tions or centers: first, those paralleling special parts of center-based programs, to be pursued by collaborators at many locations; and second, separate studies yielding synoptic data for broad geographic comparisons.

Studies that parallel parts of the center-based programs may deal with variants of the ecosystem components found in the intensive study areas, or they may be concerned with the responses of ecosystem components similar to those of the major study areas but existing under different environmental conditions.

The value of certain aspects of ecosystem analysis, particularly seasonal and successional change and productivity, is greatly increased by wide geographic coverage. Studies involving many independent observers must follow rigorous standards to be specified in manuals so that data obtained are strictly comparable. Examples of desirable studies are: (1) timing of appearance and other events in life history for easily observed and identified aquatic and terrestrial animals; (2) date of emergence, coloring, or dropping of leaves for plants with limited genetic variability and widely spread by man, such as ginkgo and metasequoia; (3) counts and/or weights of fruit or seed production made throughout the range of several wide ranging and economically important species, and (4) harvest of peak standing crops of aquatic and terrestrial ecosystems. (Yield values for agricultural crops are abundant but the relationship between economic production and biological productivity is poorly known; thus, correlations of seed yield with peak standing crop is agricultural ecosystems are needed.)

Participation of high-school and college teachers would contribute toward realization of the IBP objective of stirring widespread interest in human-oriented ecology. The teachers' interest would influence the ideas and attitudes of successive groups of students in their classes.

Both the PF and PT subcommittees endorse the general objectives of their international committees and recognize as a relevant part of the American program those contributing studies that relate directly to the specific programs of other countries. The international PF program includes studies relating to eutrophication, primary and secondary production, fish production, the chemical environment, production in man-made lakes and production under environmental extremes. The international PT program includes ecosystem processes of primary and secondary productivity, the dynamics of decomposures, and the interactions of climate, soil, and the impact of man in ecosystems.

METHODS

General

Biologists are sensitive to the need for encouraging advanced and imaginative techniques; yet comparability of results will be enhanced by inter-calibrations, standardization of measurements, and faster communications. Three types of publications will state the possibilities and limitations of techniques:

(1) published books of general reference value,
(2) handbooks of the international sections of the IBP,
(3) supplementary reports of the U.S. National Committee on new techniques and illustrative working results.

For intensive total-system studies, measurements will be made of all major components of the ecosystem. Measurements should include gross production, respiration, net production, secondary and tertiary production, rates of decomposition, exchange of matter with contiguous systems, soil and topographic settings, and microclimatic and macroclimatic variables. Energy flow, nutrient cycling, and production will be investigated on a seasonal basis. Spatial and temporal variation in selected populations should be given special attention.

Examples of techniques for the above measurements include the use of isotopes for tracing food chains and estimating rates of nutrient cycling; remote sensing with such tools as aerial photography, infrared scanning, radar, sonar, and underwater TV; biotelemetry; laboratory microecosystems; and physical and chemical methods, such as chromatographic techniques, nuclear magnetic resonance, activation analysis, atomic absorption, spectrophotometry, calorimetry, nitrogen analyzers, and respiration chambers with automatic gas analyzers.

Systems analysis

In the past two decades a variety of computer-oriented mathematical methods have been developed in industry and government for the analysis of complex systems. Many of these methods and tools have direct applications in analyzing