24-Jan-02	6.9	12	6	4.4152	0.078	1.4739	259	3	13
28-Feb-02	7.3	24	5	3.7420	0.3704	1.1308	201	5	11
14-Mar-02	7.4	2	3	3.0175	0.7568	1.497	203	0.5	11
11-Apr-02	8.7	2	6	0.8366	1.1028	1.2463	221	2	17
15-May-02	9.3	28	5	1.1225	0.1654	1.1314	217	0.5	17
18-Jun-02	9	32	4	1.4340	0.0856	1.4209	208	1	17
16-Jul-02	7.9	10	4	0.9365	0.1507	1.2142	192	6	17
15-Aug-02	7.4	8	7	2.0205	0.2195	1.5954	207	0.5	13
11-Sep-02	7.8	54	6	1.4988	0.4076	1.0400	180	5	17
08-Oct-02	7	26	11	3.4470	0.0281	1.7568	174	5	15
12-Nov-02	7.3	4	7	1.5233	0.3022	0.9743	179	0.05	19
10-Dec-02	7.6	8					167	3	15
<i>Average</i>	<i>7.8</i>	<i>18</i>	<i>6</i>	<i>2.1813</i>	<i>0.3334</i>	<i>1.3165</i>	<i>201</i>	<i>3</i>	<i>15</i>
<i>Std. Dev</i>	<i>0.8</i>	<i>16</i>	<i>1</i>	<i>1.2526</i>	<i>0.3276</i>	<i>0.2485</i>	<i>25.2</i>	<i>2</i>	<i>3</i>

DATE	pH units	COD mg/L	BOD mg/L	NH3 mg/L	NO3 mg/L	IPO4 mg/L	TDS mg/L	TSS mg/L	CI mg/L
2003									
14-Jan-03	7.2	4	10	0.2399	0.0389	0.8841	189	2	11
11-Feb-03	7.1	4	7	3.1068	0.0303	1.0006	180	0.5	11
11-Mar-03	7.1	43	7	1.7868	0.3642	1.1962	203	3	11
10-Apr-03	8.2	35	7	0.5689	0.0030	0.7800	162	29	15
13-May-03	7.6	10	7	0.8060	0.0404	0.8458	201	2	15
19-Jun-03	7.0	23	2	1.1543	0.1726	1.2762	179	0.5	11
15-Jul-03	7.1	31	7	1.7521	0.0741	1.1770	193	0.5	19
12-Aug-03	8.1	8	7	1.0118	0.1742	0.8902	178	0.5	22
09-Sep-03	7.3	47	5	1.1834	0.142	0.9558	192	2	19
14-Oct-03	6.7	2	8	2.5039	0.18	1.1679	206	1	22
11-Nov-03	7.2	59	7	0.6293	0.6881	0.6832	173	2	30
9-Dec-03	6.6	80	8	2.8217	0.0195	1.3344	189	5	41
<i>Average</i>	<i>7.3</i>	<i>29</i>	<i>7</i>	<i>1.4637</i>	<i>0.1606</i>	<i>1.0160</i>	<i>187</i>	<i>4</i>	<i>19</i>
<i>Std. Dev</i>	<i>0.5</i>	<i>25</i>	<i>2</i>	<i>0.9351</i>	<i>0.1952</i>	<i>0.2096</i>	<i>13</i>	<i>8</i>	<i>9</i>
2004									
13-Jan-04	7.0	35	7	2.5256	0.0210	1.6029	244	8	37
10-Feb-04	7.3	19	5	1.2250	0.7381	1.2328	209	1	41
09-Mar-04	6.9	27	11	1.0080	1.0290	1.5550	193	0.05	73
21-Apr-04	8.5	23	8	0.8689	0.5492	0.8122	146	38	223
12-May-04	8.4	2		0.7857	0.2539	0.8493	200	2	
15-Jun-04	7.2	19	5	2.9149	0.1169	2.3219	215	13	18
13-Jul-04	8.1	11	5	0.3232	0.3652	1.3427	200	30	22
10-Aug-04	8.3	30	2	0.5454	0.2528	0.9108	179	2	19
14-Sep-04	6.9	50	14	3.8971	0.2661	1.5404	144	52	15
12-Oct-04	6.7	19	10	3.8518	0.024	1.6378	190	10	22
17-Nov-04	7.6	16	6	0.9373	0.5406	1.3849	161	2	19
14-Dec-04	7.4	27	4	1.0771	0.309	0.7124	196	9	19
<i>Average</i>	<i>7.5</i>	<i>23</i>	<i>7</i>	<i>1.6633</i>	<i>0.3722</i>	<i>1.3253</i>	<i>190</i>	<i>14</i>	<i>46</i>
<i>Std. Dev</i>	<i>0.6</i>	<i>12</i>	<i>3</i>	<i>1.2802</i>	<i>0.2982</i>	<i>0.4589</i>	<i>29</i>	<i>17</i>	<i>61</i>
2005									
11-Jan-05	7.2	2	4	1.2073	0.3686	0.9542	183	189	26
15-Feb-05	7.1	73	17	1.9671	0.4044	1.0344	178	258	19
08-Mar-05	7.7	19	4	0.8586	0.2305	0.9679	183	187	15
14-Jun-05	7.3	23	27	2.5102	0.1401	1.4265	175	176	15
08-Sep-05	7.8	50	6	1.0662	0.153	1.3364	194	228	15
18-Oct-05	7.0	72	10	2.776	0.0234	1.454	181	219	15
15-Nov-05	7.0	24	11	0.1008	0.3653	1.309	197	207	11
13-Dec-05	7.0	27	9	2.434	0.052	1.1862	189	193	8
<i>Average</i>	<i>7.3</i>	<i>36</i>	<i>11</i>	<i>1.6150</i>	<i>0.2172</i>	<i>1.2086</i>	<i>185</i>	<i>207</i>	<i>16</i>
<i>Std. Dev</i>	<i>0.3</i>	<i>26</i>	<i>8</i>	<i>0.9469</i>	<i>0.1488</i>	<i>0.2027</i>	<i>8</i>	<i>27</i>	<i>5</i>

pH

pH indicates the balance between the acids and bases in water. It is a measure of the concentration of hydrogen ion and hydroxyl ions in solution. The pH of water is an important water quality parameter since it may influence the species composition of an aquatic environment and affects the availability of nutrients and the relative toxicity of many trace elements.

For the protection of the aquatic environment, pH values should be within the range of 6.5 to 8.5 units. Discharges should not alter the ambient pH by more than 0.5 pH units in the mixing zone.

Yearly average values for pH in Sampaloc Lake were within the acceptable range of 6.5 to 8.5. Exceedance in pH criterion was noted in June, September and November, 1996, in February 1997 and in April, May and June, 2002.

Based on Figure 1, the 3-year moving average decreased from 1996 to 2000. Afterwards, almost steady condition was noted.

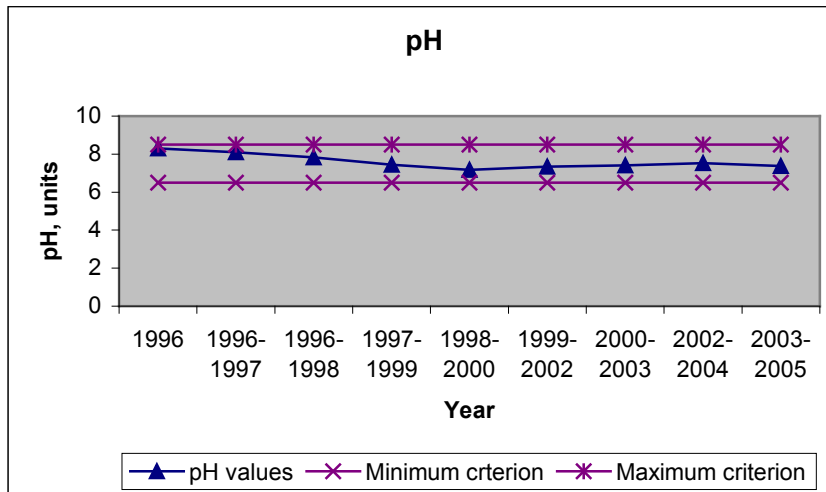


Figure 1. Three-year trend of pH values in Sampaloc Lake

Nitrate (NO₃)

Nitrate, a compound of nitric acid, is the most highly oxidized form of nitrogen found in aquatic environment. It is an essential nutrient for many photosynthetic autotrophs and in some instances, functions as a growth-limiting nutrient. It is used by algae and other aquatic plants to form plant protein which, in turn, can be used by animals to form animal protein.

The Class “C” water quality criterion for nitrate is set at 10 mg/L in lakes, reservoirs and similarly impounded water.

The Sampaloc Lake nitrate (NO₃) concentrations were very low compared to the criterion. The values ranged from 0.0020 mg/L taken at several occasions to 1.1028 mg/L in April 2002.

Although the 1996 – 2005 values were still low, nitrate concentrations exhibited an upward trend, as shown in Figure 2.

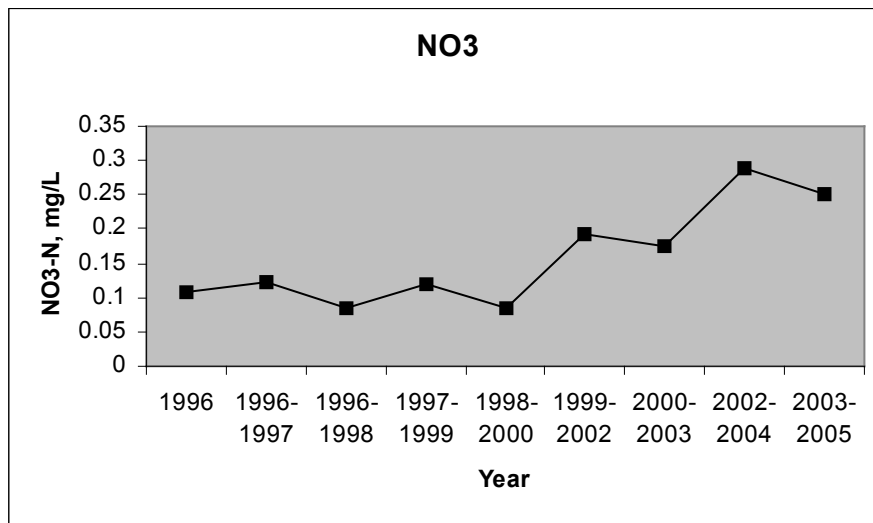


Figure 2. Three-year trend of nitrate levels in Sampaloc Lake

Ammonia (NH₃)

Ammonia exists naturally in surface waters and wastewaters. Its presence may indicate sanitary pollution. It is mainly formed by the death and bacterial decomposition of plant and animal proteins (excretion products). Other possible sources of ammonia are sewage and industrial wastes containing inorganic nitrogen, ammonia or ammonium salts, and atmospheric precipitation and fall-out. Relatively large amounts of ammonia may find their way into streams or ponds, either through the discharge of liquid manure or through the leaching of fertilizers from the soil. The U.S. Environmental Protection Agency (EPA) 1976 cited that at 0.3 mg/L, ammonia decrease the hemoglobin ability to combine with oxygen, hence suffocating the fish.

The ammonia concentrations in Sampaloc Lake ranged from as low as 0.002 in September 1996 to as high as 4.4152 mg/L in January 2002. There were several occasions when the NH₃ concentrations exceeded the criterion set by the USEPA.

As can be seen from the graph, the average values for NH₃ showed increasing trend from 1996 to 2004 and then slightly decreasing in 2005. The high NH₃ values could be attributed to the domestic wastes generated by the surrounding community and directly discharged into the lake.

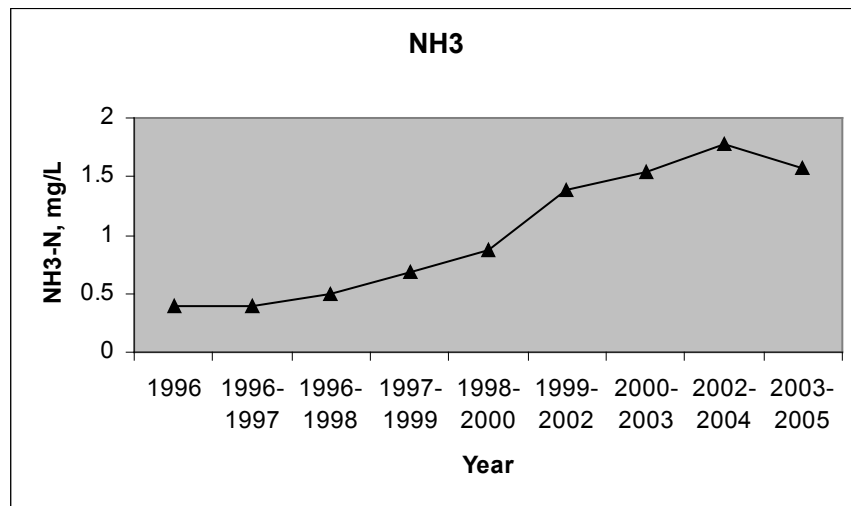


Figure 3. Three-year trend of ammonia levels in Sampaloc Lake

Inorganic Phosphate (IPO4)

Inorganic phosphate is an important plant nutrient and a primary element in the metabolic reactions of both plants and animals. Like nitrate, inorganic phosphate can also act as a limiting nutrient in a body of water.

For Class “C” waters, the allowable phosphate concentration is set 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.

Inorganic phosphate is another critical parameter for Sampaloc Lake. The level for the entire monitoring period was much higher than the water quality criteria for Class C Waters set at 0.1 mg/L. The trend for Inorganic phosphate was the same as ammonia, that is upward for the period 1996 to 2004 and then downward in 2005. Feed loses and domestic wastes containing detergents were contributory factors on the exceedance of inorganic phosphate concentrations.

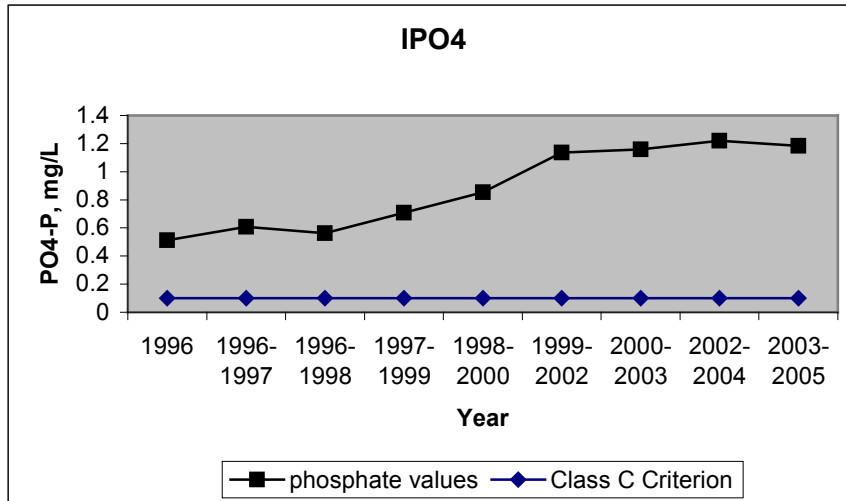


Figure 4. Three-year trend of phosphate levels in Sampaloc Lake

Total Dissolved Solids (TDS)

The dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates and possibly nitrates of calcium, magnesium, sodium, potassium, with traces of iron, manganese and other substances. The chemical content of water may be lowered artificially by dilution or raised by the addition of chemical wastes, dissolved salts, acids, alkalis, gas or oil-well brines or drainage waters from irrigated land.

Water quality monitoring of Sampaloc Lake indicated low values for TDS ranging from 144 mg/L to 287 mg/L. The highest annual average at 215 mg/L was in 2000.

The 3-year moving average for TDS as presented in Figure 5 showed generally increasing trend from 1996 to 2003 and then a decreasing trend afterwards.

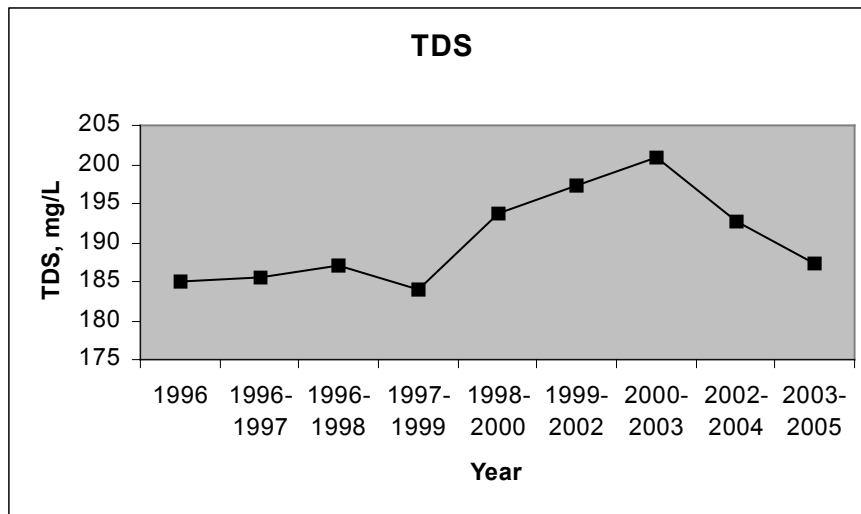


Figure 5. Three-year trend of TDS levels in Sampaloc Lake

Total Suspended Solids (TSS)

In natural waters, suspended solids consist normally of silt, clay, organic detritus and plankton. The impact of man’s activities alters and augments the suspended solids in surface waters by the discharge of liquid wastes from communities and industries, by increased erosion from deforested and cultivates areas, and by dusts that are blown into steams.

Suspended solids may kill fish and other aquatic fauna by causing abrasive injuries, by clogging the gills and respiratory passages, by blanketing the stream bottom, by destroying the spawning beds and by screening out light necessary for the photosynthetic activity of aquatic plants. Settling suspended particles may trap bacteria and bring them to the bottom of the lake or river. With excessive concentration of organic wastes, bacterial action may lead to anaerobic decomposition and anoxic condition in water.

A decreasing trend in TSS was observed from 1996 to 2003 and then later an increasing trend (Figure 6).

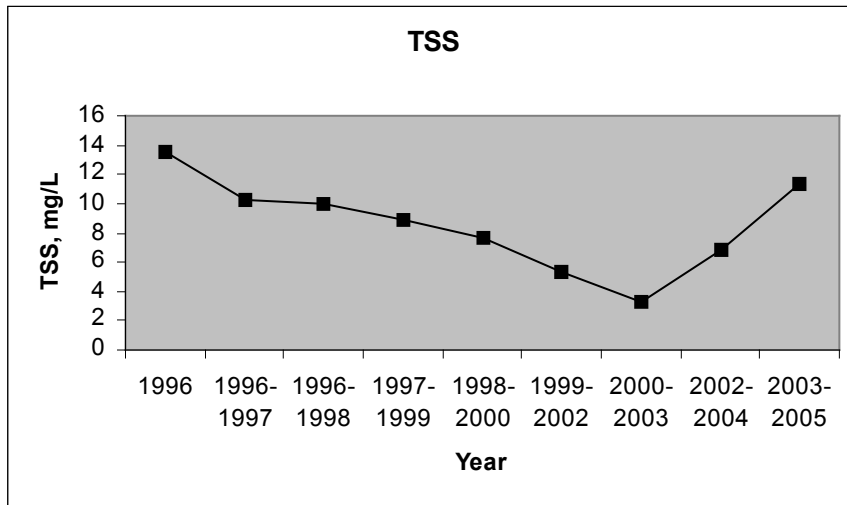


Figure 6. Three-year trend of TSS levels in Sampaloc Lake

Chloride

Chloride in natural water comes from leaching of chloride-containing rocks and soils with which the water comes in contact and from salt water intrusion. Chloride may also come from agricultural, industrial and domestic wastewater discharged to surface waters.

Sampaloc Lake as a freshwater lake exhibited low chloride values for the period 1996 to 2005.

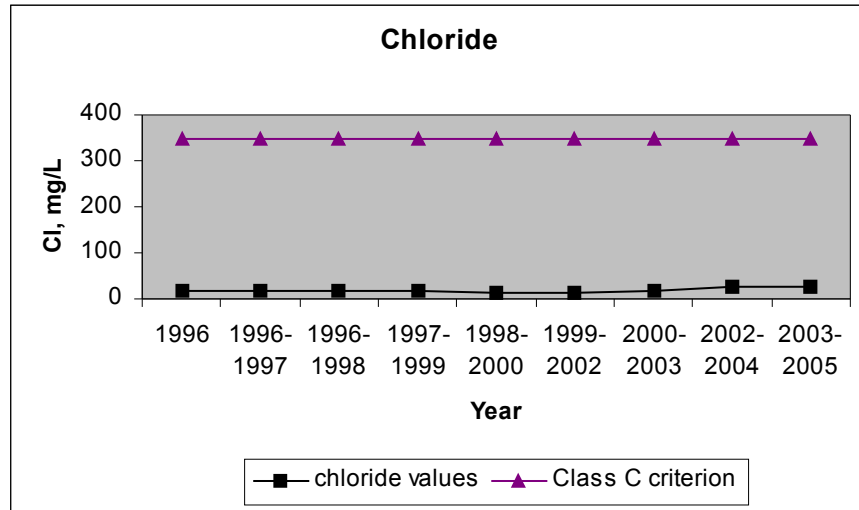


Figure 7. Three-year trend of chloride levels in Sampaloc Lake

Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand is an approximate measure of the amount of biochemically degradable organic matter present in a water sample. It is defined by the amount of oxygen required for the aerobic micro-organisms present in the sample to oxidize the organic matter to a stable inorganic form.

BOD is just a measure of organic pollution and is not a pollutant itself. A BOD load can pose a threat to aquatic environment by depressing the dissolved oxygen concentrations to levels that affect aquatic organisms.

From 1996 to 2005, the annual averages for BOD were within the set criterion for Class C waters. There were only few exceedances (January 1999, October 2002, March and September 2004, and February, June and November 2005). It is notable in the graph, however, that the BOD in Sampaloc Lake showed increasing trend during the period.

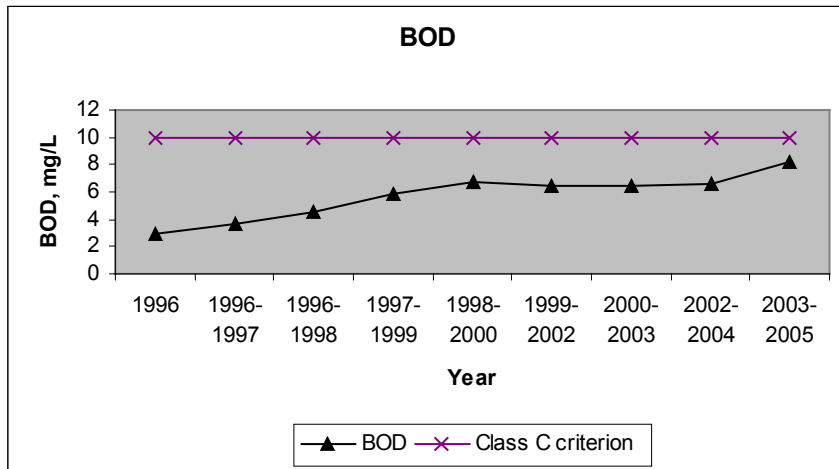


Figure 8. Three-year trend for BOD levels in Sampaloc Lake

Chemical Oxygen Demand (COD)

The chemical oxygen demand is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant, such as dichromate. It is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in water bodies and in the effluents from sewage and industrial plants.

COD may reduce dissolved oxygen levels, thus affecting the survival of aquatic organisms, yet no water quality guidelines for COD had been set.

The COD values for Sampaloc Lake ranged from 4 mg/L to 80 mg/L. The maximum monthly level was recorded in December 2003. The highest annual average was noted in 2005.

From Figure 9, COD increased from 1996 to 1999, decreased up to 2002 and increased again up to 2005.

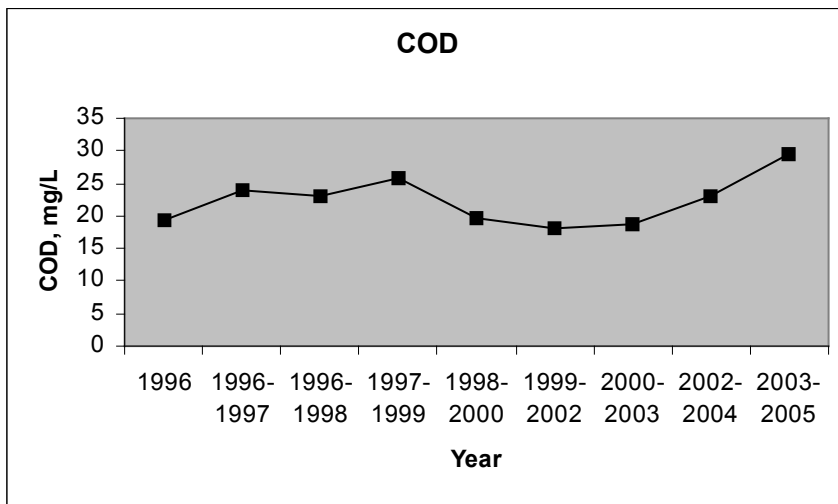


Figure 9. Three-year trend of COD levels in Sampaloc Lake

Dissolved Oxygen (DO)

The oxygen dissolved in water may be derived from either the atmosphere or from photosynthesis by aquatic plants including phytoplankton. Adequate amount of dissolved oxygen must be available for fish and other aquatic organisms. The DO requirement is dependent on temperature and varies greatly with the type of organism. Fluctuations in the concentration of DO to extremely low concentrations are particularly harmful to aquatic life.

Dissolved oxygen (DO) values at different depths were averaged on a monthly basis as shown in Table 2 and Figure 10. For the months of January and February, the acceptable level for DO set at 5 mg/L was met up to 2 meters depth only. For March, May, July and October, the criterion was met up to 4 meters, while up to 6 meters for June, September and November. In December, the criterion was not met even at the surface.

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

Depth	D.O. (mg/L)									
	Jan	Feb	Mar	May	Jun	Jul	Sep	Oct	Nov	Dec
0	6.9	6.6	8.1	8.6	9.0	6.8	7.9	6.6	6.6	4.7
2	5.7	6.0	6.6	6.9	11.3	6.0	7.3	6.6	6.5	4.6
4	4.2	4.7	5.3	7.0	8.3	5.3	6.2	5.8	6.3	4.1
6	3.8	4.7	4.3	4.5	5.5	4.6	5.3	4.9	5.8	4.2
10	3.7	3.8	3.8	3.9	4.1	3.9	4.2	4.4	4.9	3.8
15	3.4	3.9	3.6	4.4	4.1	4.0	4.1	4.0	4.5	3.5
20	3.2	3.7	3.3	3.9	3.5	3.5	4.1	3.8	4.3	3.4
25	2.6	3.3	3.2		4.0		3.8	3.0	3.0	3.1

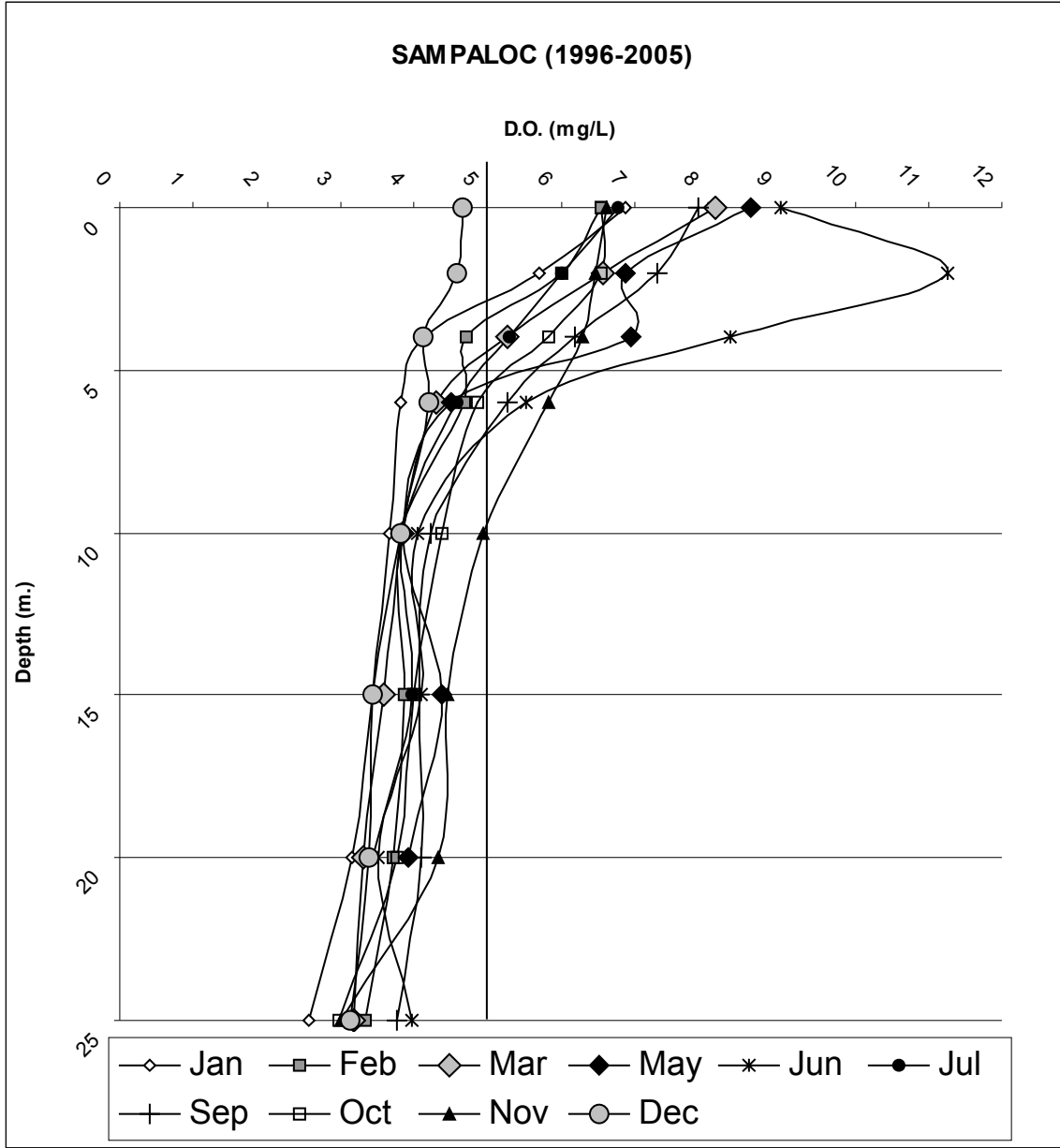


Figure 10. Ten-year monthly DO average at different depths

Phytoplankton

Phytoplankton, also known as algae, is a microscopic aquatic plant commonly found in lakes and other bodies of water. It plays a vital role in aquatic productivity because it occupies the first link in the food chain for being the primary producer. Phytoplankton serves as food for the zooplankton, fish, benthic fauna and other aquatic organisms. Its abundance is mainly dependent upon the light intensity, turbidity, and nutrients availability among other factors.

From 1996 to 2005, a total of 35 genera were identified in Sampaloc Lake, belonging to four (4) divisions namely: Cyanophyta (bluegreen), Chlorophyta (green), Bacillariophyta (diatom) and Pyrrophyta (dinoflagellate).

Table 3. Ten-year phytoplankton counts by group, 1996 - 2005

Year	Blue Green	Green	Diatoms	Dinoflagellates	Total
1996	173	304	507	0	983
1997	2552	1478	622	181	4833
1998	2244	757	138	4	3143
1999	20193	1862	1577	43	23675
2000	27867	1249	253	3	29372
2001	10728	375	12623	136	23862
2002	53	475	223	0	751
2003	103	244	549	2	898
2004	335	981	807	0	2122
2005	114	1332	3389	4	4839

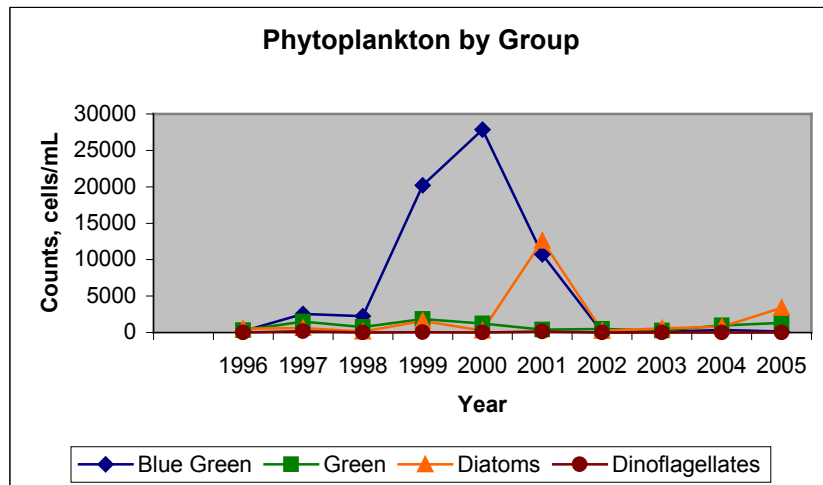


Figure 11. Phytoplankton Counts by Group

The annual average production of algae was highest in 2000 computed at 29,372 cells/ml. *Microcystis sp.*, a blue-green alga, was the most dominant among the algae identified in the lake for 2000, contributing as high as 99.9% of the total algal population. The blooms of *Microcystis* in Sampaloc lake usually occurred during calm periods with high temperature and under high light intensity. The blooms were localized in certain areas of the lake. Sometimes, the foul odor associated with the bloom affected the restaurant/eatery business and residents within the vicinity of the lake. Over the 10-year period, the other commonly identified algae in Sampaloc lake which included *Melosira sp.* (diatom), and 3 genera of green algae namely, *Crucigenia sp.*, *Oocystis sp.* and *Horomidium sp.*, showed occasional increase in numbers at certain times of the year.

In 1999 and 2001, high annual average algal counts were also noted at 23675 and 23862 cells/ml, respectively. The most common algal genera identified in 1999 was *Crucigenia sp.* (green). In 2001, *Melosira sp.*, a diatom, contributed about 76.43% of the total algal population.

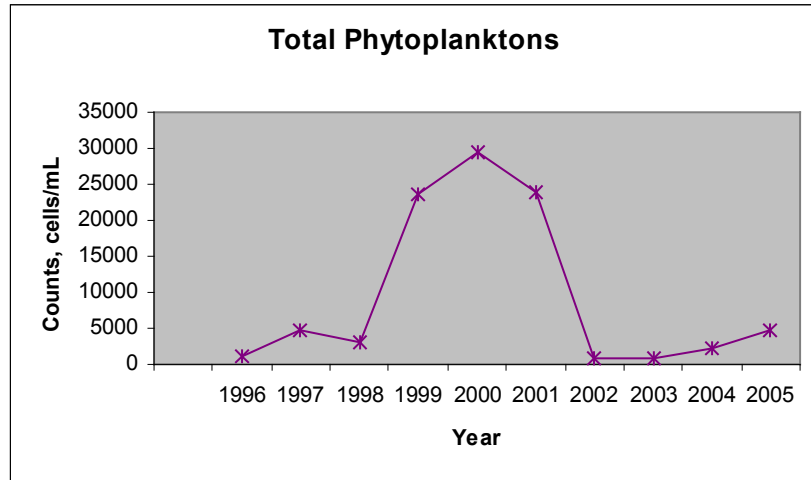


Figure 12. Total Phytoplankton Counts

The algal counts over the 10-year period did not show any definite trend. The annual average increased in 1997 and slightly decreased in 1998. Algal counts were almost consistently high from 1999 to 2001. Low counts were recorded in 2002 and 2003. Gradual increasing counts were noted from 2004 to 2005.

Zooplankton

The zooplankton occupies the consumer level in the food chain of Sampaloc Lake. In the sequence, these consumers utilized the phytoplankton (algae) as food. In the past nine (9) years, 84 zooplankton samples were collected and analyzed. The zooplankton identified belonged to three (3) major groups namely: Rotifera, Cladocera, and Copepoda.

A total of 21 species were identified. Members of the zooplankton community were generally cosmopolitan or common in distribution. Among them were 13 species of rotifers, 5 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, taxonomic basis for species identification was not discernable yet. Hence, they were just counted and included in the lists.

Copepoda predominated, Rotifera ranked second and Cladocera remained consistently low in number throughout the study period.

Annual averages ranged from 7- 28 ind. / liter. Most peaks were observed during the cold months. Except in 1997, 1999, 2003 and 2005, higher annual averages were observed during the wet season. The highest record of 85 ind./liter was observed in December 2001. In 2003, 50% of the samples analyzed yielded negative to zooplankton.

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

Except in 1999 and 2002, copepods maintained competitive advantage among other groups all the way through. Annual estimates revealed a decreasing trend of zooplankton counts. There was no change in species composition.

The zooplankton community in Sampaloc 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 unguolata
Trichocerca sp.

Phylum : Arthropoda
 Class : Crustacea

Cladocera

Bosmina longirostris
Ceriodaphnia cornuta
Diaphanosoma excisum
Kurzia sp.
Macothrix spinosa

Copepoda

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

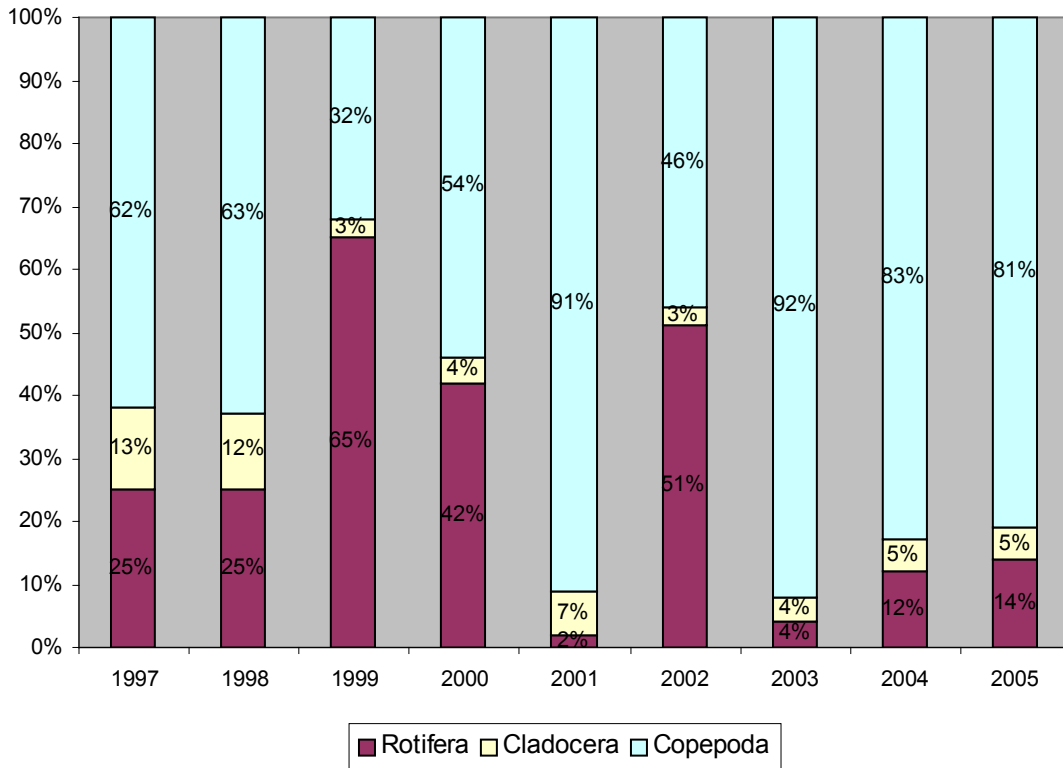


Figure 13. Percentage of Zooplankton Groups (1997 – 2005)

Chlorophyll-a

Chlorophyll-a is an indicator of phytoplankton standing biomass in the water body.

Based on the ten (10) year study period, the highest annual average was recorded in 2004 at 52.17 ug/L. The highest monthly chlorophyll-a was measured in May 2004 at 138.13 ug/L. The lowest annual average of 12.53 ug/L was registered in 1999, while the lowest monthly value was measured in July 2003 at 2.43 ug/L. A fluctuating annual average was observed during the ten-year study period. The chlorophyll-a in Sampaloc Lake ranging from 12.53 to 52.17 ug/L is still within the eutrophic level of 9.75-65.58 ug/L (Reference: Eutrophication of Lakes in China, 1990).

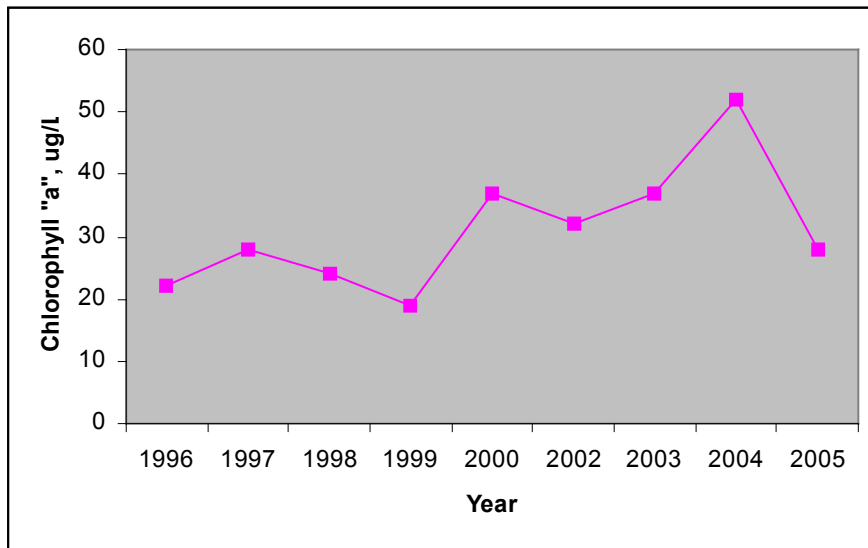


Figure 14. Annual Average of Chlorophyll -a

Lake Primary Productivity

Lake primary productivity study in Sampaloc Lake was conducted in 2002 to 2004. The main objective is to be able to determine the rate of production by the phytoplankton through the process of photosynthesis (in tons Carbon / hectare/yr) and to predict the corresponding fish production (in tons fish/hectare /year) by mathematical computation.

The three-year (3) study period was conducted in the open water of the lake every month. The method used was light and dark bottle method. Measuring the carbon utilized is difficult and expensive hence, the oxygen given off in the process was determined by using the Winkler Azide Method.

Water samples at different depths (surface, 50-600 cm. at 50 cm interval, 10, 15, and 20 meters) were collected and incubated in glass bottles for 6 hours (12 am- 6 pm). The initial D.O. and final D.O. readings were recorded to calculate the rate of photosynthesis and convert primary production to fish yield.

The computed annual average primary productions for 2002, 2003 and 2004 were 6.02; 4.46, and 5.45 tons Carbon/ha/yr. respectively. Further, assuming that the assimilation ratio (gram wet weight algae to gram fish flesh) is 25:1, the estimated fish productions in the aforementioned years were recorded at 4.82, 3.57, and 4.36 tons of fish/ha/yr.

Table 4. Lake Primary Productivity (2002-2004)

Date	tons C/ha/yr	tons fish/ha/yr
January, 2002	2.33	1.86
February	11.14	8.91
March	6.57	5.25
April	13.34	10.67
May	10.13	8.1
June	0.14	0.11
July	12.13	9.7
August	1.04	0.83
September	1.16	0.93
October	2.94	2.35
November	5.89	4.71
December	5.48	4.38
Average	6.02	4.82
January, 2003	5.56	4.45
February	3.59	2.87
March	5.45	4.36
April	8.6	6.88
May	8.4	6.72
June	3.34	2.67
July	0.41	0.33

August	2.77	2.21
September	5.91	4.73
October	5.69	4.6
November	3.83	3.07
December	0	0
Average	4.46	3.57
January, 2004	4.39	3.51
February	5.61	4.49
March	13.28	10.62
April	3.44	2.75
May	10.33	8.27
June	3.42	2.74
July	7.12	5.67
August	2.94	2.35
September	8.01	6.41
October	3.97	3.16
November	1.05	0.84
December	1.79	1.43
Average	5.45	4.35

The high primary productions were consistently observed during the dry season in April 2002, April 2003, and March 2004 at 13.34, 8.60, and 13.28 tons Carbon/ha/yr. Throughout the study period, transparency readings were adequate. Transparency values ranged from 80-200 cm. which in effect contributed to high algal productivity.

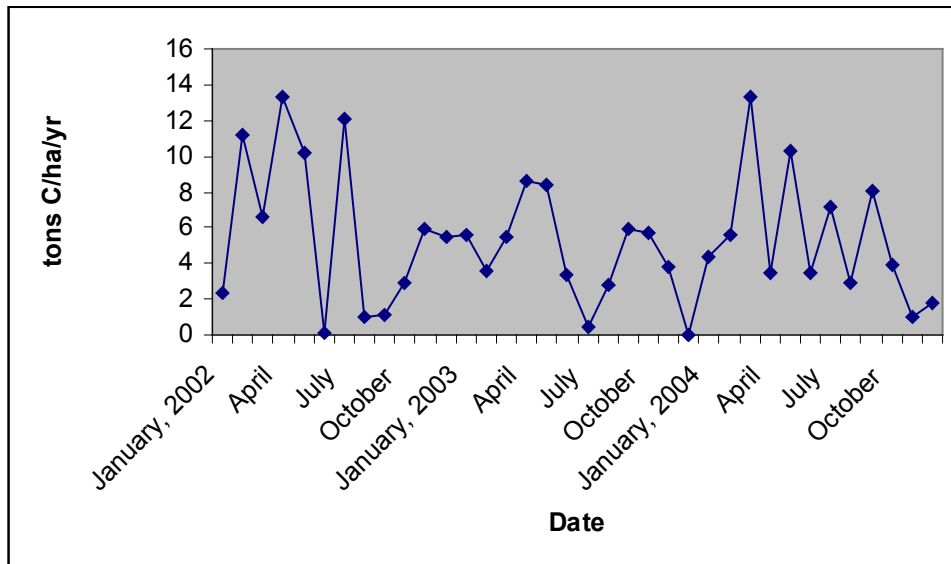


Figure 15. Lake Primary Productivity in Sampaloc Lake

CONCLUSIONS AND RECOMMENDATIONS

The Proposed Zoning and Development Plan (ZODEP) of Sampaloc Lake covers the following activities:

- Regulation of aquaculture operations in the lake
- Relocation of the residents living along the shoreline
- Demolition of commercial establishments located along the shoreline
- Preparation and implementation of a land use plan.

Some of the above activities were started in 2000. So far, very little improvement of the water quality of the lake was noted.

Nitrate, ammonia and inorganic phosphate had an increasing trend from 1996 to 2004 but slightly decreased in concentration in 2005.

BOD and pH adequately met the water quality criteria for Class C waters. However, BOD and COD had an increasing trend from 1996 to 2005. At most times of the year, adequate amount of DO was measured up to 2 meters depth only.

High algal counts were noted from 1999 to 2001, while low counts were recorded from 2002 and 2003. There was gradual increase in counts from 2004 to 2005. The chlorophyll "a" values in Sampaloc Lake are still within the eutrophic level.

On the other hand, annual estimates revealed a decreasing trend in zooplankton counts. There was no change in species composition.

In 1984, the net primary productivity was recorded at 2.22 g C/m²/day with an estimated fish potential of 6.48 tons F/ha/yr. In 1985, the algal production was recorded at 1.5 g Carbon/m²/day with an equivalent fish production of 4.38 tons F /ha/yr. These values are higher than the values taken in 2003 and 2004.

The practice of intensive feeding of fish stocks in cages has contributed to the pollution of Sampaloc Lake. Appropriate methods for artificial feeding must be implemented by the fish pen and fish cage operators to minimize the effect.

Another main source of pollution in the lake are the untreated domestic wastes from the surrounding area. Construction of a centralized sewerage treatment plant to treat all domestic wastes would help a lot to improve the water quality of the lake.

The commercial areas and some residential areas along the shoreline are now gradually being demolished and developed into recreational/ecology parks.

Proper waste management (liquid and solid) must be implemented in these parks to prevent direct discharge of wastes into the lake.

In this line, LLDA Board Resolution No. 295, Series of 2006 was approved on October 27, 2006. It provides the Guidelines for the Use of Shoreline of Sampaloc Lake , San Pablo City and its Development into a Recreational Park.

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 programs for this precious lake.

Improvement of water quality cannot be seen in just a short time. Continuous efforts must be undertaken by all the stakeholders to protect Sampaloc Lake.