Eastern Deciduous Forest Biome
Memo Report #74-2

Abstracts of the Eastern Deciduous Forest Biome, U. S. International Biological Program Lake George Site Synthesis Meeting, February 7-8, 1974

James J. Ferris, Editor

May, 1974

FWI Report #74-10

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INTRODUCTION

The Eastern Deciduous Forest Biome, U. S. International Biological Program Lake George site held a two-day site synthesis meeting on February 7-8, 1974 in order to initiate the coordination of research from the Lake George aquatic program and to establish a framework within which the investigators could most easily communicate regarding their input to synthesis activities. This report is a compilation of abstracts from the investigators who participated in this brief conference. In each case, the individual who presented the data has his name underlined.

A. Primary Production

1. Daily Rhythms in Phosphate-Limited *Euglena*

S. W. Chisholm, and R. G. Stross

Daily rhythms in cell division, photosynthetic capacity, and phosphate uptake persist in phosphate-limited cultures of *Euglena gracilis* (Z). The oscillating rate of phosphate uptake, described with Michaelis-Menten kinetics, is a result of an oscillation in V_{max}; K_s remains constant. Rhythmic rates of nutrient uptake could contribute to the coexistence and stabilization of phytoplankton populations.

2. Adaptation and Productivity of Sub-Littoral Macrophytes

R. E. Keyel, and R. G. Stross

Macrophyte productivity at 7-12 meters depth in Lake George is due almost exclusively to *Nitella flexilis*. Annual production in the South Basin in 1973 was 2.5×10^9 g dry wt/yr., three times that of the North Basin at 0.8×10^9 g/yr. Most production in the South Basin occurred from 8-11 meters, while in the North Basin most production occurred from 11-13 meters. A depth difference was also found in C fixation in the *N. flexilis*. Carbon uptake was measured by incubation with ^{14}C in a controlled environment box. Seven-meter plants fix carbon at 2-5 mg C/g dry wt. of plant/hr. at saturation, while 12-meter plants fix C at 2-4 mg C/g plant/hr. There seems to be a seasonal rhythm in uptake, with a decline around late July, early August. A daily rhythm is evident in seven-meter plants, a dip occurring between 0400 and 0800, but none is observed in 12-meter plants. Both plants seem to saturate at around 400 ft.-candles, but seven-meter plants are more active at high light intensities and 12-meter plants are more active at low intensities. Both are stimulated by phosphorus up to 1 or 2 umoles/L and unaffected or inhibited by higher concentrations. Nitrate has no stimulatory effect, and can be inhibitory.

3. Primary Productivity of Lake George, New York: Its Estimation and Regulation

R. G. Stross, R. E. Keyel, T. A. Downing, and S. W. Chisholm

A spatial temporal analysis of phytoplankton production and some of the regulatory functions have been carried out since the summer of 1969, or for four years and five summers. Photosynthetic capacity was estimated at selected stations and within each station at three profiles and five depths. Additional temporally oriented studies were carried out with isolates of lake water stored in carboys in the lake. All samples were incubated with carbon-14 in constant light (1500 ft.-c.) and at lake temperatures.

Conclusions are as follows. Spatially, the more significant gradient is the typically decreasing photosynthetic capacity with northward direction in Lake George. Temporally, daily and seasonal rhythms were general. There is also the strong hint of an annual trend; the 1973 summer estimates were only 1/2 that of the means of the preceding four summers. These estimates have been incorporated into an integrated daily estimate and as such they show potential competition of the phytoplankton with the attached macrophytes (especially *Nitella flexilis*).

Photosynthetic capacity may be extended to a photosynthetic potential by the addition of phosphate but not with the addition of other plant nutrients, normally. The potential for photosynthesis is therefore nutrient restricted in some instances. Disclosure of a nutrient limited condition by the assemblage is conditional however, and the tentative conclusion is that species composition dictates whether the response is to be immediate, within three hours, or whether limitation must wait for the subsequent daily cycle.

4. Zonal Distribution of Rooted Macrophytes in the Littoral Zone of Lake George

C. W. Boylen, and R. B. Sheldon

Data from the summer of 1973 from each station included several components - macrophyte species present, depth of observation (between 1 m and 10 m), relative abundance on a scale from 1 to 10, and the nature of the lake bottom sediments (also 10 classifications). General features of each station were also recorded including fetch, location, and shore characteristics.

A SCUBA diver, proficient in making ecological observations of the macrophytes, surveyed fifty major littoral zones. A sheet of plastic 25 cm x 30 cm was used on which to record the data underwater using a regular no. 2 graphite pencil while the diver traversed the specified littoral zone. Samples of questionable species were removed from the lake for identification following the keys of Fassett (1957) and Muenscher (1944). Final verification of all plant species was made by Dr. Eugene Ogden, New York State Botanist. Voucher specimens were properly preserved and are kept on herbarium file in the Department of Biology, Rensselaer Polytechnic Institute.

Computer analysis of the data is in progress. It is expected that analyses will show distribution relationships among species and will relate to other variables. Present conclusions show that among the most prevalent species are Vallisneria americana, Potamogeton robbinsii, P. perfoliatus, P. amplifolius, Isoetes macrospora, and Myriophyllum tenellum.

5. Biomass Distribution of Rooted Macrophytes in the Littoral Zone of Lake George

C. W. Boylen, and R. B. Sheldon

Biweekly biomass collections of macrophytes were taken from Warner Bay and Hearts Bay and expressed as g dry weight per meter^2 at each depth for specific plant sections of each species (leaves, stems, roots, rhizomes, fruits or flowers, and sloughed material), the total biomass of each species, and the cumulative total of all species.

The maximum biomass in Warner Bay was 200 g dry weight/m^2

produced at 3 meters; 75% of that total biomass was produced by the single species Vallisneria americana. The maximum total biomass in Hearts Bay was 30 g dry weight/m^2 also produced at 3 m. Two thirds of that was produced by Potamogeton amplifolius. Maximum standing crop in each bay occurred in late July to early August.

Photosynthetic rate determinations were made for Potamogeton robbinsii removed from Lake George at various times between March and September 1973. Computer analysis is in progress, results inconclusive at this time.

B. Secondary Production

1. Selective Feeding in Daphnia and Diaptomus

K. G. Bogdan, and D. C. McNaught

The herbivorous zooplankton community in Lake George, a deep oligotrophic lake in New York, USA, is dominated by two genera - Daphnia and Diaptomus. In an attempt to quantify the feeding abilities of these species, filtering rates were measured on two resource subsets of the natural algal assemblage; netphytoplankton and nannophytoplankton, where netplankton was separated from nannoplankton by passage through a 22 nitex net.

By a series of manipulations of the algal assemblages and through utilization of C-14 tracer techniques, filtering rates for the species on netplankton in the presence of nannoplankton and on nannoplankton in the presence of netplankton were obtained. A comparison of the data obtained from each setup allowed one to compare the species as to their relative abilities to ingest netplankton versus nannoplankton.

Results show a definite difference between the species. Daphnia showed the same efficiency of capture for both netplankton and nannoplankton, while Diaptomus showed an inability to capture netplankton as efficiently as nannoplankton.

2. Numbers and Biomass of Lake George Fishes

C. George, and J. H. Gordon

The most common fishes of the shoal waters (i.e., surface to 5 m) of Lake George were inventoried by underwater observers during the summer of 1973. Using a lake perimeter approximation of 210 km and the weight of collected materials the adult and subadult populations and biomass were estimated (e.g., Redbreast sunfish, *Lepomis auritus*, n = 48,600, B = 2.576 kg; Rock bass, *Ambloplites rupestris*, n = 38,300, B = 2,480; Pumpkinseed sunfish, *L. gibbosus*, n = 29,900, B = 1,582; Smallmouth bass, *Micropterus dolomieui*, n = 16,900, B = 1,815 kg;

Yellow perch, Perca flavescens, n = 3,600, B = 313 kg). Figures for the first three mentioned species are considered reasonable approximations for the entire lake. Because of movements into the deeper portions of the lake figures for the latter two species are useful for the approximation of incidence in shallow waters only. If lake perimeter is revalued, population estimates must be changed accordingly.

3. Status of Secondary Production Studies at Lake George

D. C. McNaught

Significant progress was made during 1972-73 in investigations of zooplankton feeding, remineralization of P and N by herbivorous zooplankton, biomass of centrarchid fishes, and preliminary estimates of benthic biomass. Both Diaptomus, the dominant calanoid in Lake George, and Diaphanosoma were shown to select small phytoplankton foods. Daphia and Diaphanosoma, both cladocerans, preferred bacteria over algae (McNaught and Bogdan). As lakes become more nutrient enriched and algae growth is stimulated, remineralization may increase disproportionately. Zooplankters excrete more P and N at high food (10 M cells/ml) and high temperature (20°C), which may in turn have a feedback effect on algal growth (LaRow). Benthic populations in Lake George are dominated inshore by chironomids and in deep water by Pontoporeia. Numbers of these large amphipods are about the same as in 1922 (Perrotte). Fish studies were likewise initiated in 1973. Lake George is dominated by centrarchids which included Redbreast sunfish, Rock bass, Pumpkinseed sunfish, Smallmouth bass, and Yellow perch (George). Such estimates of biomass are vital to model validation.

C. Aquatic Decomposition and Mineral Cycling

1. Decomposition in Lake George, New York

M. Dazé, and L. S. Clesceri

A monitoring of heterotrophic microflora activity spanning three seasons of the year was accomplished. With sediment from five depths in both Warner and Hearts Bays, growth studies were carried out by measuring the rate of assimilation of radioactive glucose under unlimiting nutrient conditions at in situ (day of sample collection) temperatures. Since viable counts of microorganisms were impossible because of the particulate nature of the system, bacterial cell numbers were measured by measuring the content of DNA in the sediment. A factor for converting mg DNA to cells per ml is being validated with measurements of DNA content of pure cultures isolated from the sediment. Additional variables monitored were dry weight and organic weight per assay volume of sediment and data on fluctuations in macrophyte biomass were obtained from the macrophyte investigators. The dependence of heterotrophic growth rates upon the independent variables: organic and dry weights, temperature, DNA content (thus cell number), and plant biomass, was investigated by regression analysis. With data best-fitting a linear model, analysis showed a maximum dependence on temperature, then DNA content and plant biomass. An inverse relationship existed between growth rate and organic weight, and there was no dependence on dry weight.

2. Dissolved Organic Carbon in Lake George

S. Kobayashi

Results from the 1973 IBP study are reported for Stations 1 and 6 in Lake George for dissolved organic carbon (DOC) and "humic matter" (HM). DOC results are abbreviated due to instrument failure. HM is calculated similar to Fuhs (1971).

DOC values for Station 1 for the period of 6 March through 1 August averaged 4.2 mg C/l, while HM values averaged 1.0 mg/l from 6 March through 26 September. No distinct DOC depth relationships were found although the values increased from March to August. HM values showed an increasing trend both with depth and time.

DOC and HM values for Station 6 covered only the summer period. For the 13 June to 1 August interval, DOC values averaged 5.0 mg C/l with no distinct depth relationships. HM values for the 13 June to 26 September interval averaged 0.9 mg/l, again with an increasing trend with depth showing in late summer. HM at the Lake George outlet increased through mid-summer and declined to early summer values in the fall, ranging from 1.2 to 1.5 mg/l.

Previous results of Fuhs (1971) indicate that the major contributions of DOC and HM from the Lake George tributaries occur in April to mid-May and are the probable reason for the increasing trend of DOC and HM found at Station 1.

3. Nitrogen and Phosphorus in Lake George: Sources, Balances and Trends

D. B. Aulenbach

The estimated annual nitrogen and phosphorus sources and sinks in Lake George were presented. The major source of nitrogen to the lake is from precipitation, including both wet and dry fallout, directly on the lake. The major source of phosphorus is most likely the unsewered areas of the lake. Specific data are not yet available on the degree of phosphorus removal by the soil in a septic tank system.

Data were presented showing the concentrations of ortho-, total soluble, and total phosphate in Lake George during 1973. Some of the values were evaluated in terms of the variation in analytical results.

The suggested 48 hour cycle of ortho-phosphate postulated from the 1972 data was not confirmed in similar studies during 1973.

The total phosphorus at Station 1 was higher in 1973 than in 1970, whereas the value was lower at Station 6 in 1973. The total soluble phosphorus in 1973 was approximately double that value for 1970 at Station 1. At Station 6 there was slightly more total soluble phosphate in 1973. No significant trend in concentration in ortho-phosphate over several years could be detected.

4. Aquatic Decomposition and Mineral Cycling

L. S. Clesceri

A resume of certain past intersite and interprocess syntheses was made for aquatic decomposition and mineral cycling at Lake George and Lake Wingra:

Various examples of syntheses resulting from the use of common techniques at the two sites, from the simultaneous collection of data at a site, and from interprocess experimentation were given.

Examples from the last project year (end August 1973) included sediment decomposition and macrophyte productivity in Warner and Hearts Bays. Simultaneous sampling for these two processes resulted in the detection of correlations between plant productivity and microbial activity. Early summer increases in both of these processes are observed. It is unlikely that the microbial response is purely a temperature response since the microbial activity falls back as summer progresses and rises again in late summer as the plant biomass begins to decrease and organic carbon from the dying plants becomes available to the microbes.

Interprocess experimentation was shown to be needed to determine the reaction of decomposition to process variables. Studies are planned at Lake George to examine the influence of different carbon sources on the decomposition process. Experimentation is also going on for parameter estimation for the decomposition model with respect to dissolved oxygen, temperature, and nutrient level.

D. <u>Physical Process</u>

1. Lake George Climate and Water Temperatures - A Progress Report.

S. Katz

The climate variables needed for the prediction of water temperatures in a lake as a function of time and depth are: a) air temperature, b) total radiation (sun and sky), c) wind speed, d) humidity and, e) water surface temperature. The air temperatures at three National Weather Service Stations (Glens Falls Farm, Glens Falls Airport, and Whitehall) have been compared with the temperatures recorded at Burnt Point (Lake George) to provide suitable intercomparison for the period 1970-1972 and to provide a regional coverage for the entire lake. Predictions of temperature at each of the stations can be made from the temperatures of the other stations using correlations based on the above data. Mean monthly temperatures are nearly the same at all four stations within 2°C of each other. Daily maxima and minima show greater variability, but systematic differences are evident. The progressive alternation and movement of air masses appears on plots of maximum and minimum daily air temperatures through the year.

Solar radiation at Burnt Point was plotted for 1970 and an empirical equation determined for average yearly variation: $240 + 200 \sin (0.0172\, t - 1.76)$ langleys/day, with t in days of the Julian calendar. Weekly water temperatures versus depth were plotted for a station west of Diamond Island for 1971 and 1972. Fluctuations of over 5°C occur in late August and September extending to depths of more than 20 meters. They seem to be associated with prolonged periods of low air temperatures. Other related data - humidity, precipitation, wind - are being collected, correlated and studied.

E. Modeling and Data Management

1. Implementation of a Pelagic Ecosystem Model

D. Scavia and R. A. Park

The pelagic ecosystem model, an open-water model of CLEAN, predicts the biomass level of two size-classes of phytoplankton, two herbivorous zooplankton types and omnivorous zooplankton, piscivorous and non-piscivorous fish, particulate and dissolved organic matter, decomposers, and dissolved ortho-phosphate. The model has been calibrated for Lake George and predicts zooplankton biomass quite accurately. Predictions of other trophic levels are not as good due to constraints imposed by forcing functions.

Responses of this system to perturbations can be observed by varying the inputs to the system and/or the parameters. Responses to additional nutrient loads, temperature changes, and elimination of trophic levels, in the model, provide insight to the impact of external influences on the lake.

2. Formulation of a Benthic Invertebrate Model

C. S. Zahorcak, and R. A. Park

A numbers-biomass model for benthic insects has been formulated as an updated version of the consumer model. Mean weight is calculated, so that an allometric response to weight can be incorporated into each process, replacing the less accurate population distribution term.

The effects of dissolved oxygen has also been incorporated into several processes.

Two size classes are modeled: eggs through third instar, and fourth instar and pupae. This separates the older larvae for a better indexing of pupation and emergence.

Emergence and exuviation are triggered by reaching pre-determined mean weights, functions of each species in each lake.

The two pairs of equations are thus of the form:

$$\frac{dB_j}{dt} = {}_i\, C_{ij}\,(W, DO) - (R_j(W, DO) + F_j(W, DO) + U_j(W, DO) + M_j(W, DO)$$

$$+ G_j(W, T) + {}_k\, C_{jk}(W, DO))*B_j$$

$$\frac{dN_j}{dt} = \frac{I_j(W, T)}{W_n} - \frac{P_j(W, T)}{Y_n} - \frac{M_j(W, DO) + {}_k\, C_{jk}(W, DO)}{W}$$

where $W_n = W_{egg}$ & $Y_n = W_{3rd.\ in.}$, when size class 1

and $W_n = W_{3rd.\ in.}$ & $Y_n = W_{pupae}$, when size class 2

I = influx

P = promotion

W = weight

DO = dissolved oxygen

T = temperature

3. Computerized Data Management; Ecosystem Analysis Program, Lake George, New York

R. C. Kohberger, J. W. Wilkinson, J. Fisher, D. Kumar

The capabilities of the data storage, retrieval and analysis features of FIND and ADLIB are briefly described. The current status of the data bank is discussed. In so doing, it is stressed that those scientists producing these data should make much greater use of the fact that their own data, as well as associated data, are already formated and stored in a computer thus facilitating much more sophisticated data analysis than they are currently doing.