centers: first, those paralleling special parts of center-based programs; second, geographically extensive, independent studies yielding synoptic data for broad geographic comparisons.

Studies which parallel parts of center-based programs will be pursued by collaborators at many locations and can contribute much to the overall objectives. Such studies 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. These studies will be valuable provided that the methods are comparable and that the data can be subjected to systems analysis.

The value of certain aspects of ecosystem analysis, particularly seasonal and successional change and productivity, is greatly increased by a wide geographic coverage that includes international cooperation. Studies of this type will involve many independent observers and must follow standards (to be specified in manuals) so that data obtained are strictly comparable. Examples of desirable studies are:

- Timing of appearance and other events in life history of easily observed and identified animals, both aquatic and terrestrial
- Seasonal development of plants and animals with limited genetic variability and widely spread by man
- Counts or weights of fruit or seed production made throughout the range of several wide-ranging and economically important species
- Harvest of peak standing crop of terrestrial and aquatic ecosystems
- Correlations of seed yield with peak standing crop in agricultural ecosystems

For the intensive, total system studies, measurements will be made of all major components of the ecosystem(s). Such measurements will 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 will be given special attention.

Examples of techniques to be used in measuring components include the use of isotopes for tracing food chains and estimating rates of nutrient cycling; remote imagery, such as aerial photography, radar, sonar, and underwater TV; biotelemetry; laboratory microecosystems; and physical and chemical methods, such as chromatography, nuclear magnetic resonance, atomic absorption, activation analysis, spectrophotometry, calorimetry, and respiration chambers with automatic gas analyzers.

Systems-analysis techniques will supplement more traditional methods of gathering information. The newer approach will be applied in at least three important ways:

- Examination of existing data on ecosystem processes by sensitivity analysis of certain factors as an aid in allocation of resources for integrated system studies
- Use of computer techniques for rapid organization and analysis of data derived from phases of total system studies that involve electronic recording equipment
- Analysis and integration of results obtained from studies designed to develop and test ecological theory

Because of shortages of biologists capable of undertaking the type of studies needed, training is a major concern. Three phases are essential:

- University pre- and post-doctoral programs that require close cooperation between the basic biological and natural resources departments and those responsible for training in physics, chemistry, mathematics, and computer science
- Special institutes for instruction in modern methods for the practicing ecologists
- Short courses or symposia for biologists wishing to become more familiar with recent advances

At least three working conferences under the sponsorship of the Subcommittees on Terrestrial and Freshwater Productivity will be held during the winter and spring of 1967 to define more clearly the work to be undertaken in analyses of total ecosystems and contributory studies. One conference will consider criteria to be used in selecting sites for the total system studies. A second conference will outline procedures to be used (1) in the contributory studies, which will parallel parts of the total system studies but will be carried out in many locations under different environmental conditions, and (2) in accumulating synoptic data on plant and animal development (phenology), fruit and seed yields of wide-ranging and economically important species, and harvest of peak standing crop of aquatic and terrestrial ecosystems. A third conference will be held May 18-19 following the