Ecology: The Biome Approach
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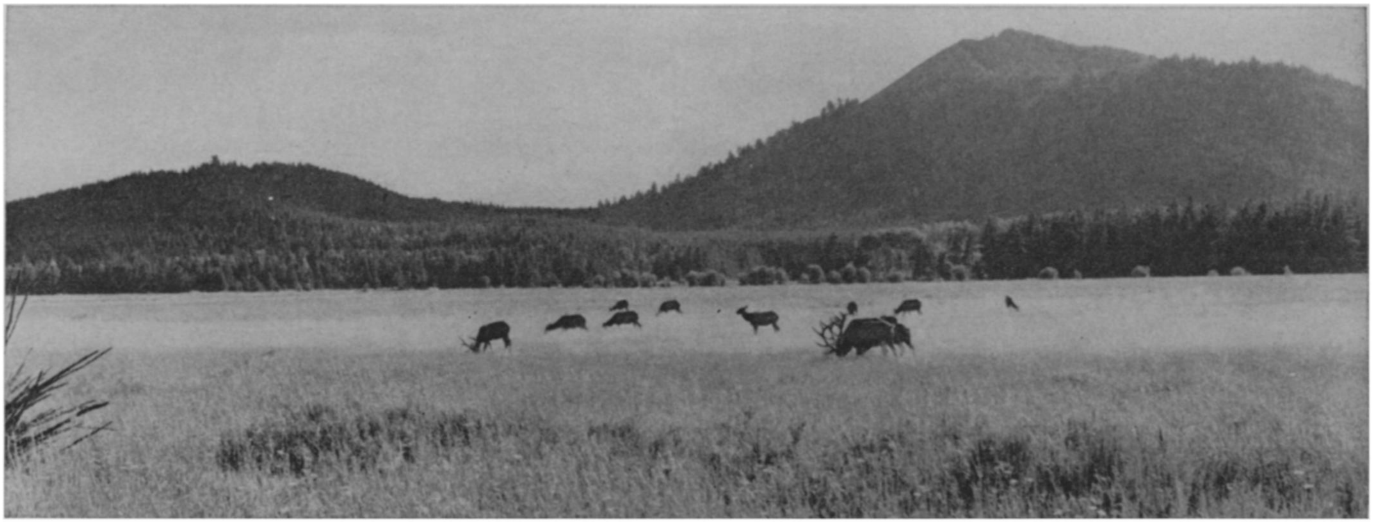
Source: *Science News*, Vol. 98, No. 10 (Sep. 5, 1970), pp. 204-205
Published by: Society for Science & the Public
Stable URL: https://www.jstor.org/stable/3955402
Accessed: 03-01-2019 16:13 UTC



Interior

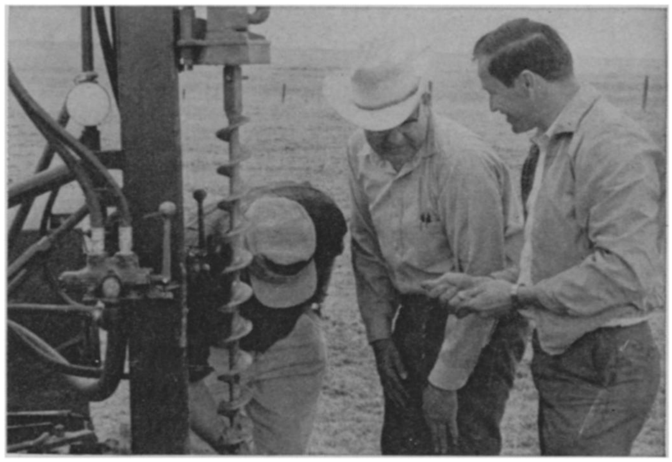
Meadow in the mountains of Wyoming has features similar to those of grasslands found all over the world.

NATURAL SCIENCE

Ecology: The biome approach

Biologists are turning to a teamwork technique to solve the problems of fragmentation in ecological research

by Richard Gilluly



Colorado State Univ.

Van Dyne (right): Data must be shared by everyone.

The ecological view takes into account everything—or aims to. The word ecology is variously defined and increasingly abused, but there is agreement among scientists that it means the study of living things in relation to their total environment, living and nonliving.

The trouble has been that biologists, and even ecologists, have often restricted themselves to too narrow a point of view. Even the simplest ecosystem is so complex that no man could possibly grasp its totality. But the specialists have continued conducting their specialized work and publishing it in obscure journals, often with little likelihood that specialists in other fields would ever get around to reading it. Biology has remained a fragmented science, failing to acknowledge that any given ecosystem is a single entity, as, in fact, the total biosphere is.

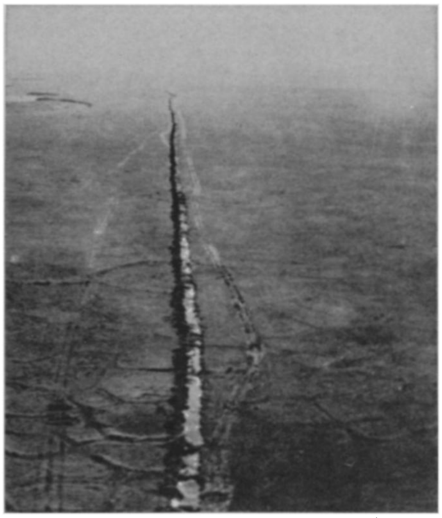
But a new approach that has already begun to end the fragmentation is evolving through the International Biological program (SN: 6/29/68, p. 617). The technique uses an interdisciplinary team of scientists, accompanied by systems analysts equipped with the computers and knowledge necessary to make mathematical models of increasing sophistication. The team descends on some particular ecosystem considered representative of a type found many places in the world. A preliminary mathematical model is established as a basic framework. Then specialists from a variety of disciplines begin feeding data into the model, constantly refining it and filling in the holes. Sometimes in the beginning the gaps are temporarily plugged with guesswork data until the reality can be determined.

The technique is called the biome approach. Biome is a word roughly synonomous with ecosystem; in this context it means a representative ecosystem. For example, Asia, Australia, North America and Africa all have large expanses of grasslands; although the animal life living on the grasslands is widely different on different continents, the plant life sometimes is similar. And even though the animal life is different, animals often fill the same ecological niches in widely separated locations. In other words, grasslands have more similarities than differences; knowledge about grasslands on one continent often is transferable to grasslands on another. The same is true of coniferous forests, deciduous forests, tropical rain forests, deserts and tundra —other representative biomes.

"The beauty of the biome approach," says Samuel B. McKee, IBP staff officer with the National Academy of Sciences in Washington, "is that it forces scientists to work together. The mathematical model can't wait for published data. Scientists have to share data immediately." Besides, he adds, the amount of data generated by a team is so immense that it could not possibly be published. So when a team on one continent wishes to share its data with scientists elsewhere, communication is accomplished immediately by providing a transcript of a computer tape.

Several biome studies are in progress in the United States now; the most advanced one is the grasslands biome study in northeastern Colorado. Other IBP studies not as far along are of Eastern deciduous forests, Western coniferous forests, deserts and Alaskan tundra; a tropical rain forest study is


Interior
Deciduous forest: A typical biome.


Interior
Tundra: Subject of biome study.

planned. Although each study puts a small area under intensive surveillance, inputs are also obtained from a much wider area. In the grasslands study, for example, a comprehensive network is being established to provide grasslands data from an area reaching from Montana to New Mexico.

The grasslands project (SN: 6/29/68, p. 617) has been under way for more than two years now, financed this year by a $1.8 million grant from the National Science Foundation. The area of intensive study is the 15,000-acre Central Plains Experimental Range. But the entire 105,000-acre west division of the Pawnee National Grasslands is considered the province of the team. Some 60 to 80 scientists, most from universities, are involved part-time, plus a full-time staff of about 30 scientists, systems analysts and programmers. Colorado State University at Fort Collins is the academic center of the study and the site of the computer.

The national grasslands area has been maintained in a fair degree of ecological equilibrium for about 20 years. Thus it is possible to manipulate the ecosystem with various stresses and note the results with precision. One study, for example, involves exposing grasslands to four levels of grazing: none, light, moderate and heavy. The effects on the total system will be noted. Another study involves irrigating to increase grass production. The object is to produce data on the effects of irrigation on all other forms of life, especially birds and insects. In the studies of other biomes the same basic approach will be taken.

The biome studies will emphasize man's influences on the environment, including the effect of pollutants. A contemplated new IBP program for worldwide monitoring of pollution would be on a representative biome basis.

"Part of the problem in the past," says Dr. Lee M. Talbot, an ecologist with the President's Environmental Quality Council, "is that studies have tried to get away from man's influences. They ignored man as a potent ecological influence."

The grasslands project already has produced some new insights. "The impact of insects on grasslands was unexpected," says Gerald Wright, executive assistant to Dr. George M. Van Dyne of Colorado State University, director of the project. As it turns out, the insects are far more important—both as consumers of vegetation and as food for larger animals—than had been thought. This knowledge has important implications in the use of pesticides.

But results of the bulk of the program are still to come.

A huge amount of data has begun to flow into the project this summer, says Wright, and by fall, "it will be an avalanche." Clearcut patterns should begin to emerge when workshops and report meetings are held in October and November.

Actually, no over-all mathematical model of the grasslands yet exists. Models first must be made of segments of the total. Two basic approaches are being taken. The first is to model some particular process, such as energy or nutrient flows, throughout the entire study area. The other is to construct point models of one square meter, which try to take into account everything within such microenvironments. Both types of models will be extended as new data become available. To be modeled, for example, will be microwatersheds a little over an acre in size. "Initially, we will deal with several models," explains Wright, "then we will move toward integration."

A separate set of experiments is an empirical check on the extrapolations of the mathematical models. The above-ground vegetation, for example, is harvested and weighed to check on the mathematical projections of material flows. Birds and other animals are counted in another such check. "This is often valid research in itself," says Wright. "But it will not be used in the model, except as a check."

One advantage of the project is its flexibility; since it is essentially a day-to-day operation, the scientists are not prone to get locked into long-term errors that might distort their findings. The project is continually revised as new perceptions of reality become available. "The developing model gives a continuous update on what new data are needed," says Wright. "Directions can change quickly."

Earlier plans, for example, called for core sampling and weighing of below-ground living material down to 60 centimeters. But it was discovered that there is virtually no change in the biomass below 10 centimeters except in isolated instances. The 60-centimeter core-sampling was called off.

The grasslands biome project is a pioneering effort to initiate cooperation between members of disciplines who have not traditionally worked together. Included in the team are entomologists, wildlife biologists, zoologists, ornithologists, aquatic biologists, range scientists, ecologists, biomathematicians, microbiologists, climatologists, hydrologists and agronomists.

"Initially, it was a hell of a lot of work to get cooperation, and a very strong leader was needed," says Wright, himself a systems ecologist. "These people were isolated in their own niches. But there can't be any hesitation by one man to provide data, and we've made a hard and fast rule that all data must be available to everyone in the biome."

Under Dr. Van Dyne, the system has begun to work. Human ecology is integrating itself with natural ecology. The implications, not just for the future of biology but for the future of the world, may prove significant. □