Limnology of the Jackson Hole Area

Michael Parker
Zoology Department
University of Wyoming
Project Number 165

I. During the course of the summer lakes were visited on 26 occasions. Because of difficulties in obtaining reagents for chemical analyses the planned work on the kinetics of nutrient uptake, a basis for evaluating Swan Lake as a chemostat, went for the most part undone. However, three experiments were performed as best possible, and the samples and data are being processed.

II. Swan Lake.

Despite the fact that few experiments on uptake kinetics were performed, the lake was visited on 13 occasions. The objectives were to obtain descriptive data on routine water chemistry and on detritus, phytoplankton, and zooplankton populations. The latter data will be used to make estimates of the contribution of zooplankton to nutrient regeneration in the lake, and to help test an hypothesis concerning the interrelations between phytoplankton and detritus abundance. Analysis of the data has barely begun.

Some typical physical and chemical data are presented in Table 1. They show the influence of the sewage at station I (station numbers are reversed from those in reports from 1955-1959); moving away from the sewage inflow dissolved phosphorus and oxygen and light penetration increase, while seston decreases. This indicates that in future studies the lake should be considered as having two or perhaps three basins. The oxygen demand at station I is very high, more than 6 ppm. being consumed in darkened bottles over a 24 hour period.

III. Jackson Lake.

The lake was visited on three occasions. The purpose was to obtain information on the phytoplankton and zooplankton populations. The samples have not yet been inspected.

IV. Other Lakes.

A variety of lakes was visited after midsummer when it became apparent that the possibility of performing the uptake experiments in Swan Lake was becoming very slim. The objective was to obtain information on routine chemical and physical factors, and on detritus, phytoplankton, and zooplankton populations. Samples were taken at all lakes for later analysis of detritus, phytoplankton, zooplankton, and particulate nitrogen. The chemical and physical data referred to in the discussion below are summarized in Table 2.

TABLE 1. Data from Swan Lake, VII/18/69.

Parameter	Station Number		
	I*	II*	III*
Temperature (° C)	20.6 17.1	22.4 16.8	21.0
O_2 (ppm)	7.2 2.0	11 10	10.5
Dissolved Phosphorus (ppm)	3.0	1.0	0.8
Secchi (m)	0.3	0.6	0.9
Extinction Coefficient (light)	3.57	2.70	2.44
Seston (mg dry wt per liter)	82 49	25 34	20

(*Sta I, ½, 1½m; Sta II, ½, 1 m; Sta III, 3/4 m)

TABLE 2. Physical and Chemical Data from Various Lakes of the Jackson Hole, Wyoming Area. (All data collected after VII/22/69.

Lake	Depth (meters)	Temperature °C	Oxygen ppm	Alkalinity ppm $CaCO_3$	Hardness ppm $CaCO_3$	Ca^{++} ppm	pH	Conductivity µmhos	Seston (dry wt) mg/l
Amphitheater	1	18.0	6.2	14.4	3.2	1.3	7.2	9.6	1.5
	7.5	17.5	6.3	13.5	4.0	1.3	6.2	10.8	0.4
Surprise	1	20.2	6.1	8.6	3.1	1.3	7.6	9.7	1.1
	4	18.7	7.1	9.8	4.0	1.0	8.2	9.9	0.7
Bradley	1	16.9	7.7	12.0	2.3	5.0	7.0	21.0	0.5
	19*	9.6	2.3	21.5	3.5	8.8	6.5	26.0	1.7
Taggart	1	18.5	7.5	23.7	15.0	7.3	7.7	34.2	1.6
	9	17.1	7.7	24.1	15.5	6.9	<8.3	52.9	2.4
Leigh	0.7	19.1	6.9	17.2	11.2	3.5	<8.3	34.6	0.5
	11	17.0	7.7	19.3	11.2	4.8	<8.3	35.5	0.8
String		----	6.8	15.6	----	---	<8.3	36.0	1.2
Jenny	1	18.1	6.9	30	12.5	4.2	<8.3	40.8	---
	21	5.3	8.3	33	12.0	5.0	<8.3	42.2	---
Two Ocean	1	22.0	8.1	106	64	24.0	>8.3	210.0	---
	8.8	7.6	H_2H	144	88	40.0	<8.3	236.0	---
Brooks	0.5	15.6	10.5	135	543	12.6	>8.3	94.3	---
	13	6.9	H_2S	135	742(?)	10.6	<8.3	95.2	---

*Not bottom

(a) Amphitheater, Surprise, Bradley, Taggart chain. As expected the chain acts as a river, having more dissolved salts the farther downstream one samples (Amphitheater to Taggart). The conductivity varied from 10 micromhos (only 3 times that of "tap" distilled water) in the upper two cirque lakes to about 40 micromhos in Taggart, which also receives Cascade Creek. Although some shelter is offered Amphitheater and Surprise Lakes by the surrounding terrain, the lakes do not stratify thermally. By the beginning of August these lakes had warmed to temperatures comparable to lakes in the hole. The data indicate that all the lakes are oligotrophic, and in August there is apparently little allochthonous matter suspended in the water as the seston was low, about 1 mg dry wt/liter (compare to Swan Lake). It is interesting to note, however, the low concentration of dissolved oxygen in Bradley Lake at 19 m.

(b) Leigh, String, Jenny chain. Leigh Lake was not sampled in the deepest portion, but rather in the arm near the outlet. Certainly the lake must stratify thermally. There is a slight increase in dissolved salts in going from Leigh to Jenny Lake as indicated by an increase in conductivity from about 35 micromhos to 41 micromhos. Other data are also indicative of oligotrophic conditions. The Secchi disk reading for Leigh and Jenny Lakes were 8.7 and 18 meters respectively. The extinction coefficient calculated from light penetration data in Jenny Lake is 0.184, which is extremely low (very clear water; compare to values of more than 4 in Swan Lake). Oxygen concentrations in these two lakes clearly indicate the paucity of biological activity; the amount of gas in solution increases with depth, showing very little modification of the amount dissolved due to the physical conditions of temperature and oxygen's partial pressure in the atmosphere.

(c) Two Ocean Lake. This lake appears to be quite productive, and a large standing crop of the blue-green algae Anabaena was found. The conductivity indicates more dissolved salts in solution than in any other lake visited, 220 micromhos. The lake is reported to occasionally have fish kills in the spring after the ice breaks up. The oxygen data may help to explain this phenomenon. On VIII/12/69 the thermocline began at about 4 m, and while the dissolved oxygen at 5 m was 7.6 ppm, at 6 m it was 2.5 ppm, at 7 m 0 ppm, and there was H_2S at 8.7 m. This indicates particulate organic matter produced in the epilimnion settles into the hypolimnion in such quantities that its decomposition leads to anoxic conditions. During some winters photosynthesis may produce enough particulate organics to produce similar anoxic conditions in some or much of the deeper layers in the lake. There must still be enough oxygen for fish's survival at shallower depths. However, the anoxic conditions in turn can lead to the presence of large quantities of reducing compounds in the deeper water. After the ice breaks up in spring, the first wind strong enough to completely circulate the lake will redistribute these reducing compounds to all depths. If their quantity is great

enough they can react with and remove all molecular oxygen from solution. In turn this would lead to the fish kill, since even at shallow depths there would be no oxygen. Extinction coefficients, calculated from light penetration data, also tend to confirm the idea that there is a build up of particulate matter in the hypolimnion. In the epilimnion k is 0.55, while in the hypolimnion it increases to 1.27. Some people have suggested that the lake is meromictic, but at least for the shallower eastern basin of the lake the conductivity data do not confirm this. The deeper western basis may be meromictic, but no sampling was done there.

(d) Brooks Lake. The lake is located out of Jackson Hole east of Togwotee Pass. When visited at the end of the summer there was a large standing crop of Anabaena. Other data also indicate the lake is productive; the conductivity is about 95 micromhos, alkalinity 135 ppm (as $CaCO_3$), and anoxic (H_2S) conditions were found at 13 m. This is perhaps to be expected from the occurrence of limestone in the area, the drainage basin, and the local terrain.

It is uncertain if the data from the uptake experiments and zooplankton excretion (Swan Lake) will be sufficient to constitute a paper. However, the data from the lake survey will be written up for publication, and the information from phytoplankton and detritus counts will probably also be included in a paper based primarily on work from outside the Jackson Hole area.

Juhani Terhivuo helped with most of the above work, and I would like to thank him for his patient assistance.

Supported by the University of Wyoming.