CHAPTER 2

METHODOLOGY
Physical parameters

Water temperature

Surface water temperature of the lake water was recorded in the field at the time of sampling by dipping a Celsius mercury thermometer just below the surface layer. Bottom temperature at the sampling site was recorded by immersing a thermometer in the water sample as soon as it was collected.

Water transparency

Light penetration through lake water was measured with a Secchi Disc of 20 cm diameter painted white and black on upper surface and black on the lower surface. The Disc tied with a graduated nylon rope was first lowered into the water and the depth was noted at which it disappeared from sight. The rope was then pulled up and the depth was noted at which it reappeared. The average of the depth where Secchi Disc disappeared on lowering and reappeared on raising was taken as the measure of the transparency value using the formula:

\[
T = \frac{X + Y}{2}
\]

where \( T \), \( X \) and \( Y \) represent transparency in cm; depth
at which the Disc could not be observed while lowering the rope and depth at which the Disc was visible while raising the rope (Poole and Atkin, 1929).

The data on chemical parameters was obtained for the two year period (1988 - 1989) except for Na, K and TDS where data pertains to only 1989.

Chemical Analysis

The chemical analysis of the water samples for various characteristics was carried out using the methods outlined in Mackereth (1963), Golterman and Clymo (1969) and A. P. H. A. (1970). The surface water samples were collected in polyethylene bottles of one litre capacity, while the bottom samples were collected with the help of a Ruttner Plexiglass sampler. Water samples for dissolved oxygen was collected in a separate glass stoppered bottles of 125 ml + 2 ml capacity. Initial fixation of dissolved oxygen was carried out in the field.

To estimate variate value for a specific observed value a curvilinear relationship was transformed to linear logarithmic relationship so as to provide best fit. The equation is represented as:

...
\[ Y = a X^b \]

or \[ \log Y = \log a + b \log X \]

where \( X \) is the recorded absorbance and \( Y \) is the given concentration.

**Hydrogen-ion-concentration**

The hydrogen-ion-concentration of the water samples was measured by using a Elico-digital pH meter (Type LI - 122). Before use the pH-meter was calibrated each time against buffer solutions of known hydrogen-ion-concentration usually of pH 4, pH 7 or pH 9.

**Dissolved Oxygen (D. O)**

Dissolved oxygen content of the lake water was determined by following the unmodified Winkler's method (Mackereth, 1963). The samples were collected in 125 ml ± 2 ml capacity air tight glass stoppered bottles and immediately fixed in the field by introducing 0.5 ml of Manganese Chloride solution (100 g of Crystalline MnCl₂ • 4H₂O, diluted to 200 ml of distilled water) and 0.5 ml of Winkler's reagent (100 g of KOH and 60 g of KI diluted to 200 ml of
of distilled water) to form the precipitate of Manganous hydroxide. The bottles were tightly stoppered taking care that no air bubbles are trapped and carried to the laboratory for further analysis.

In the laboratory, 0.5 ml of conc. \( \text{H}_2\text{SO}_4 \) was introduced in each bottle to dissolve the precipitate. 100 ml of this solution was titrated against 0.01 N sodium thiosulphate solution using starch as an indicator. The amount of sodium thiosulphate used in the titration was multiplied by the normality factor of 0.8 to obtain the dissolved oxygen concentration. The results are expressed as mg/l.

**Specific conductivity**

The specific conductance of water sample was determined by using a Systronics direct reading conductivity meter (Type 303). The instrument was calibrated by using N/10 KCl solution at 25° C. The results are expressed as \( \mu \text{S} \) at 25° C.

**Calcium and Magnesium (Ca + Mg)**

Total hardness due to Calcium and magnesium was determined by titration method with Eriochrome Black T (EBT) as an indicator.
25 ml of the water sample was taken and to it was added 1 ml of dilute buffer solution and a little of Erichrome Black T. The solution was heated to 70 °C and titrated against EDTA till blue colour appeared. The total quantity of calcium and magnesium present was calculated by multiplying the volume of EDTA used, by a factor of 6.432. The results are expressed as mg/l.

Total phosphorus (Tot. P)

25 ml of unfiltered water sample was evaporated to dryness and the residue heated with 1 ml of 70 % perchloric acid to destroy organic matter. Perchloric acid was evaporated by heating and the residue allowed to cool. To the cold dry residue 10 ml of distilled water and 0.5 ml of acid molybdate solution were added and the contents mixed thoroughly to form phosphate molybdate complex. A drop of 2\% stannous chloride was added after 5 minutes to reduce the phosphate molybdate complex and the intensity of the blue colour so developed was measured after 15 minutes on Systronics Spectrophotometer using red filter at 730 nm. The results are expressed as μg / l.

Nitrate - nitrogen (NO₃ - N)

Nitrate - nitrogen was estimated by Diphenylamine
sulphuric acid method. One ml of the unfiltered water sample was taken in a test tube and treated with a drop of supersaturated sodium chloride solution. It was followed by the addition of 4 ml of nitrate reagent (20 ml of stock solution prepared as: 2.2 g diphenylamine + 150 ml conc. H₂SO₄ + 58 ml of distilled water). The contents of the test tube were vigorously shaken and cooled at once under tap water. The intensity of blue colour developed was measured after 70 minutes on Systronic Spectrophotometer (Type 302) using red filter at 700 nm. The results are expressed as µg / l.

Ammonical - nitrogen (NH₄ - N)

NH₄ - N was estimated by Nessler's method. 25 ml of water sample was treated with 0.5 ml of Seignette salt (K - Na tartarate). This was followed by the addition of 1.5 ml of Nessler's reagent and the contents were thoroughly mixed. After 30 minutes the extinction was measured at 400 nm on the Systronic Spectrophotometer using blue filter. The results are expressed as µg / l.

Total dissolved solids (TDS)

50 ml of unfiltered lake water was taken in a
China dish and evaporated to dryness. The dish along with the dried residue was ignited in a muffle furnace at $550 \pm 50^\circ C$ for about an hour till constant weight was obtained. The initial and the final weights were taken after cooling in a dessicator and the results are expressed as:

\[
\text{TDS mg} / \text{L} = \frac{A - B \times 1000 \times 1000}{V}
\]

where $A$ is the final wt. of dish in g, $B$ is the initial wt. of dish in g, $V$ is the volume of sample taken in ml.

\textbf{Sodium and Potassium}

Both sodium and potassium were estimated by flame photometer (Systronics type 121). The instrument was calibrated using sodium chloride and potassium chloride salts. Sodium filter was used during the estimation of sodium and potassium filter during the estimation of potassium. The results are expressed as mg/L.
QUALITATIVE AND QUANTITATIVE ENUMERATION OF PLANKTON

Qualitative analysis

Sampling for the qualitative analysis of photoplankton and zooplankton was carried out by hauling a plankton net No. 25 (mesh size 64 μm) in different directions both horizontally and vertically in the lake. From the plankton sample thus obtained a sub-sample was examined live under microscope, while the other portion was preserved by fixing in 1% acid Lugol solution for subsequent examination.

Quantitative enumeration

For quantitative enumeration of the plankton a known volume of the lake water (3 litres) collected from surface and bottom was filtered through the plankton net No. 25 (mesh size 64 μm). The filtered samples were collected in a small polyethylene bottles. The samples were fixed in the field by adding 1% acid Lugol solution. The filtered samples were then measured and used for quantitative enumeration. The counting was done by placing 1 ml of the sample in a Sedgewick Rafter Chamber (1 ml capacity) carefully with the help of a pipette so that no air bubble was trapped into the Chamber.
The counting was carried out by placing the Sedgewick Rafter Chamber under a compound microscope provided with a mechanical stage. The entire Chamber was carefully examined and the total number of individuals of the plankton species were noted. The individuals per litre were calculated as follows:

\[
\text{Individuals per litre} = \frac{V \times X}{V'}
\]

where \( V \) is the total volume of the sample observed. 
\( X \) = number of individuals / ml. 
\( V' \) = Total volume of the sample passed through the net.

The plankton were identified to species level wherever possible; otherwise only up to generic level. The works of the following authors were consulted for identification: Ward and Whipple (1959); Desikachary (1959); Cholnoky (1966); Suxena and Venkateshwarlu (1966, 1968); Philliposce (1967); West and West (1978); Contant and Duthie (1978); Book (1981) and Adoni (1985). The data has been collected for two years (1988 - 1989) except in case of Chlorophyll and fish losses which were sampled during 1989.
Chlorophyll a

One litre of water sample was filtered through a Whatman GF/C glass fibre filter. These filters have a slightly irregular effective pore size, therefore a small quantity of Mg CO₃ suspension was placed on the filter and drawn through before the water sample was filtered. The samples were filtered on a specially designed plex filtration glass apparatus - Millipore. After the sample was passed through the filter, the filter was ground in a Teflon tissue grinder with acetone until it was thoroughly macerated. The macerated sample was placed in a centrifuge tube with the required rinses of the mortar and pestle and the final volume was made up to 10 ml plus the volume of the filter. After centrifugation the absorbance was read at 750 and 665 m\( \mu \) on a Spectrophotometer with wave length range of 290 - 750 m\( \mu \). The absorbance was read both before and after acidification with 2 drops of 1N HCl.

\[
\text{Chl a (mg/m}^3\text{) } \mu g/ l = \frac{(A \times k \times 665_o - 665_a) \times V}{Vf \times 1}
\]

\( A \) = Absorption coefficient of chlorophyll a = 11.0

\( k \) = Factor equate the reduction in absorbancy in initial chlorophyll concentration = 2.43

...
Fish collection

To assess the fish loss due to harvesting, 100 Kg of cut plant material was sorted in the harvester itself and entangled fish was collected from the weed. In the laboratory the fish were identified, sorted, weighed and measured and preserved specieswise.

Statistical analysis

Confidence limits

Mean obtained for a sample may not be the true value of the actual mean of the population. To express this uncertainty, confidence limits were assigned to the observed mean (\( \bar{X} \)). To get satisfactory results the value of confidence limits were chosen at 95\% which means that the observed mean will enclose...
the true mean with the frequency of this confidence limits. Confidence limits were derived by the following formula:

\[ 95\% \text{ confidence limits} = \bar{X} \pm (t \times \text{standard error}) \]

where \( \text{standard error (SE)} = \frac{s}{\sqrt{n}} \)

\[ s = \frac{\sqrt{\Sigma x^2 - (\Sigma x)^2 / n}}{n - 1} \]

where \( n \) is the total number of samples.

The value of \( 't' \) was obtained from the \( 't' \) distribution table by entering \( n - 1 \) degrees of freedom for a probability of 0.05 (Bliss, 1967; Yule and Kendall, 1953).

Significance test assess the probability that the apparent effect could have arisen by chance. The lower this probability the more likely is the conclusion that the effect was real. Thus significance is important in accepting the validity of the conclusions derived from a data (Bliss, 1967; Yule and Kendall, 1953).

\( 't' \) test

To find out whether the two sample means, both ...
at surface and bottom before and after deweeding, differ significantly, the value of 't' was calculated by using the following expression:

\[ t = s \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{1/n_1 + 1/n_2}} \]

where \( \bar{x}_1 \) and \( \bar{x}_2 \) are respectively the means of the sample at surface level before and after deweeding, \( n_1 \) and \( n_2 \) are the total number of samples, and 'S' is the standard deviation of the difference between the two samples. The value of 'S' was calculated by the following equation:

\[ S = \sqrt{\frac{\sum (x_1 - \bar{x}_1)^2 + \sum (x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}} \]

To find out the impact of harvesting on various lake parameters the raw data collected was subjected to "Analysis of Variance" as recommended by Yule and Kendall (1953). The following relationship has been employed:

\[ Z = \frac{1}{2} \log_e \frac{V_1}{V_2} \]

where \( V_1 \) and \( V_2 \) are variations between and within the operations respectively.
Correlation coefficients

To determine the strength of relationship between length and weight of the fish, the correlation coefficient was derived by the formula:

$$ \sum f_{xy} - \frac{\left( \sum fx \right) \left( \sum fy \right)}{n} $$

$$ R = \sqrt{ \frac{\sum fx^2 - \left( \sum fx / n \right)^2}{n} \cdot \frac{\sum fy^2 - \left( \sum fy / n \right)^2}{n} } $$

where $x$ is the length, $y$ the weight of the fish and $f$ the frequency. The regression equation was derived by following relationship:

$$ y = a + bx $$

where $a$ and $b$ are constants and fixed for a particular equation.

Coefficient of Determination

Coefficient of determination ($R^2$) gives the measure of the proportion of variation in weight of fish associated with variation in length.

...
Estimation of weed removal

Biomass removal by harvesters have been derived by the relationship:

\[
\text{Biomass removal (BR)} = \sum_{k=1}^{1} \sum_{j=1}^{m} \sum_{i=1}^{n} X_{ijk}
\]

where

\begin{align*}
X &= \text{Average quantity of weed mass harvested per trip/harvester} \\
n &= \text{Average number of trips/day/harvester} \\
m &= \text{Number of harvesters} \\
l &= \text{Average annual number of working days/harvester.}
\end{align*}

Estimate of fish loss

The fish loss was calculated, using the following relationship:

\[
\text{Fish loss (FL)} = \sum_{s=1}^{P} \text{BR} \times W_s
\]

where

\begin{align*}
W_s &= \text{Estimated fish loss of } s\text{th species} \\
\text{BR} &= \text{Biomass removal} \\
P &= \text{Total number of species}
\end{align*}
Plankton populations are broadly classified into the following groups:

<table>
<thead>
<tr>
<th>Group</th>
<th>% population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td>Rare</td>
<td>0 - 2</td>
</tr>
<tr>
<td>Frequent</td>
<td>2 - 5</td>
</tr>
<tr>
<td>Dominant</td>
<td>5 and above.</td>
</tr>
</tbody>
</table>

Following abbreviations are used in the text:

- **B. D.**  - Before deweeding
- **A. D.**  - After deweeding
- **C. S.**  - Control station
- **E. S.**  - Experimental station
- **NE**     - Nehrupark station
- **NG**     - Nagin station
- **S**      - Surface
- **B**      - Bottom