Mt. Kemble Lake

Environmental Survey: Aquatic Flora

Final Report

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INTRODUCTION

This investigation of Mt. Kemble Lake was undertaken during the Spring, Summer, and Fall of 1978. The object of this survey was to observe the ecology of the lake, particularly as pertains to aquatic flora, and to make such recommendations for restoration and/or enhancement of this freshwater system as would be possible from a limited data base. An attempt has been made in this Final Report to communicate basic ecological principles as they are operative in the analysis utilized.

Eutrophication

A discussion of the environmental status of Mt. Kemble Lake depends upon a clear understanding of the biological phenomenon called eutrophication. From the moment a lake is formed, either by natural geological changes, or as in the case of Mt. Kemble Lake, by the hand of man, it begins to collect nutrients which are carried in through groundwater, streams, overland drainage, and even dust, rain, and snow from the atmosphere. In much the same way that fertilizer helps land plants grow, nutrients in a lake promote the growth of algae and higher forms of rooted and floating plants (i.e., Angiosperms). The plants eventually die, sink to the bottom, and eventually fill the lake with material variously described as ooze or muck. The lake eventually becomes shallow and weedy, turns into a swamp, and eventually becomes dry land. It is only the time that this natural aging process (eutropnication) takes which may vary markedly. In nature, this process normally takes eons to complete the transition from lake to dry land. However, the activities of man are capable of greatly accelerating this aging process. Human activities greatly increase the rate of eutrophication. An appreciation of the dynamics of nutrient cycles is of critical concern in the management of Mt. Kemble Lake.

Eutrophication is characterized by the gradual build-up of essential plant nutrients in lake waters. More nutrients enter the closed system that exit from it providing a net gain. It should be noted that even in a natural state, the rate of eutrophication can vary enormously from one lake to another. Man-made lakes created by impounding rivers are usually victims of rapid eutrophication caused by enormous volumes of sediment carried by the river itself. Greater than 90% of such man-made lakes usually have symptoms of some eutrophication. Mt. Kemble Lake is no exception to this experience.

In freshwaters it is well established that phosphorus, an element found in all living things, is usually the major culprit in eutrophication. Plant debris, animal and human wastes, and most fertilizers and detergents contain phosphorus. When roads or houses are built, trees cut, or fields plowed, such activities increase erosion of phosphorus-laden soil into lakes. Plant growth in lake waters cannot be supported simply by phosphorus. A complete spectrum of macro and micro nutrients (i.e., phosphorus, nitrogen, potassium, boron, iron, manganese etc.) is required by all plants. However, phosphorus concentration in freshwaters is usually the rate-limiting element.

Trophic conditions

Eutrophication (the process of aging by ecological succession) proceeds in the following sequence:

(1.) Oligotrophic Lake (low concentration of nutrients; diverse flora & fauna; original depth etc.)

(2.) Mesotrophic Lake (higher concentration of nutrients; depth starting to fill-in with sediments and organic debris)

(3.) Eutrophic Lake (luxurious concentrations of nutrients; biological disturbances common; depth much reduced etc.)

(4.) Pond, Marsh, or Swamp

(5.) Dry Land

Traditionally the trophic state of a lake (i.e., Oligotrophic; Mesotrophic, or Eutrophic) is determined by measurement of selected physical, chemical, and biological parameters. Turbidity (as measured by the depth at which a white disc can be seen under water-Secci Disc); total inorganic phosphorus; inorganic nitrogen; phytoplankton counts (or some substitute, ie., mean chlorophyll assay); dissolved oxygen; and sometimes other selected data, have been traditionally utilized to establish the trophic condition of a lake.

Although extensive chemical data was not gathered in this preliminary study, Mt. Kemble Lake is apparently in what could be described as a transitional mesotrphic condition. Unless remedial steps are taken to reverse or slow the aging process, Kemble Lake will proceed predictably toward a eutrophic condition. Each step in this process will make the lake less desireable. Eutrophication is a dynamic process and further assessments would need to be carefully tempered with supplementary data.

Significance of phosphorus in eutrophication

Phosphorus is usually the key element controlling the rate of eutrophication of most lakes. It is only one of about twenty nutrients which is needed for algal and higher plant growth. Any one of these nutrients will become limiting, according to Liebig's law of the minimum, if it is present in the smallest quantity relative to the amount needed for growth. Phosphorus is the limiting nutrient in most freshwater lakes (N:P ratio greater than approx. 14:1), but other nutrients can also become limiting if phosphorus is over-supplied. In some freshwater lakes in which the Nitrogen:Phosphorus ratio is less than 14:1, nitrogen is the nutrient limiting algal production. In the absence of chemical data, it is impossible to say that phosphorus is unequivocally the key element controlling eutrophication in Mt. Kemble Lake, but it certainly is a likely candidate.

However, of the nutrients which limit plant productivity, phosphorus is the easiest to control. Large amounts of other nutrients, particularly nitrogen and carbon, can enter lakes from the atmosphere or other natural sources (i.e., nitrogen fixation by blue-green algae & bacteria). In light of the fact that anthropogenic sources of phosphorus (e.g., sewage) are so important, phosphorus is easier, relative to other nutrients to control. Although nutrient dynamics is the most important concept in understanding eutrophication, other environmental factors (i.e., light, temperature, alkalinity etc.) are also essential ingredients for plant growth.

Thermal Regimens of Lakes

The thermal regimens of lakes exert significant effects upon overall lake ecology primarily due to the associated phenomenon of thermal stratification. Seasonal changes in air temperature induce changes in water temperature resulting in a cycle of events of mixing and stratification which controls the dispersion of nutrients and dissolved gasses throughout the water column thereby affecting the biological activity in the lake.

During the winter, surface water under ice is very near 0 C. Since water reaches its maximum density at 4 C, the warmer, denser waters will occur at the bottom of the lake. This is inverse stratification. With the gradual warming of surface waters in the spring of the year, the lake becomes homothermous throughout at a temperature of 4 C. Under these conditions, winds generate mixing action which may be complete from top to bottom even in very deep lakes. This distributes nutrients, dissolved oxygen, and other materials throughout the water. As spring progresses into summer, surface waters continue to warm, and a layer of rapidly decreasing temperature (the thermocline or metalimnion) is formed acting as a barrier which prevents the cool, deeper, heavier waters (hypolimnion) from mixing with the warm upper waters (epilimnion). The lower waters (cold) are effectively isolated from the overlying warmer layers and the atmosphere, and if the volume of the lower waters is small and the oxygen consumption rate high (i.e., from fish activity & organic decomposition processes) these bottom waters may become depleted of oxygen. This tends to be the case in eutrophic lakes. In severe cases caused by the oxygen demands of decaying plant blooms which have sunk below the surface, oxygen supply may be low enough to cause fish kills. This happened recently off the coast of N.J. most liklely due to New York City's sewage. In the Fall, mixing of thermal layers will again occur as the surface waters cool & the lake will become homothermous. The bottom waters are reoxygenated at this time. As winter progresses, surface water temperatures again approach 0 C, and the inverse stratification patterns are again established.

Lakes and reservoirs with high discharge to volume ratios are often completely mixed during the summer due to the rapid movement of water. Deep lakes and reservoirs with a low discharge to volume ratio often exhibit the classical lake stratification cycle. Operation of Kemble Lake's discharge rate can have a major influence on the thermal structure.

Temperature data obtained in this study indicate that Mt. Kemble Lake is large enough and its discharge rate such that stratification does occur. Fish populations exist primarily in the cooler lower waters. Extensive decaying plant blooms creating oxygen demands could conceivably cause biological problems (i.e., fish kills, odors, lowered dissolved oxygen, elevated bacterial counts). The blooms noted in this study are not sufficient to cause such problems at this time. Future dynamics could alter this analysis.

Property Values

In discussing accelerated eutrophication changes occurring in Mt. Kemble Lake, some economic analysis cannot be ignored. It is a common assumption that the value of lake shore property is depressed along eutrophic lakes. However, this assumption is difficult to prove or even accurately quantify. Economic studies generally show that lake frontage with algae average 80 to 85% of the value of clean frontage. Property values usually decline steeply with the initial accumulation of small amounts of algae, but as algal growth increases, the rate of decline of real estate value seems to level off. It has been shown, for example, that eutrophication has caused a significant decline in the value of property located over much of the lower Great lakes and perhaps Lake Michigan. If a depreciation of even 10% were applied to lake shore property with plant-growth problems, this cost would surely be significant.

Typical Water Quality Problems; Abatement Procedures; Causes of Pollution

The most common water quality problems encountered in freshwater lakes are: (1.) algal blooms; (2.) low dissolved oxygen; (3.) decreased water clarity; (4.) rooted aquatic vegetation (5.) declining fish populations (6.) high fecal coliform counts; (7.) increased concentrations of nutrients (e.g., phosphorus). Field data obtained in this study indicate that both algal and higher rooted aquatic vegetation blooms occur. Water clarity appears to be relatively good and may or may not be declining. By indirect evidence (plant disturbances) it can be inferred that nutrient build-up is occurring.

Usual causes of decreases in water quality (pollution) are cultural eutrophication, natural eutrophication, man-made impoundments, nutrients from sewage or other sources, and septic tanks. Abatement procedures include harvest, dilution, dredging, diversion, watershed control, and sewage control. Elements of these symptoms, causes and remedies, are discussed in the following sections of this Report as they specifically apply to Mt. Kemble Lake.

Plant Blooms in Mt. Kemble Lake

During the spring, summer, and fall of 1978 two major plant blooms were observed:

(1.) Spirogyra sp.

Spirogyra is a filamentous green alga. Growth of this organism was first observed as bottom mats in the Breeder Pond in May. Some clumps of this alga, which can be readily recognized by its distinctive green appearance & coarse, stringy, silk-like feel, were observed in the northern end of the lake.in May. By June, Spirogyra had spread throughout the Breeder Pond and the northern end of the lake (station #1). The bloom of Spirogyra was largely contained in the northern end of the lake and the Breeder Pond and persisted into July in its most severe form (i.e., floating "mats"). By August, Spirogyra was no longer a dominant bloom & dying "clumps" were evident in the vicinity of station #1. Odor problems from decaying algae were not evident.

(2.) Potamogeton diversifolius (Pondweed)

Potamogeton is a rooted higher plant (Angiosperm-flowering plant). A bloom of this organism followed the bloom of Spirogyra. Potamogeton was first observed in small amounts in July. By August, this plant was the dominant biological disturbance. Once again the major "clumps" of this plant were located in the northern portions of the lake. Although

Pondweed is a rooted plant, it frequently detaches and forms floating mats as did occur this summer. This plant bloom attenuated in September. By that time some floating clumps of plant material (usually a combination of dying Spirogyra & Potamogeton) did reach as far as the beach area. Odors were not evident & swimming was not impaired at the beach area. Pondweed is believed to be the major food for ducks in the U.S.

Cause of Plant Disturbances in Mt. Kemble Lake

Plant disturbances of the type observed in Mt. Kemble Lake only occur under suitable environmental conditions which of necessity involve nutrient-enriched waters. In effect, fertilization produces plant growth in much the same manner as with land gardens. Some natural fertilization cannot be avoided (i.e., leaves, atmospheric particulates etc.), but the activities of man are responsible for the difficulties encountered in this situation.

The rate of sediment introduced into the lake appears excessive and most probably represents the major source of "fertilization" for the lake. It is likely that erosion upstream has contributed considerable amounts of nutrients to the lake. A portion of these nutrients are readily soluble, presumably, and would contribute to excess plant growth in the lake. Insoluble sediments also contribute to plant blooms by lowering the depth of the lake and thereby creating a more favorable environment for rooted aquatic plants (i.e., Potamogeton) and shallow-water-preferring algae (i.e., Spirogyra). Both of the plant blooms observed in the lake during this study originated in the shallow northern waters (i.e., Breeder Pond & Station #1) which have had their depth slowly reduced by sediment over time. This is persuasive circumstantial evidence implicating sedimentation as a major element involved in the production of nuisance plant growth. Additional field data would be required to state unequivocally that sediment from the feeder stream is the primary cause of nuisance organisms. It is possible, but not likely, that septic system drainage into that northern portion of the lake is largely responsible for "fertilizing" plant disturbances.

Control of Nuisance Organisms

Chemical control of algal blooms (i.e., Spirogyra) and higher plants (i.e., Potamogeton) is possible by the use of algicides (i.e., copper sulfate) and herbicides (i.e., Paraquat). However chemical control measures attack only the symptoms (i.e., nuisance organisms) and do nothing to ultimately solve the problem. Eutrophication problems are produced by over-"fertilization" and only mechanisms of cessation and removal of excess plant nutrients will truly address the problem. The most desireable method of alleviating eutrophication is to restrict nutrient input. Toward this end it is recommended that:

(1.) Mechanisms for possible control of upstream erosion be explored (i.e., legal & political approaches) and

(2.) Efficient septic systems around the lake should be rigorously enforced. Progressive lake communities have found it expedient to conduct surveys of waterfront properties regarding the age, location, type of usage (i.e., phosphate detergents? quantity?), and efficiency (i.e., periodic dye tests) of their septic systems.

Another place in which the eutrophication cycle can be broken concerns the nutrients which are already in the lake in the form of sediments and plant mattter. Plants ultimately die & decay with their nutrients ultimately being recycled next year. Some nutrients will naturally be removed from the lake (i.e., in the form of harvested fish & diluted out-flow water), but most will enter a cyclic ecological process within the lake's system.
In order to remove nutrients already present in the lake (either in inorganic "free" form, i.e., sediments, or "captured" form, i.e., plant matter) and thus further alleviate eutrophication, it is recommended that:

(1.) The Breeder Pond & northern portion of the lake be dredged. Dredging is not an immediate requirement, but will be required ultimately to remove sediments already deposited together with newly accrued materials. It is possible that much of the sediment is eroded topsoil. A texture analysis of sediment cores (i.e., percentages of sand, silt, & clay) would establish the marketability of any dredgings for fill purposes. Dredging should be a portion of your long-term plans.

(2.) Plant harvesting procedures be employed during the summer months. It is suggested that a regularized collection procedure of surface and shallow-water plants utilizing boats and rakes could effectively control nuisance plant growth (i.e., Spirogyra & Potamogeton). Harvesting should begin when blooms are seen in May and continue as need would dictate through the summer months. The first plant disturbances would be found in the Breeder Pond. Early control of nuisance plant growth by harvesting should significantly reduce the extent of later blooms. Such harvesting is a simple and inexpensive procedure & certainly ecologically beneficial.

Should the lake's condition deteriorate to a point where harvesting procedures are impossible or ineffective, chemicals can be used to control nuisance organisms. Chemicals should be used as a last resort as they only postpone the problem. It should be noted that two distinct classes of plants caused a nuisance problem in the lake: an alga (Spirogyra) and a higher flowering plant (Potamogeton). These groups respond to different types of chemicals. Copper sulfate is probably the most widely used chemical against algae. It would be effective against Spirogyra but ineffective against Potamogeton. Copper sulfate once added to a lake does not simply go away. True, some of this chemical is diluted and lost from the lake, but most of the copper ends up in bottom sediments. The biological effects of this sediment-held copper remain unclear, but there is some documented evidence that it is harmful to fish populations & perhaps other animal forms. It is possible that decomposing algae killed by some algicide could ultimately "fertilize" a higher plant bloom (which would be unaffected by the algicide) of a more serious nature than the original algal bloom.

Specific herbicides would have to be used to control the bloom of Potamogeton. Many of these herbicides are quite toxic & must be used with discretion. Should such chemicals be required, their selection & dosage should be carefully considered. Harvesting and nutrient-control procedures are the simplest and safest methods of attacking the eutrophication problem.

Significance of Bacterial Counts

High coliform counts are always a sign of fecal contamination & implicate leaky septic systems. Health officials will justifiably close the lake if acceptable standards are violated. The significance of high coliform counts is quite self-evident.

High total bacteria counts are indicative of high amounts of organic matter in the lake. Bacteria are largely saprophytes and feed only on dead organic matter. Should a serious plant bloom develop, the plant material produced will ultimately die and decay. The decay process produces high bacterial populations. Some of these bacteria can cause minor health problems (i.e., eye & ear infections). High bacterial counts are not a healthy sign & usually indicate excessive amounts of organic matter. Oxygen depletion can result from excess bacterial activity, the implications of which have been discussed earlier. Control of nuisance plant growth by algicides and/or herbicides leads to much dead organic material & usually produces high bacterial counts. This is another reason why harvesting and nutrient-control procedures are preferred to chemical controls of nuisance organisms.

SUMMARY

A preliminary environmental survey of Mt. Kemble Lake was conducted during the Spring, Summer, and Fall of 1978. Plant flora, temperature, and pH were monitored. Phytoplankton populations appear within a normal range. The filamentous green alga *Spirogyra* and the flowering plant *Potamogeton* were identified in nuisance concentrations. Control of eutrophication and its effects is recommended by means of plant harvesting, dredging, and nutrient-control procedures. Chemical controls of nuisance organisms are recommended only after simpler and more effective procedures have failed and should be regarded as a last resort.

APPENDIX

FIGURE 1. Eutrophication Cycle

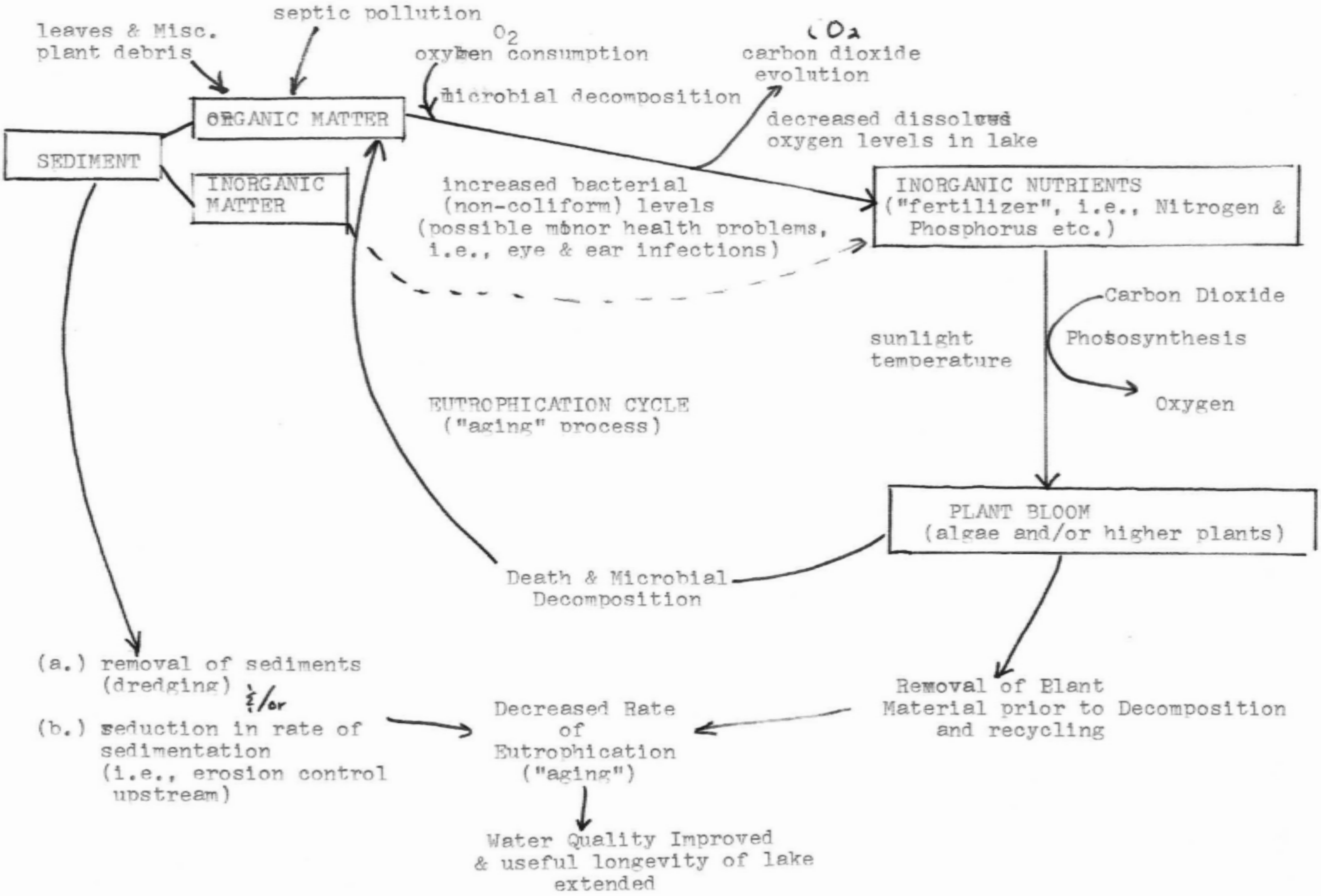
leaves & Misc. plant debris
septic pollution
O_2
oxygen consumption
CO₂
carbon dioxide evolution
microbial decomposition
decreased dissolved oxygen levels in lake
ORGANIC MATTER
SEDIMENT
INORGANIC MATTER
increased bacterial (non-coliform) levels (possible minor health problems, i.e., eye & ear infections)
INORGANIC NUTRIENTS ("fertilizer", i.e., Nitrogen & Phosphorus etc.)
Carbon Dioxide
sunlight temperature
Photosynthesis
Oxygen
EUTROPHICATION CYCLE ("aging" process)
PLANT BLOOM (algae and/or higher plants)
Death & Microbial Decomposition
(a.) removal of sediments (dredging) &/or
(b.) reduction in rate of sedimentation (i.e., erosion control upstream)
Decreased Rate of Eutrophication ("aging")
Removal of Plant Material prior to Decomposition and recycling
Water Quality Improved & useful longevity of lake extended

FIGURE 2. Location of sampling sites

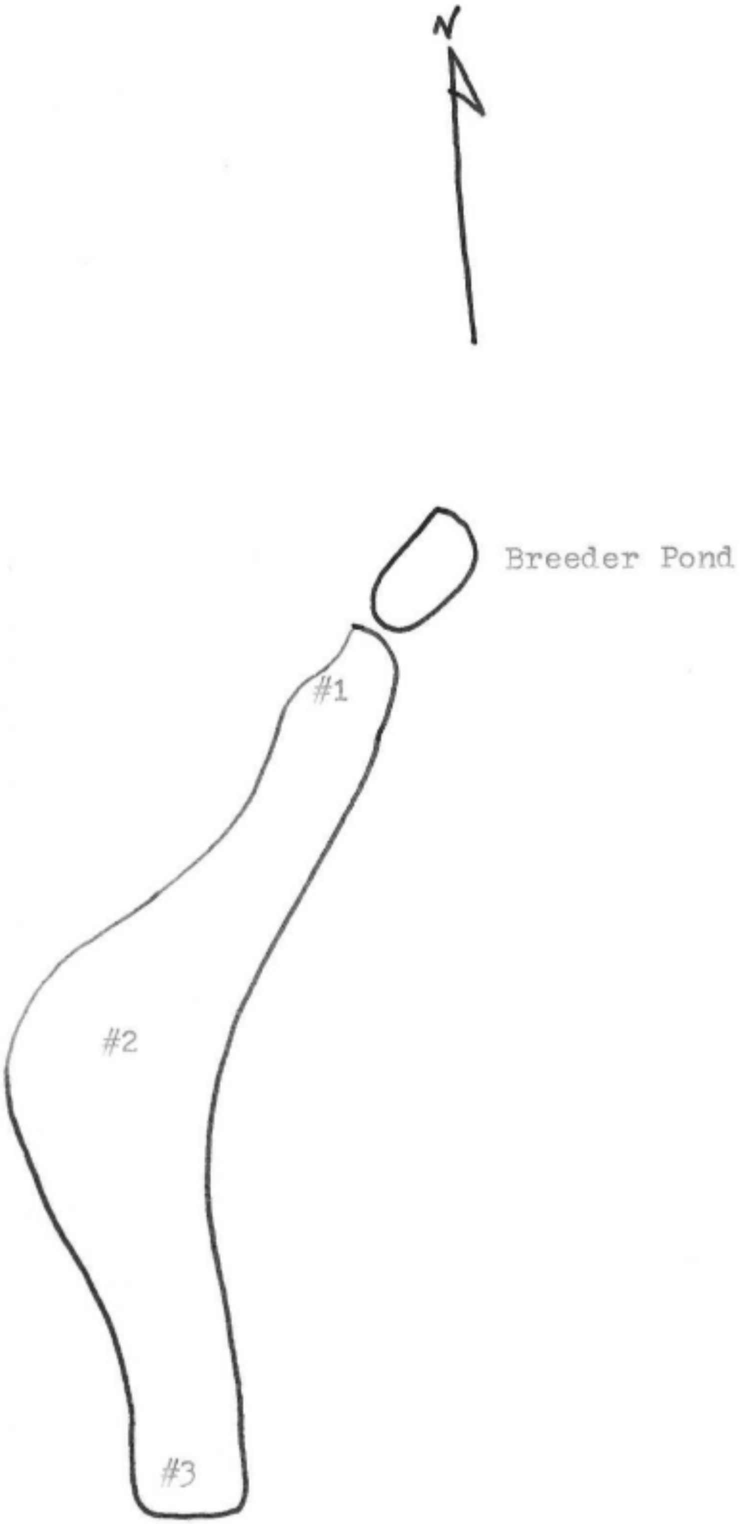

TABLE 1. Recorded observations of Mt. Kemble Lake at selected sampling dates

TABLE 1.

25 April 1978. 4:00 pm

Sampling locations were established. Station #1 is in the northern shallow lake area adjacent to the Breeder Pond. Station #2 is opposite the main bathing beach. Station #3 is at the southern terminal end of the lake. The water level is low. Station #1 had an average depth of approximately 1 or 2 feet.

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10 May 1978. 4:00 pm

There is a moderate-sized bloom of *Spirogyra* sp. in the Breeder Pond. A few "clumps" of this alga are also found in the vicinity of Station #1 but appear to have been washed over from the Breeder Pond. Visibility in the Lake is between five and six feet. The water level is significantly higher than it was two weeks ago. There has been rain in the interim. The water level can be artificially controlled. The depth at Station #1 is approximately 3 feet vs approximately 1 foot at last sampling. There is not a great difference in depth between Station #1 and the Breeder Pond.

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25 May 1978. 4:00 pm

The *Spirogyra* bloom is still in progress in the Breeder Pond. Floating masses of this algo were observed passing over the dam into the upperpportion of Mt. Kemble Lake. Clumps of *Spirogyra* were observed in the vicinity of Station #1 and appear to have been derived primarily from Breeder Pond inocula. The depth of the Lake at Station #1 is now approximately 3 feet. Water Temperature is not noticeably warmer at thisppoint. It appears as if a portion of the algal bloom is dying as some detritis is evident at Station #1 and is usually associated with algal mats. Water is turbid. No odors are evident. The bloom of *Spirogyra* sp. is not yet of severe nuidsance variety. There has been considerable rain in recent weeks. The water level of the lake is high.

Normal phytoplankton present. *Asterionella* bloom has died-out. More flagellates present.

TABLE 1. (cont.)

12 June 1978. 10:00 am

The Spirogyra bloom is still contained almost entirely to the Breeder Pond and is growing in submerged bottom mats. This alga covers most of the bottom of the Breeder Pond. No gloating algal nuisance. No odors. There has been considerable rain in the last week which presumably provided enhanced flushing of the Lake. Phytoplankton counts (quantitative and qualitative aspects) appear quite normal for a dystrophic lake of this sort. Scenedesmus is becoming a dominant member of the phytoplankton. The temperature of the surface waters has warmed up considerably and stratification is evident in the deep water portions of the Lake. Healthy turtle population in the Breeder Pond.

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29 June 1978 1:00 pm

The Breeder Pond continues to maintain the bloom of Spirogyra sp. Bottom "clouds" are present and some surface clumps can be noticed.

Growth of Spirogyra spp. has progressed in the vicinity of Station #1. Quite noticeable bottom "clouds" of this organism are now present and surface clumps of reproducing and older material are commonly visible. Some bottom growth of Spirogyra can now be located along the eastern border of the Lake almost as far as Station #2, but this is not yet a nuisance. The western lake border in this same area is clear; the depth appears to be generally greater perhaps accounting for this distribution contrast.

The clarity of the water in the vicinity of the main bathing beach continues to be quite good. The only algal problem exists in the northern shallow portion of the lake adjacent to the Breeder Pond (i.e., Station #1).

Normal phytoplankton counts were obtained. Stratification evident at Station #2 and Station #3.

TABLE 1 (continued)

19 July 1978

There is a nuisance bloom of Spirogyra which has continued to worsen since the last collection date. Significant "clumps" are floating in the Breeder Pond and the northern portions of the lake at shallow depths (Collecting Site #1).

For the first time Potamogeton diversifolius (Pondweed) is present in noticeable but not nuisance concentrations in both the Breeder Pond and Site #1.

The water clarity appears quite acceptable for a presumably humic lake of this type.

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12 August 1978

Collections & site analysis were made with Bob Gray today. The clarity of the lake waters is not good today due to the abnormally high amounts of rain that have been received in the preceeding seven to ten days. This rain also explains the lower water temperature (64 F) noted in the Breeder Pond when contrasted with the upper waters of the lake proper (approx. 73 F).

The bloom of Spirogyra is starting to die-off & is now apparently on the bottom of the lake. No floating mats of algae were observed in the Breeder Pond. There are a few scattered "clumps" of algae largely contained in the northern portions of the lake. No odors. Largely cosmetic problem.

The most noticeable change in the lake's flora is the dominance of Potamogeton. This plant has replaced the algal bloom as a dominant nuisance organism. This is in contrast to the last collection when Spirogyra was the dominant plant nuisance. Dying & reproducing "clumps" of Spirogyra present.

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4 September 1978

There is some Potamogeton around the northern periphery of the of the lake. Much Pondweed in the Breeder Pond. Clumps of Pondweed wash over the dam next to the Breeder Pond and enter the lake proper via this route. Pondweed begins its growth in the Breeder Pond apparently. Some necrotic clumps of Spirogyra have washed-up from the bottom & are scattered throughout the northern lake waters. There were even a few "clumps" in the vicinity of the bathing beach, but no major problem. Cosmetic problem along N.W & N portions of lake. Exceptional amt. of rain in August.

TABLE 2. Phytoplankton

Mt. Kemble Lake
Phytoplankton

Cells·ml^{-1}

ORGANISM DATE	4/25/78			5/10/78			5/25/78			6/12/78			6/29/78		
Station #	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Asterionella	80	15900	11900	1500	2470	2000	83	—	—	—	—	—	—	—	—
Fragillaria	470	160	80	361	139	—	—	—	—	—	56	56	—	—	—
Misc. Unicells	220	310	170	278	220	420	778	833	806	611	472	583	440	1310	292
Scenedesmus	100	550	550	55	417	810	778	500	389	2280	2670	1920	220	—	83
Misc. Centrate Diatoms	55	55	55	56	11	—	83	1940	139	83	111	27.8	56	139	13.9
Misc. Pennate Diatoms	300	110	139	528	250	28	56	28	0	56	83	111	55.6	0	56
Navicula	220	360	830	110	28	56	389	83	56	27.8	—	—	83	28	—
Tabellaria	220	110	—	56	—	28	83	—	—	250	83	—	167	—	—
Cymbella	83	—	—	560	—	83	306	—	—	—	—	—	—	—	—
Diatoma	30	—	—	—	—	28	56	—	—	—	—	—	—	—	—
Synedra	190	190	140	56	639	1000	222	111	1670	0	27.8	27.8	—	—	13.9
Nitzschia	—	—	—	28	—	—	—	—	—	—	—	—	—	—	—
Closterium	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ankistrodesmus	—	83	140	167	167	139	80	28	—	139	250	310	194	83	111
Misc. Desmids	—	60	30	28	28	—	—	—	—	56	83	139	—	28	28
Chlorella	66	—	60	139	83	139	1940	9170	220	472	222	194	310	361	210
Micratinium	—	—	—	56	—	—	56	111	83	139	444	—	28	140	—
Flagellates- Misc.	—	—	—	56	28	28	22	111	361	—	—	—	—	28	—
Chlamydomonas	—	—	—	—	—	—	—	306	833	28	—	—	—	—	—
Chodatella	—	—	—	—	—	—	—	—	—	—	—	—	83	56	28
Oocystis	—	—	—	—	—	—	—	—	—	—	—	—	222	1390	1030

TABLE 3. Temperature of Lake Waters

Temperatures of Lake Waters

DATE	Breeder Pond		Station #1		Station #2		Station #3	
	surface	bottom	surface	bottom	surface	bottom	surface	bottom
4/25/78			58 F (14.4 C)		58 F (14.4 C)	53 F (11.7 C)	59 F (15 C)	51 F (10.5 C
5/10/78	54 F		57 F (13.9 C)	57 F (13.9 C)	57 F (13.9 C)	51 F (10.5)	57 F (13.9 C)	51 F (10.5
5/25/78			63 F (17.2 C)	59 F (15 C)	63.5 F (17.5 C)	56 F (13.3 C)	64 F (17.8 C)	53 F (11.7 C
6/12/78	63.5 F		72 F (22.2 C)	69 F (20.6 C)	72 F (22.2 C)	52 F (11.1 C)	72.5 F (22.5 C)	52 F (11.1 C
6/29/78			81 F (27.2 C)	76 F (24.4 C)	79 F (26.1 C)	53.5 F (11.9 C)	79 F (26.1 C)	58 F (14.4 C
7/19/78			81 F (27.2 C)	71 F (21.7 C)	79.5 F (26.4 C)	63.0 F (17.2 C)	79.5 F (26.4 C)	57 F (13.9 C
8/12/78	64 F		73 F (22.8 C)	70 F (21.1 C)	74 F (23.3 C)	67 F (19.4)	73 F (22.8 C)	67 F (19.4 C
9/12/78	80 F		74 F (23.3 C)	73 F (22.8 C)	74 F (23.3 C)	68 F (20 C)	74 F (23.3 C)	67 F (19.4 C