APPENDIX

A. Abbreviations

atm	atmosphere
BOD	biological oxygen demand
cal	calorie
C/sec	counts per second
CST	central standard time
cu ft	cubic feet
diam	diameter
DO	dissolved oxygen
gm-cm	work, gram-centimeters
ha	hectare
hp	horsepower (metric), as the power of rating of the equipment employed
hp-hrs	work, (metric) done by the equipment employed or hp x hours
ID	inside diameter
ihp	indicated horsepower (metric) theoretical power, excluding any losses through equipment
ihp-hrs	work (metric), theoretical work, excluding losses through equipment
incr	increase
kg	kilogram
l	liter
m	meter
mg	milligram
min	minute

mm	millimeter
n	polytropic exponent for gases
p	pressure (absolute)
ppm	parts per million
P32	radioisotope of phosphorus
rel	relative
S	stability
sec	second
sta	station
T	absolute temperature
t-C	ton-calorie
t-m	ton-meter
U	undersaturation
UBT	upper boundary of the thermocline (p.37)
v	volume
w	work
^{o}C	degrees centigrade
t	elapsed time
free air	volume of air at conditions stated

B. Lakes

	Cather L.	Katharine L.
Location	Sec.3,T32N,R9W	Sec. 4, T41N,R12E
County	Chippewa	Vilas
State	Wisconsin	Wisconsin
Map	Hydrographic UW (Fig.1,p.6)	Provisional UW
Area	0.425 ha	6.07 ha
Average depth	3.1 m	1.5 m
Maximum depth	10.9 m	5.8 m
Volume	1315×10^2 m^3	938×10^2 m^3
Volume/stratum		
0-1 m	388×10^2 m^3	
1-2 m	295	
2-3 m	201	
3-4 m	137	
4-5 m	98.8	
5-6 m	72.5	
6-7 m	52.7	
7-8 m	36.5	
8-9 m	22.5	
9-10m	9.97	
10-10.9 m	1.45	

Lakes (continued)

	Sawmill P.	Tub L.
Location	Sec. 7,R4E,T43N	Sec. 11,T32N,R9W
County	Vilas	Chippewa
State	Wisconsin	Wisconsin
Map	Hydrographic UW (Fig. 4,p.14)	Hydrographic (provisional)
Area	0.125 ha	0.720 ha
Average depth	4.0 m	3.0 m
Maximum depth	7.1 m	7.7 m
Volume	49.9×10^2m^3	216×10^2 m^3
Volume/stratum		
0-1 m	11.33×10^2 m^3	59.7×10^2 m^3
1-2 m	9.43	44.2
2-3 m	8.08	37.4
3-4 m	7.01	31.3
4-5 m	6.06	22.4
5-6 m	5.02	13.3
6-7 m	2.89	6.7
7-7.1 m	0.052	1.2 (7-7.7 m)

Lakes (continued)

	Tuesday L.	West Lost L.*
Location	Sec. 36,R42W,T45N	Pigeon R. Trout Res. Area
County	Gogebic	
State	Michigan	Michigan
Map	None available	*
Area	3 ha (estimated)	1.46 ha
Average depth	8-9 m	6.2 m
Maximum depth	17 m	12.8 m
Volume	2500 x 10^2 m^3	892 x 10^2 m^3

* From Hooper et al. (1953)

Lakes (continued)

	Turk L.
Location	Sec. 10,T32N,R9W
County	Chippewa
State	Wisconsin
Map	Hydrographic, UW (Fig. 2, p.9)
Area	0.441 ha
Average depth	2.0 m
Maximum depth	6.0 m
Volume	876.6 x 10^2 m^3
Volume/stratum	
0-1	374 x 10^2 m^3
1-2	274
2-3	156
3-4	54.3
4-5	14.6
5-5.7	3.68

C. Methods

1. Measurement of air delivered to lake

During the tests conducted on open water the volumetric air-flow was calculated from the following data, and applied according to the empirical formulas of Crane (p.82):

Line pressure, hydrostatic pressure at point of discharge, area of orifice, coefficient of discharge for

orifices (0.65), gas constant for air, temperature of the air in the pipe at point of discharge, expansion component(polytropic exponent for air).

During the tests conducted in winter, a 2 1/2" "Emco" air meter (Pittsburgh Equitable Meter Co.) was used with suitable corrections made for pressure and temperature.

2. Light

Light measurements were made with the Whitney Underwater Photometer, used with the photocell directed upward. Measurements under the ice were made with the sensing unit attached to an offset arm. This allowed the readings to be taken at a horizontal distance of about 1.5 m from the hole cut through the ice cover.

3. Temperature

All temperature measurements prior to 1955 were made with a Whitney resistance-type thermometer (to the nearest 0.1° C.). Later measurements were made with a Whitney thermister-type unit.

4. Oxygen

Oxygen determinations were made according to the sodium-azide modification of the Winkler method as described in "Standard Methods for the examination of water and sewage" (9th. Ed., Amer. Pub. Health Assoc.,NY.,N.Y. 286 pp). Samples were taken with a 1 liter Kemmerer water sampler. The resulting sample represents the approximate average value of a stratum 0.4 m thick.

5. Radiophosphorus P^{32}

In 1954 this material (330 millicuries) was delivered to Sawmill P. as KH_2PO_4 dissolved in water, from an 18 liter glass carboy. The solution was pumped directly into the hypolimnion through a weighted rubber tube. Water samples were collected from the various depths and brought into the laboratory for analysis. One liter samples of water were evaporated to a volume of less than 100 ml on a hot plate, filtered through Whatman #42 filter paper, and made up to volume in a 100 ml volumetric flask. An aliquot of the solution to give less than 300 mgms of $MgNH_4 \cdot H_2O$ precipitate was taken, and the radiophosphorus along with any additional phosphorus present was precipitated as magnesium ammonium phosphate according to a procedure adapted from Kolthoff and Sandell (1947).[1] The magnesium ammonium phosphate precipitate was collected on an aluminum filter ring and prepared for counting in the Geiger-Mueller counter according to the method proposed by MacKenzie and Dean (1948).[2]

The above procedure and execution of the analyses was by E. Zicker.

In 1957 radiophosphorus was (300 millicuries) delivered to Tub L. in the form of phosphoric acid, combined with 1.36 kg of 12N phosphoric acid in a twenty liter carboy,

[1] Kolthoff, I. M. and Sandell, E. B. 1947. Textbook of quantitative inorganic analysis. Macmillan Co., N. Y., N. Y.

[2] MacKenzie, A. J. and L. A. Dean, 1948. Procedure for measurement of P-31 and P-32 in plant material. Anal. Chem. 20: 559-560.

made to volume with lake water. The contents were pumped into the hypolimnion through a plastic tube. One liter samples were collected from various depths above and below the thermocline, returned to the laboratory and processed within 24 hours after collection. The samples were filtered through both a #2 mesh and a #20 mesh bolting cloth and 960 ml of the filtrate were used for the determination of the activity. The phosphorus was brought into solution and tested with a 90 NB Beta Gamma Geiger Counting tube. The active phosphorus content of the water sample was prepared for counting by evaporating the sample, muffling the residue with magnesium at 550°C for four hours and dissolving the residue in approx. 2 N HCl. The above procedure and execution of the analyses was by M. C. Sparr.[1]

6. Phosphorus

No tracer chemical was used in the 1956 experiment. The phosphorus determinations were made as follows: 1 liter samples were evaporated to dryness, and the residue ashed in a muffle furnace at 550°C for four hours. Two mg of magnesium nitrate were added to prevent volitization of the phosphorus. The ash was taken up in dilute sulfuric acid, titrated with sodium hydroxide to an end-point of pH 3.3 using 2,4-dinitro phenol as an indicator, and made to volume in a 50 ml volumetric flask. The phosphorus content was determined by the

[1]Sparr, M. C. Jr. (1958). The effect of chemical and physical treatments upon light penetration and phosphorus content of bog waters. MS Thesis. U. Wisconsin. (unpublished)

stannous chloride-molybdate-blue method. Distilled water was treated in a similar manner and used as a blank.

In order to determine the "soluble" fraction of phosphorus, 1 liter samples were filtered through a "millipore" colloidal-type filter. The analysis was conducted as indicated above, on the filtrate, the "insoluble" fraction was obtained by difference.

The above procedure was employed by Sparr and reported by him in 1958 (loc. cit.)

D. Equipment

1. Water pumps

In the 1954-55 tests light-weight centrifugal water pumps were employed. (models FP99 and FP7, McCulloch Motor Corp., Los Angelas, Calif.) These pumps had a rated capacity of 15.8 liters/sec (7 m head of water pressure) and a rated power of between 7 - 8 hp (4000 rpm).

2. Air compressors

In most cases piston-type compressors were used, they were run at their maximum allowable rpm because of the low pressures encountered. A low pressure, blower-type unit was employed in one test. It was found to be unsatisfactory, possibly because of the initial stetic pressures encountered in the air-distribution system. This cause was not established, however.

3. Plastic pipe

The pipe used was semi-rigid, solvent-weld, plastic pipe of either the "Kralastic" or "Cycolac" types, (Skyline Industries, Titusville, Pa.) Nominal size = 3.18 cm, OD = 3.61 cm and ID = 3.18 cm.

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