Deciduous Forest Biome
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SYNTHESIS OF STUDIES OF AQUATIC SECONDARY PRODUCTION WITHIN EDFB-IBP

A final technical report for Union Carbide Subcontracts for the Eastern Deciduous Forest Biome, IBP, Lake George Site

By

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Introduction

The primary objective of investigators dealing with secondary production in the EDFB during 1972-73 was the implementation of process models. Of these, four appear to be most advanced, including 1) the zooplankton biomass model, 2) the zooplankton resource allocation model, 3) the benthic biomass model, and 4) the fish biomass model. Data collection continued during 1972-73 to augment model calibration and validation.

Data and Parameter Summaries

The primary efforts of the Aquatic Secondary Production Workshop was to address synthesis through implementation of models. Parameters common to consumers were identified for functional groups including zooplankton, benthic invertebrates and fishes. Similarly, data sets available at present, those applicable from open literature sources, and those to be collected during the coming field year were identified and catalogued as in the attached table (Table 1).

Approximately two-thirds of the data sets and parameter estimations were considered available during the spring of 1973 and in sufficient breadth and depth to allow adequate implementation of a first-generation consumer model for each of the functional groups. The remaining one-third was to come from efforts scheduled for the remainder of 1973. Foremost among those were feeding-assimilation studies for zooplankton, more accurate estimates of natural mortality rates for zooplankton, and establishment of fish feeding studies at Lake George. Both the latter were considered particularly important to even rudimentary calculations of production rates as well as essential to modeling efforts.

Model Implementation: It is critical to the success of the EDFB that implementation of process models be accomplished by those most directly engaged in model building and data collecting. Primary responsibilities for process models reflect these criteria, and listings of specific individuals and primary sites (in parentheses) follows:

1. Fish Biomass: J. Kitchell, J. Koonce, R. O'Neill (Lake Wingra)
2. Zooplankton Biomass: R. Park, D. McNaught (Lake George)
3. Zooplankton Resource Allocation: D. McNaught, J. Bloomfield, R. O'Neill, H. Shugart (Lake George)
4. Benthic Biomass: R. Park, C. Sterling, J. Peterson, W. Perrotte, R. O'Neill (Lake George, Lake Wingra)

Progress in implementation was varied considerably. The fish biomass model has been completely implemented under the leadership of J. Kitchell at Lake Wingra. It is now being used in pertubation studies (thermal pollution).

The zooplankton biomass model has been completed by R. Park and is running at Lake George. Recently numbers of zooplankton (samples of 1970-1973) have been converted to biomass with the use of regressions of length on weight for a more detailed validation of this model.

The zooplankton resource allocation model has been revised by J. Bloomfield and D. McNaught at Lake George and preliminary validation is complete. O. Smith, R. O'Neill and H. Shugart at Oak Ridge are currently developing a new model to predict community structure (competition matrix).

The benthos model is running at Lake George. Claudia Sterling, W. Perrotte, and J. Peterson will work with R. O'Neill in implementation.

Finally, the linkage of secondary production models to primary production models and remineralization models is vital to biome success. A preliminary description of CLEAN (Comprehensive Lake Ecosystem ANalyzer) has recently been submitted for publication (Park et al., 1973).

Publications and Manuscripts

Vital to the reputation of the Biome for quality science are the publications resulting from integrated studies. Presently we have identified a single publication and ten manuscripts expected to be completed by December 1973.

A. Publication

1. Elwood, J. Primary Production and Grazing Rates in Streams Measured with the ^{32}P Balance Method.

B. Manuscripts Submitted

2. Kitchell, J. et al. Fish Biomass Model (Trans. Amer. Fish. Soc.)
3. Kitchell, J. et al. Diel Movements of Fishes (Trans. Amer. Fish. Soc.)

C. Manuscript

4. McNaught, D. and J. Bloomfield. Resource Allocation Model for Zooplankton (M.S.)

D. Manuscripts Promised by winter 1973-74.

5. LaRow, E. *Leptodora* Population Dynamics
6. LaRow, E. Nutrient Tissue Analysis of Zooplankton
7. Barr, C. Carbon Cycle in Streams
8. Bogden, K. Filtering Rates of Zooplankton with Respect to Size-Selective Feeding
9. Woodall, W.R. Salamander Feeding Habits in Streams of Natural and Manipulated Watersheds
10. El-Shamy, F. Comparative Feeding and Growth of Bluegill Sunfish in Lakes Wingra and Mendota.

The investigators of secondary processes recognize that the success of the Biome is closely related to publication in the best refereed journals, including Limnology and Oceanography, Fisheries Research Board of Canada, Science, Trans. American Fisheries Society, Water Research, Ecology, Copeia, American Naturalist.

Further publications dealing with the synthesis of studies of secondary production will result from publications of the Final PF Symposium at Reading, England, September, 1972. Currently these will include:

11. Kitchell, J. Food Consumption by Fishes.

Interactions with Other Process Groups

Development and validation of adequate consumer models is contingent on access to pool dimensions and particle size distributions for algal biomass and detritus. Discussions with the Aquatic Primary Production working group at Durham in the spring of 1973 resulted in agreement on the form and content of data sets to meet these needs.

As expected, the experiences of several individuals in implementing models for specific groups led to concern regarding the adequacy of certain features of the general consumer model. In particular, it appears that improvements are called for in the present temperature term and the carrying capacity notation and interpretation. Secondly, there was concensus on the need for a numbers-biomass interaction capability for existing models.

The above actually represent typical examples of the kinds of problems we seek to address in synthesis. In general, we have identified certain shortcomings in our modeling capability and wish to remedy them. Improvements in the temperature and carrying capacity terms are required to allow more critical evaluation of thermal enrichment applications and to provide a greater response capability of models to major system changes associated with the eutrophication process. A numbers-biomass basis for these models seems essential to more general evaluation of processes like size-selective predation operating in natural ecosystems and resultant changes in community structure relative to such selective harvest.

Interbiome Synthesis

Prerequisite upon the success of synthesis within the Biomes, efforts must be made in the aquatic areas to stimulate interbiome cooperation. An aquatic specialist committee (W. Minshall, J. Hobbie, J. Hall, D. McNaught, Chairman) has been formed within the Austin Office (O. Loucks) to coordinate interbiome synthesis. The first effort was a meeting of Aquatic Decomposition modelers and synthesizers under the direction of J. Hobbie. Proposed future needs were determined at a meeting of this committee in May 1973 in Seattle, Washington, in conjunction with the Coniferous Modeling sessions. An outline for aquatic synthesis was prepared and included tentative writing assignments. The general completeness of our data sets suggests that the immediate sharing of data between Biomes is vital for a meaningful synthesis.

Application of Implemented Models

In applied areas our models have already been used to look at the stimulation of aquatic ecosystems by heat. Certainly they are most applicable to problems of nutrient enrichment. In other instances we can contribute significantly to community structure theory, and especially the concepts of carrying capacity (K) and stability. We stress that it is desirable to accomplish both basic and applied research in one effort--indeed this constitutes one of the strengths of the EDFB program.

Table 1. Available Data for Invertebrate Consumers and Fishes for Model Calibration (G = Lake George, W = Lake Wingra).

Group	Population Data					
	Numbers	Biomass	r,b,d	α	K	Size Structure
Zooplankton						
Herbivorous	G, W	G, W	G	G	G	G
Predaceous	G, W	G, W	G	G	G	G
Benthos	W	W	-	-	-	-
Fishes	W	W	-	-	-	W

Group	Process Rates				
	Feeding	Respiration	Egestion	Excretion	Growth
Zooplankton					
Herbivorous	G	G	G	G	G, W
Predaceous	-	G	G	G	-
Benthos	W	-	-	-	W
Fishes	W	W	W	W	W

References cited:

Park, R. *et al.* 1973. A generalized model for simulating lake ecosystems. Simulation (submitted).