the reality of nature. These facts, coupled with a new ability to cope with events at the ecosystem level of organization, portend an exciting and rapidly expanding future for ecological research. There will be rapid growth in interdisciplinary research, with emphasis on the design and analysis of complex experiments on natural ecosystems.

The greatest single change under way is a shift toward the study of whole ecological systems, such as lakes, forests, estuaries, or drainage basins and landscapes. Projects on all of these are being designed. Each one requires a variety of investigators and a degree of interdependence among investigators that has previously been rare in ecology. Ecology will become deeply interrelated with such allied areas as meteorology, hydrology, soil science, geology, and physical oceanography. The theoretical framework surrounding our understanding of whole systems will involve cybernetics, information theory, game theory, decision theory, topology, general systems theory, stability control theory, and open systems theory. Despite this mixture of disciplines, the goal is the development of a unified theory of ecosystems.

A major problem hindering the study of large sytems is the difficulty of designing both controls and replicates for experiments. Both are needed, however, and a trend toward large-scale manipulative experiments that include these safeguards must take place. This requires large study tracts that are guaranteed against disturbances, in a variety of major biomes (some of these can include strong human influences such as agriculture, providing the systems are relatively unchanging over a decade). It is axiomatic that, the larger the system under study, the fewer there are (fewer molecules than atoms, fewer populations than organisms). The relative paucity of ecosystems requires a greater emphasis on techniques that rely on less replication than is usual in other fields. This places a greater burden on the reliability of the data, in systems where reliability in the past has been poor. Thus, even if large study areas are obtained, their instrumentation must nonetheless be intensively developed.

The synthesis of a theory of ecosystems, and also the development of programs for their management, require large increases in research at the level of physiological ecology. We know far too little about too few species. The field is young, and has so far stressed organisms in extreme environments, such as the desert or the arctic, where environmental variables test the capacities for survival. In the future, species in benign environments will be studied more, even though this will require greater precision in measurements of both physiological and environmental factors.

A second impetus to greatly expanded work at the level of physiological ecology derives from the worldwide need for more and better food. The present array of cultivated crops and domesticated animals were collected while man exploited only the most favorable parts of the world. There is no reason to suppose that these species are the best for the rest of the world. Indeed, a number of recent studies have shown new species to be superior. Thirteen species of wild game in Southern Rhodesia have proven to be more profitable than cattle as sources of meat. Red deer, on the island of Rhum, off Scotland, are much more productive than the combination of sheep and cattle that previously were grown there. On the Siberian tundra, the Saiga Antelope is superior to sheep and goats, while in many regions of Australia kangaroos are superior to sheep. Man has only begun to examine this millions of other species around him for those that may be useful.

Another trend in physiological ecology will be a shift away from small samples of genetically homogeneous material to larger samples encompassing the full range of genetic variability present in the population. Although this adds another dimension of complexity to such research, it is the only way that such studies can become useful in the synthesis of information at the level of populations and ecosystems.

To date very few studies have combined competent study of both population genetics and population ecology in natural populations. Recent laboratory work shows that the two are strongly interdependent, that genetical composition changes rapidly under varying ecological pressures, and that ecological capacities alter greatly with varying genetic composition. The role of reversible changes in gene frequencies as on of the ways populations adapt to environmental variation (in addition to changes in behavior, physiology, etc.) will be studied much more extensively. Here again, the integration of the two subjects, both mathematically complex, is feasible only with development of systems methods.