

DYNAMICS OF ECOSYSTEMS

Man's activities are upsetting natural conditions in many parts of the world. They are changing all of the world's biotic communities and have altered much of the earth's surface. Many of these changes are not well understood, and basic information is needed if natural resources are to be more effectively and efficiently managed.

It is most urgent that studies be undertaken leading to a clear definition of existing conditions, to an understanding of the mechanisms and processes that control the various components of an ecosystem, and to a better comprehension of the interactions among the components of these ecosystems. Emphasis should be placed on primary productivity and its meaning for man, on trophic structure, energy-flow pathways (food chains), limiting factors, interactions of species, biogeochemical cycling, species diversity, and other attributes that interact to regulate and control the structure and function of communities.

Terrestrial and Freshwater Ecosystems

The program will not be restricted to natural areas, but will include comparison of ecosystemic processes in environments under various degrees of control by man. Ecological succession should serve as a background in which the general objectives can be pursued. The principles of succession are central to the growing difficulties in the relation between man and nature; yet very few of the generally accepted ideas concerning succession have been tested experimentally or related to whole landscapes as they exist at any one time.

Solution of the basic problems of productivity requires investigations on a broad front and at various levels of complexity, including laboratory studies of individual species, studies of species and populations in their natural habitat, studies of communities of organisms in a restricted habitat or environment, and multidisciplinary studies of complex ecosystems.

Knowledge of the population structure of the individual species, the ways in which they interact, and the extent to which these communities, aquatic or terrestrial, can be manipulated will lead not only to the development of a new level of ecological theory but also to practical increases in productivity.

Marine Ecosystems

An interdisciplinary study of a representative marine ecosystem seems long overdue. Before we can hope to understand relevant processes and to predict the result of changes in the natural environment, we must assess not only the organisms and their population density but also (1) the relation between one species and another, and (2) the effects of seasonal changes, fluctuations in chemical factors, exchange between the water and bottom sediments, and other variables.

An ecosystem approach is necessary because a number of problems confronting biologists relate not just to individual organisms or a single species but to an entire complex of societies and communities of organisms. In the marine environment, physical, chemical, and geological processes and conditions may affect, even control, the ultimate success of organisms and of populations. A complete ecosystem study requires the cooperative effort of many specialists.

Analyses are most likely to be successful where the life cycles of the dominant organisms are short and the number of trophic levels few, for duration and frequency of field observations are thus reduced. However, since the structure of a biotic community is determined more by the history of environmental conditions than by circumstances at a given time and place, observations must be continued long enough to provide just such a history. For a major ecosystem, this implies a series of observations continuing for some years. Observations will require enlightened insights into causal relationships, insights that can perhaps be best developed through intensive studies of selected processes and mechanisms, in both field and laboratory.

The diversity and multiplicity of observations needed make it clear why the ecosystem approach has been applied to marine communities imperfectly and infrequently. No individual possesses all the abilities and interests required. Only by a coordinated attack can we hope to solve some of our major problems (e.g., marine pollution) or to increase productivity by deliberate modification of the sea.

Modification of the Environment

Eutrophication—an Example of Unplanned Modification. Eutrophication of natural waters is an ex-