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INTERNAL REPORT 27

TROPHIC RELATION MODEL BASED ON DENSITY DEPENDENT PROCESSES

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INTRODUCTION

We have developed graphical and logical models for explaining the production of a consumer on the basis of the capacity of an ecosystem to produce that consumer (the productivity of the system for that consumer), on the basis of the biomass of the consumer, and on the basis of the age structure of the consumer. These models involve density phenomena occurring at all trophic steps from light and plant nutrients up to and including the particular consumer,as well as trophic pathways in competition with the path leading to this consumer. These density phenomena and pathways can be used to model the productivity of the system for a particular consumer, with the biomass and age structure of the consumer population as the other determinants of its production.

We are now developing formal mathematical models based on responses of individual organisms and leading to our empirically and logically derived models. Preliminary mathematical formulations are being used through a computer program to determine whether output relations are logically and empirically confirmed. In addition, data from various sources are being assembled so that we can synthesize an idealized sockeye lake system and an idealized salmonid stream system.

MATHEMATICAL MODEL

The mathematical model is now composed of a system of difference equations that represent a particular consumer, its herbivorous food organisms, algae, and light and plant nutrients. Positive and negative feedback relations exist between the equations. The equations themselves consist of recruitment, mortality, consumption, metabolism, and growth components, formulated on laboratory and field evidence and theoretical considerations.

Preliminary computer output based on this mathematical model generally leads to expected relations, thus suggesting that the system of equations provides a suitable basis for further model development.

SYNTHETIC LAKE AND STREAM ECOSYSTEMS

On no single lake or stream ecosystem have sufficient measurements been made to provide an adequate basis for trophic analysis and modeling. But taken together, studies on lakes and streams in the Coniferous Forest Biome appear to have provided enough information on the components of such systems for us to combine data from different lakes and streams and thus synthesize hypothetical representative lake and stream systems. For modeling, because adequate information on single systems is not now available, this is a logical step. This will also make available in readily usable form such information as now exists. Such data will permit us to use and test our model for both lake and stream ecosystems.

ASSEMBLY AND ANALYSIS OF LAKE AND STREAM DATA

We are now assembling and analyzing readily available data on sockeye salmon lake and salmonid stream ecosystems. Data on sockeye salmon lakes in Alaska and British Columbia are available in publications, theses, and reports. Data on Berry Creek, Drift Creek, and the Mt. St. Helens experimental streams are similarly available. These data represent a great deal more information than will be accumulated as a result of aquatic work done during this Biome investigation, and they should be fully exploited. These data also will provide us with information to further develop and test our models.

INTERDEPENDENCY WITH OTHER BIOME PROJECTS

This project is closely related to the University of Washington project on the Wood River sockeye lakes, the Oregon State University project on Lookout Creek in the Andrews Experimental Forest, and the Weyerhaeuser project on the experimental streams at Mt. St. Helens. The generality of our model and its explanatory and predictive powers will make it of value in synthesizing and analyzing data from these other projects. And data from these other projects will assist us in further development and testing of the model. We are already working closely with Weyerhaeuser on their data, and arrangements have been made to begin work with the University of Washington staff. We are working regularly with the Oregon State University staff on the Lookout Creek project.

REFERENCE

WARREN, C. E., and G. E. DAVIS. 1971. Laboratory stream research: Objectives, possibilities, and constraints. Annual Review of Ecology and Systematics. Vol. 2 (in press).