Contract Report 528

Monitoring of Eureka Sportsmen's Club Lake, 1991

by David L. Hullinger and
Raman K. Raman
Office of Water Quality Management

Prepared for the Eureka Sportsmen's Club
Eureka, Illinois

March 1992

Illinois State Water Survey
Chemistry Division
Peoria, Illinois

A Division of the Illinois Department of Energy and Natural Resources

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INTRODUCTION

In an effort to improve the water quality of their lake, the Eureka Sportsmen's Club members asked the Illinois State Water Survey to continue monitoring their lake through 1991. The monitoring program was begun in 1990.

In June 1990 the club members installed a floating mechanical aerator/destratifier at the deepest point on the lake. This installation was completed just in time to add oxygen to the stratified layer of water in the lower part of the water column that was devoid of dissolved oxygen (DO). This action was responsible for preventing a fish kill due to lack of oxygen, and also eliminated certain chemicals that could be toxic to fish.

Water Survey staff visited the lake at least twice a month from April 8 to October 21, 1991, and more frequently during critical summer months. Readings for temperature and dissolved oxygen were made at one-foot intervals from the surface to the lake bottom in the deepest part of the lake near the destratifier and in each of the bay areas. A YSI Model 58 dissolved oxygen meter with a 40-foot probe was used. Samples for chemical analysis were collected at the surface and at one foot above the bottom at the deep station. Surface water samples were collected for algal identification and enumeration.

METHODS AND MATERIALS

Samples taken for analysis were rushed to the laboratory, where they were immediately analyzed for pH, alkalinity, and conductivity. Soon thereafter, analyses were performed for all other parameters. The water quality parameters analyzed and the analytical methods used in the laboratory are shown below.

Analytical Procedures

Water Quality Parameters	*Analytical Laboratory Method*
pH	Combination pH electrode, Metrohm-Herisau (E588)
Alkalinity	Potentiometric titration
Specific conductance	Conductivity cell, Metrohm-Herisau (E587)
Turbidity	Ratio turbidimeter (HF DRT 100D)
Total suspended solids	Dry weight of total suspended solids retained on glass fiber filter, dried at 103-105°C
Total phosphorus	Acid digestion, ascorbic acid reduction
Dissolved ammonia	0.45 μM filtration, modified phenate method
Dissolved nitrate	0.45 μM filtration, chromotropic acid method

Algal samples were identified by microscopy and counted as to individuals up to species level in four main groups: blue-greens, greens, diatoms, and flagellates.

RESULTS AND DISCUSSION

Although the mechanical destratifier performed very well after being activated on April 11, 1991, figure 1 (isothermal plots) and table 1 (temperature and dissolved oxygen profiles) show that the lake was thermally stratified before that date. Isopleths of dissolved oxygen in figure 2 along with the data shown in table 1 indicate that dissolved oxygen concentrations in the bottom waters tended to be below 4 milligrams per liter (mg/l) from the last half of June through the first week of September.

Very little rainfall occurred during the summer of 1991, and the tributary stream of the lake became dry during June. As a result of the lack of rain, the lake level dropped to 12 to 18 inches below spillway elevation. With no influent of fresh water and no water flowing over the spillway, the lake became a self-contained system. Hot seasonal temperatures combined with abundant nutrients already present in the lake encouraged an early proliferation of duckweed and algae.

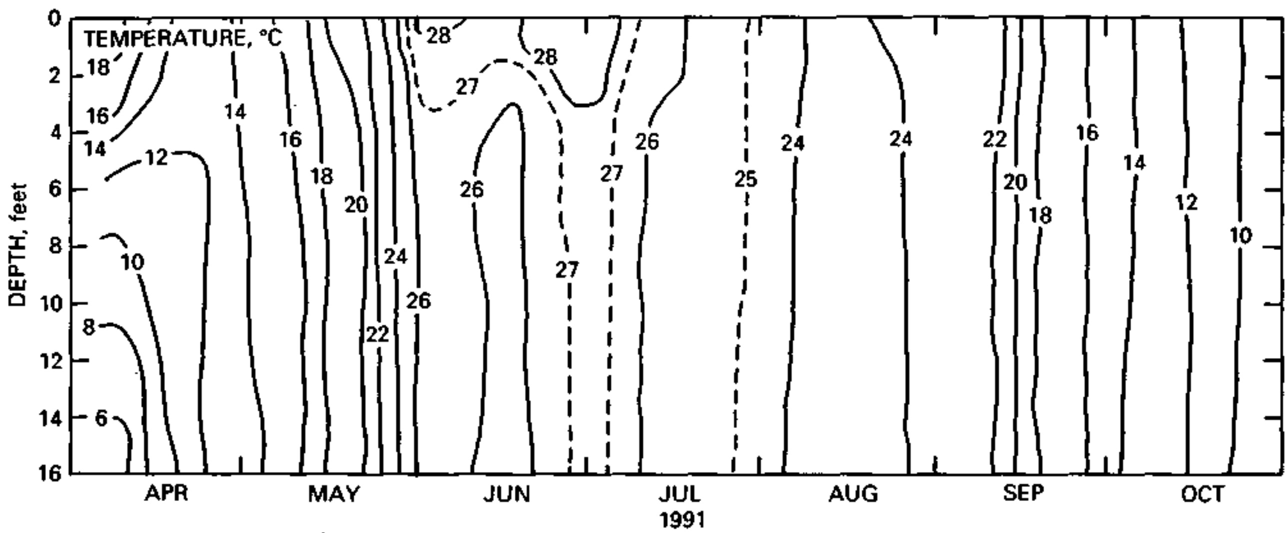

Figure 1. Isothermal plots for the deep station on Eureka Sportsmen's Club Lake, 1991

Table 1. Temperature and Dissolved Oxygen Profiles at the Deep Station on Eureka Sportsmen's Club Lake, 1991

	4/8/91		*4/22/91*		*5/7/91*		*5/20/91*		*6/3/91*		*6/17/91*		*7/1/91*		*7/3/91*		*7/8/91*	
Depth	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*
Surface	18.3	12.9	12.9	9.3	16.1	6.2	21.0	9.3	28.1	7.8	27.9	6.6	30.3	10.9	28.1	5.2	29.3	6.3
1'	18.1	12.8	12.9	9.3	15.8	6.1	20.5	9.3	27.9	7.7	27.1	6.6	29.6	10.8	27.9	5.0	29.3	6.3
2'	17.6	13.0	12.9	9.3	15.0	5.8	20.0	8.2	27.4	7.6	26.3	5.3	28.4	4.3	27.8	4.3	28.8	6.3
3'	16.4	14.4	12.9	9.2	14.5	5.8	19.3	6.6	27.2	5.8	26.0	4.7	28.0	3.4	27.7	4.2	28.4	4.8
4'	14.3	20+	12.2	9.2	14.5	5.7	19.2	6.4	26.9	5.2	25.9	4.3	27.9	2.7	27.7	3.6	28.0	3.7
5'	12.4	20+	11.9	8.5	14.4	5.7	19.2	6.3	26.8	4.9	25.8	4.1	27.8	2.5	27.6	3.5	28.0	3.5
6'	11.4	17.0	11.8	8.3	14.4	5.6	19.2	6.3	26.8	4.8	25.8	4.1	27.8	2.3	27.6	3.1	27.9	3.4
7'	10.6	12.0	11.8	8.3	14.3	5.7	19.1	6.3	26.7	4.6	25.8	3.9	27.8	2.3	27.6	3.0	27.9	3.4
8'	9.8	9.6	11.7	8.3	14.3	5.6	19.2	6.3	26.7	4.6	25.8	3.9	27.7	2.2	27.6	3.1	27.9	3.4
9'	8.7	7.2	11.6	8.2	14.3	5.6	19.2	6.2	26.7	4.6	25.8	3.9	27.7	2.2	27.5	3.1	27.9	3.4
10'	8.3	2.0	11.6	8.2	14.3	5.6	19.1	6.2	26.7	4.6	25.8	3.7	27.7	2.2	27.5	3.1	27.9	3.3
11'	7.4	0.6	11.6	8.1	14.3	5.6	19.1	6.2	26.7	4.6	25.7	3.7	27.7	2.1	27.4	3.1	27.9	3.3
12'	6.6	0.4	11.5	8.1	14.3	5.6	19.1	6.1	26.7	4.5	25.7	3.6	27.7	2.0	27.4	3.1	27.9	3.3
13'	6.3	0.4	11.5	8.2	14.2	5.6	19.1	6.1	26.7	4.4	26.7	3.5	27.6	1.8	27.3	3.3	27.8	3.1
14'	6.0	0.4	11.4	8.2	14.2	5.6	19.1	6.2	26.6	4.4	25.7	3.4	27.6	1.5	27.3	3.4	27.7	3.1
15'	5.9	0.4	11.3	8.2	14.1	5.6	19.0	6.2	26.6	4.3	25.6	3.4	27.5	1.4	27.2	3.3	27.7	3.0
16'	5.8	0.3	11.3	8.1	14.1	5.6	19.0	5.6	26.5	4.0	25.6	3.4	27.5	0.8	27.2	3.3	27.7	2.8

	7/15/91		*7/29/91*		*7/30/91*		*7/31/91*		*8/1/91*		*8/2/91*		*8/6/91*		*8/12/91*		*8/26/91*	
Depth	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*
Surface	26.8	5.9	25.0	3.8	26.3	6.0	24.0	3.1	24.7	4.1	25.0	4.6	23.9	3.7	23.7	5.7	24.5	4.6
1'	26.8	5.8	25.0	3.6	25.4	5.5	24.0	3.0	24.5	3.6	25.0	4.6	23.9	3.4	23.5	5.6	24.5	4.6
2'	26.1	5.6	25.0	3.6	24.6	3.6	24.1	2.9	24.4	3.3	24.9	4.3	23.9	3.2	23.3	5.0	24.4	4.5
3'	25.9	4.6	25.0	3.6	24.3	3.0	24.0	2.9	24.4	3.2	24.9	3.3	23.9	3.0	23.1	4.8	24.2	4.0
4'	25.7	4.3	25.0	3.5	24.2	2.8	24.0	2.9	24.4	3.2	24.9	3.5	23.9	3.0	23.1	4.5	24.1	3.8
5'	25.7	4.3	25.0	3.5	24.2	2.8	24.0	2.8	24.4	3.2	24.8	3.5	23.9	3.0	23.1	4.5	24.1	3.8
6'	25.6	4.3	25.0	3.5	24.2	2.8	24.0	2.8	24.3	3.2	24.8	3.5	23.9	3.0	23.1	4.5	24.1	3.8
7'	25.6	4.3	25.0	3.5	24.2	2.7	24.0	2.8	24.3	3.2	24.8	3.5	23.9	3.0	23.1	4.4	24.0	3.8
8'	25.6	4.3	25.0	3.5	24.2	2.7	24.0	2.7	24.3	3.2	24.8	3.6	23.9	3.1	23.1	4.4	24.0	3.8
9'	25.6	4.2	25.0	3.5	24.2	2.6	24.0	2.7	24.3	3.1	24.8	3.6	23.9	3.1	23.0	4.3	24.0	3.8
10'	25.6	4.2	24.9	3.5	24.1	2.6	24.0	2.7	24.3	3.0	24.8	3.8	23.9	3.0	23.0	4.3	24.0	3.8
11'	25.6	4.2	24.9	3.5	24.1	2.6	24.0	2.7	24.2	3.0	24.8	3.9	23.9	3.0	23.0	4.2	24.0	3.8
12'	25.6	4.2	24.9	3.5	24.0	2.6	24.0	2.7	24.2	2.4	24.8	3.9	23.9	3.0	23.0	4.3	24.0	3.8
13'	25.6	4.2	24.9	3.5	24.0	2.6	24.0	2.7	24.2	2.1	24.8	4.3	23.0	3.0	22.9	4.3	24.0	3.6
14'	25.6	4.2	24.9	3.5	24.0	2.6	24.0	2.7	24.2	2.1	24.8	4.3	23.9	3.1	22.9	4.2	24.0	3.5
15'	25.6	4.2	24.9	3.4	24.0	2.6	24.0	2.7	24.2	2.0	24.7	4.0	23.9	3.1	22.8	4.2	24.0	3.5
16'	25.4	4.1																

	8/31/91		*9/3/91*		*9/9/91*		*9/23/91*		*10/7/91*		*10/21/91*	
Depth	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*	*Temp*	*D.O.*
Surface	26.7	8.7	25.1	8.5	24.9	8.5	17.2	11.7	13.9	8.9	10.5	9.5
1'	26.6	8.5	25.0	8.3	24.9	8.0	17.2	11.7	13.9	8.9	10.4	9.5
2'	26.0	6.8	24.9	6.3	23.0	5.1	17.1	12.1	13.7	8.6	10.3	9.4
3'	25.6	3.8	24.3	4.2	22.7	4.5	17.0	12.0	13.6	8.5	10.2	9.4
4'	25.4	3.1	24.2	3.8	22.7	4.5	17.0	11.0	13.6	8.4	10.2	9.3
5'	25.4	3.3	24.2	3.7	22.6	4.5	16.8	10.7	13.6	8.4	10.2	9.3
6'	25.4	3.1	24.2	3.6	22.6	4.3	16.8	10.3	13.6	8.3	10.2	9.3
7'	25.4	3.0	24.2	3.6	22.6	4.3	16.7	10.3	13.6	8.3	10.1	9.3
8'	25.4	2.7	24.2	3.5	22.6	4.2	16.7	10.1	13.5	8.2	10.1	9.2
9'	25.3	2.6	24.1	3.5	22.6	4.2	16.6	10.0	13.5	8.2	10.1	9.2
10'	25.3	2.6	24.1	3.5	22.6	4.1	16.5	10.0	13.5	8.2	10.1	9.3
11'	25.3	2.6	24.1	3.4	22.5	4.1	16.6	10.0	13.5	8.3	10.1	9.3
12'	25.3	2.6	24.1	3.4	22.5	4.0	16.4	9.5	13.4	8.3	10.1	9.3
13'	25.3	2.5	24.1	3.4	22.5	4.0	16.4	9.5	13.4	8.3	10.1	9.2
14'	25.3	2.4	24.1	2.6	22.5	3.9	16.4	9.6	13.3	8.1	10.1	9.3
15'	25.1	2.0	24.0	2.0	22.4	3.8	16.2	9.8	13.2	8.0	10.1	9.1

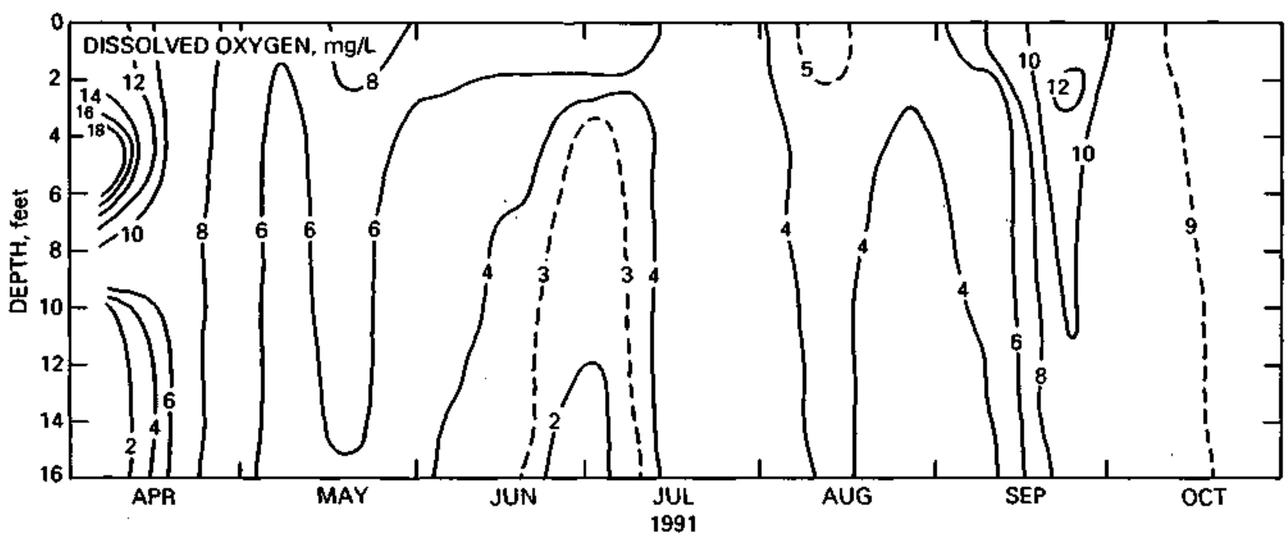

Figure 2. Isopleths of dissolved oxygen for the deep station on Eureka Sportsmen's Club Lake, 1991

By early June, duckweed populations were quite high in the lagoon, in the dog-leg bay, and in the main bay. Club members did a good job of physically removing as much duckweed as they could.

Algae of all types also flourished. Table 2 lists the algae present at the deep station. The type of algae to be most concerned about is blue-green algae. These algae are typically floaters, and concentrations can be so high that they cause both green scum and taste and odor problems in water. They also give a "day-glow" green paint color to the surface. These high concentrations of algae are called "blooms." Other types of algae, such as green algae and diatoms, can also cause a green scum, as well as a "green pea soup" effect on the surface. The four species of blue-green algae found in greatest numbers in the lake were *anabaena spiroides, anacystis cyanea, anacystis thermalis,* and *aphanizomenon flos-aqua.*

By early July, blue-green algal blooms were prevalent in the lagoon, the dog-leg bay, the main bay, and in most other areas except in the vicinity of the deep station. By late August, the duckweed population was significantly reduced and had been replaced with larger populations of blue-green algae. Often the blue-green algae population was so heavy in the lagoon and dog-leg bay areas that "mats" of these algae appeared to float on the lake surface. Strong odors were also given off from heavy concentrations of blue-greens. Then by the end of September, all the algae concentrations had decreased significantly.

Even though the destratifier was performing adequately, the lack of rain during summer 1991 was too great a challenge. With no fresh oxygen-containing water entering the lake, the oxygen demand from the decomposition of leaves, duckweed, algae, and other materials in the bottom sediments was greater than the destratifier alone could supply. The level of dissolved oxygen in the water column 2 to 3 feet below the surface at the deep station often became dangerously low for fish to survive.

Table 2. Algal Types and Densities at the Deep Station on Eureka Sportsmen's Club Lake, 1991

	Algal species	*4/8*	*4/22*	*5/7*	*5/20*	*6/3*	*6/17*	*7/1*	*7/3*	*7/8*	*7/15*	*7/29*	*7/30*	*8/1*	*8/2*	*8/6*	*8/12*	*8/26*	*9/3*	*9/9*	*9/23*	*10/7*	*10/21*	*No. of obser-vations*
BG:	*Anabaena spiroides*							2237	1743		357	148	149	34	107	65	106		TNC	200				11
	Anacystis cyanea							347	431			408	134	311	155									6
	A. thermalis										1376						95	424	TNC	1964	74			6
	Aphanizomenon flos-aquae				48	21		935	851	40	315	217	67	61	67		965	843	TNC	567		371	431	16
	Oscillatoria sp.					15			53			212		11					TNC					5
G:	*Actinastrum hantzschii*							11																1
	Chlorella sp.		4841																			398		2
	Coelastrum microporum			4		11	116			38														4
	Crucigenia rectangularis								84															1
	Errerella bomhemiensis									21	42													2
	Micactinium pusillum								11															1
	Oocystis borgei		32	15	13					32	21									11			84	7
	Pediastrum duplex					6	95	11	32		95	270	36	11	11	124	175	307	53	347	53		63	16
	P. simplex																122		21			74	21	4
	S. dimorphus					61	2426	21	42		32				8	32	58			11				9
	Schroederia sp.																						11	1
	Sphaerocysris sp.																			32				1
D:	*Cyclotella atomus*		315																					1
	C. meneghiniana				98		851																252	3
	C. ocellata	145																						1
	Melosira granulata		95		122	164		95	63		74	122		36	67	145	138	148	116		3875	498	1554	16
	Nitzschia sigmoidea		11																					1
	Synedra acus	311	32																					2
F:	*Ceratium hirundinella*							42	95	40		281	13	6	21						21			8
	Endorina elegans									13														1
	Euglena gracilis		53																				63	2
	Trachelomonas crebea		32	17	118	116	189		95	34	116	164		8		4	133	95	21	189	95	69	116	18
De:	*Glenadinum sp.*									6	21			2		4	53							5
Total		446	5411	36	399	394	3677	3699	3500	224	2449	1822	399	480	436	374	1845	1817	TNC	3289	4118	1410	2596	
Number of species		2	8	3	5	7	5	8	11	8	10	8	5	9	7	6	9	5	8	7	5	5	9	

Note: Density in counts per milliliter;
BG - Blue-greens; G - Greens; D - Diatoms; F - Flagellates; and De - Desmids.
TNC - Too numerous to count

As shown in table 1, the first time dissolved oxygen reached levels of concern was July 1. To help overcome the demand for oxygen by the decomposition process, 10 pounds of potassium permanganate were mixed into the lake at the site of the destratifier on July 2 (figure 3). The second occasion of concern was July 8, and a second potassium permanganate treatment was made on July 12. Immediate benefits were noticed in the DO profiles of July 3 and July 15.

During the week of July 29 the dissolved oxygen concentrations at the deep station dropped precipitously in the lower lake layers. DO concentrations were below 4 mg/l, thereby threatening a fish kill (figure 3 and table 1). The Club's annual fish fry was scheduled for August 2 at the lake. Water Survey personnel monitored the dissolved oxygen levels daily that week. Applications of potassium permanganate were made three times to improve the oxygen concentrations. Probable fish kills that critical week were thus successfully prevented.

Each of the potassium permanganate treatments required 10-pound applications to this 4- to 5-acre lake. In the majority of treatments, the entire amount of oxidizer was suspended in a container under the water surface near the destratifier, from which current action could distribute the potassium permanganate throughout the lake. At other times 7 pounds of the oxidizer were added with the destratifier, while 3 pounds were dragged in a container behind a boat through the bay areas. Both upflow and downflow modes were used with the destratifier.

During the 1991 season, potassium permanganate was added eight times: on July 2, 12, and 31; August 1, 2, 7, and 25; and on September 12, as shown in figure 4.

In addition to monitoring at the deep station, temperature and dissolved oxygen profiles were also run in the lagoon, in the dog-leg bay, and in the main bay. Due to more shallow depths in each of these areas, natural surface aeration was considered adequate to keep the dissolved oxygen levels high enough to support fish life, even on the lake bottom, without the use of the bubblers that had been used in 1990.

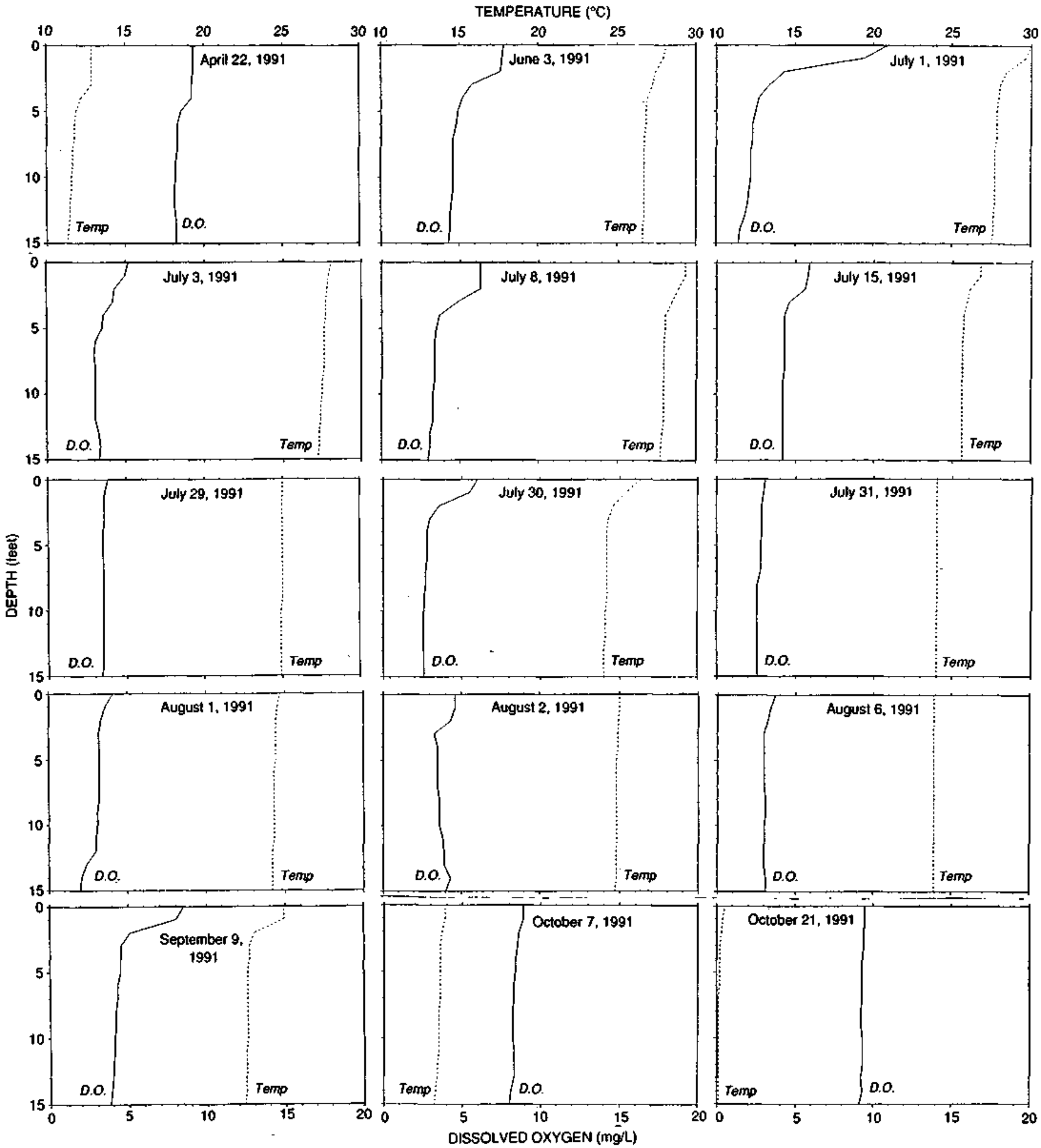

Figure 3. Temperature and dissolved oxygen profiles for the deep station on Eureka Sportsmen's Club Lake, selected dates, 1991

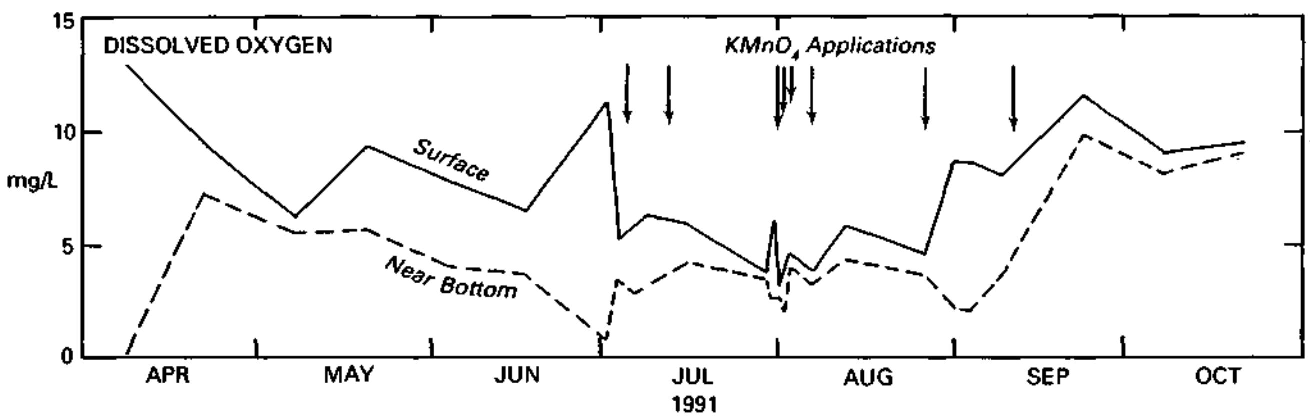

Figure 4. Temporal variations in dissolved oxygen at the deep station on Eureka Sportsmen's Club Lake and potassium permanganate application dates, 1991

Table 3 lists the means and ranges of the chemical analyses performed on surface water and on water one foot above the lake bottom at the deep station near the destratifier. All chemistry values were within reason and showed no cause for alarm, again demonstrating the effectiveness of the destratifier. Appendix A gives the results of all chemical data.

SUMMARY AND CONCLUSIONS

The year 1991 proved to be a challenge for management of the Eureka Sportsmen's Club's Lake. By spring, the lake had already received a new supply of leaves, which were a source of added nutrients. With the summer being hot and nearly without rain, the lake's influent stream became dry. The lake level then dropped to approximately 12 to 18 inches below the spillway elevation by early August. Even with the destratifier running, the overpowering demand for oxygen by decomposition of leaves, duckweed, algae, and other substances in the bottom sediments depleted dissolved oxygen supplies in the lower three-fourths of the water column to dangerously low levels. Possible leakage from the outdoor privy near the lagoon was also suspected of entering the lake. Potassium permanganate had to be added to the lake on eight occasions to avoid possible fish kills.

If horizontal mixers can be placed in the lagoon, the dog-leg bay, and the main bay to keep the surface water in constant motion, duckweed and algae are not likely to grow to the extent they did in the last two years. The oxygen demand from decomposition should then be reduced, and dissolved oxygen can be kept at safer levels for fish habitation.

If another year of drought occurs, consideration of a dilution-flushing technique may be warranted. In this procedure ample ground water is added at the inlet of the lake to dilute and thereby flush it. The rate of supply of dilution water to the lake should allow the lake volume to be displaced in three to four weeks.

Table 3. Means and Ranges of Chemical Constituents, April 8 to October 21, 1991

	Surface		*1 foot above bottom*	
Constituents	*Mean*	*Range*	*Mean*	*Range*
Temperature (°C)	22.9	10.5-30.3	20.9	5.9-27.7
Dissolved oxygen (mg/l O_2)	7.1	3.1-12.9	4.4	0.4-9.6
Specific conductance (μmho/cm at 25°C)	433	418-456	439	424-482
Suspended solids (mg/l)	19	4-82	21	11-37
Turbidity (NTU)	33	7-158	31	17-93
pH (pH units)	8.66	7.96-9.30	8.41	7.66-9.19
Alkalinity (mg/l as $CaCO_3$)	187	170-197	189	175-204
Total phosphorus (mg/l P)	0.24	0.06-0.62	0.24	0.08-0.32
Diss. ammonia nitrogen (mg/l N)	0.17	0.01-0.38	0.28	0.02-0.76
Diss. nitrate nitrogen (mg/l N)	0.12	0.06-0.53	0.11	0.04-0.51

Also, it may be helpful to consider creating an additional sediment basin upstream of the inlet to the lake to act as a small wetland. This would help clean the water coming from the nearby hog farm before it enters the lake.

Our recommendations for 1992 are as follows:

1. Continue using the destratifier.
2. Install horizontal mixers instead of the diffused air aeration systems in the three bay areas to keep the water in constant motion. This should help reduce the populations of both duckweed and algae. The bubblers in these areas were not needed in 1990 and 1991, because dissolved oxygen levels in these areas were never a problem.
3. Remove as many leaves as possible from the lake.
4. Remove as much duckweed from the lake as possible whenever it is present.
5. Investigate possible leakage around the holding tank of the outdoor privy. Fixing small leaks, installing a new liner, or repositioning the entire structure to higher ground are all options to consider.
6. Minimize the effluent and drainage entering the lake from the nearby hog farm. Creation of an additional sediment basin/wetland could be one solution.
7. Monitor the dissolved oxygen and temperature profiles in the lake twice monthly from April through October 1992.
8. Consider providing dilution water for flushing action during periods of scarce rainfall. The possibilities of using ground water, municipal water, or diversion from nearby creeks or streams could be investigated.

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Appendix A. Chemistry Data for Eureka Sportsmen's Club Lake, 1991

Deep Station - Surface

	4/8	*4/22*	*5/7*	*5/20*	*6/3*	*6/17*	*7/1*	*7/3*	*7/8*	*7/15*	*7/29*	*7/30*	*7/31*	*8/1*	*8/2*	*8/6*	*8/12*	*8/26*	*9/3*	*9/9*	*9/23*	*10/7*	*10/21*
Conductivity (μmho/cm at 25°C)	439	456	440	429	441	427			428	430	432	435	433	428	435	438	435	436	424	430	418	428	431
Turbidity (NTU)	7	14	55	12	12	18	32		20	25	31	28	28	29	24	31	22	30	105	158	17	15	10
pH (units)	9.04	8.64	7.96	8.55	8.29	8.58	8.86	8.41	8.61	8.39	8.51	8.68	8.52	8.55	8.59	8.50	8.55	8.80	9.15	9.11	9.30	9.00	8.60
Alkalinity (mg/l as $CaCO_3$)	173	186	170	173	178	185	179	182	187	185	193	193	193	194	195	195	197	196	193	190	191	185	188
Total P mg/l	0.06	0.10	0.21	0.12	0.24	0.20	0.21		0.21	0.27	0.24	0.24	0.24	0.26	0.26	0.29	0.27	0.25	0.54	0.62	0.20	0.13	0.11
NH_3-N (D) mg/l	0.04	0.18	0.34	0.03	0.24	0.07	0.06	0.14	0.12	0.22	0.26	0.27	0.38	0.34	0.27	0.41		0.19	0.01	0.02	0.02	0.04	0.12
NO_3-N (D) mg/l	0.08	0.13	0.53	0.06	0.14	0.12	0.10	0.06	0.19	0.15	0.10	0.08	0.08	0.12	0.11	0.13	0.14	0.09	0.08	0.07	0.06	0.06	0.08
Susp. solids (mg/l)					4	8	16		9	14	15	18	16	19	13	14	7	15	56	82	19	13	5

Deep Station - One Foot above Bottom

	4/8	*4/22*	*5/7*	*5/20*	*6/3*	*6/17*	*7/1*	*7/3*	*7/8*	*7/15*	*7/29*	*7/30*	*7/31*	*8/1*	*8/2*	*8/6*	*8/12*	*8/26*	*9/3*	*9/9*	*9/23*	*10/7*	*10/21*
Conductivity (μmho/cm at 25°C)	482	462	438	431	440	429			435	433	435	436		442	438	438	438	441	442	435	424	426	435
Turbidity (NTU)	20	19	93	18	17	22	27		30	34	34	31		29	24	39	27	34	39	52	27	18	17
pH (units)	7.66	8.45	7.93	8.19	8.00	8.41	8.09		8.42	8.24	8.25	8.46		8.42	8.50	8.50	8.58	8.65	8.62	8.55	9.19	8.90	8.62
Alkalinity (mg/l as $CaCO_3$)	204	186	175	175	180	180	187		189	189	188	195		193	191	195	195	197	197	190	192	187	188
Total P mg/l	0.08	0.24	0.30	0.14	0.23	0.24	0.17		0.25	0.31	0.30	0.25		0.26	0.27	0.32	0.28	0.27	0.29	0.28	0.24	0.15	0.14
NH_3-N (D) mg/l	0.76	0.34	0.37	0.03	0.34	0.19	0.26		0.27	0.33	0.27	0.49		0.40	0.32	0.38		0.24	0.20	0.11	0.02	0.04	0.14
NO_3-N (D) mg/l	0.09	0.14	0.51	0.06	0.12	0.17	0.05		0.11	0.13	0.09	0.09		0.10	0.09	0.09	0.12	0.09	0.11	0.07	0.06	0.04	0.08
Susp. solids (mg/l)					11	16	20		22	23	22	20		24	16	27	11	17	25	31	37	17	16