The Experimental Ecological Reserves Project

Preserving Sites for Long-Term Environmental Research

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From a desert biological station in Arizona to a Yukon River ecological station in Alaska; from laboratories high in the Rockies of Colorado to a marine research facility in Connecticut—within the United States there are hundreds of natural land areas equipped with research facilities to study the forests, prairies, tundra, wetlands, and mountains. No two sites are alike: Their common frame of reference is their availability for research to help understand and preserve natural resources.

Until the past decade, there was little or no attempt to inventory and evaluate such sites, owned by the Government, universities or research centers, and by private organizations or individuals.

Studies in the past of the Nation's natural land and marine areas have included some of these research sites. For instance, in 1963 the American Association for the Advancement of Science identified existing or potential research facilities. In 1971, the American Institute of Biological Sciences (AIBS) reported to...
the National Science Foundation on private or university-related field stations useful for biological education and research. And in 1974, AIBS assessed the Nation's natural areas and their role in land and water preservation.

Using information from these and other studies, a group of some 30 scientists is now making a detailed assessment of ecological reserves that seem best suited to experimental research. This program, the Experimental Ecological Reserves (EER) Project, supported by the National Science Foundation, is directed by a national advisory organization, The Institute of Ecology. Its purpose is to provide opportunities for long-term manipulative ecological research and to establish an ecological data base that will contribute to effective management of America's land resources.

A natural ecosystem is a complex, highly evolved biological and physical unit where living species have become adapted to the surrounding land, water, and climate, as well as to one another, and exist in a state of balanced interrelationship—until some change alters the environment.

At the present time, an estimated 3,000 to 4,500 natural areas exist in the United States—distinct in the sense that they are set aside for preservation and, in principle, are not to be disturbed by dams, drainage, landfill, buildings, or otherwise changed by man to accommodate his growing population and affluence. Of these, an estimated 300 areas are established research sites being considered as potential experimental ecological reserves.

Through questionnaires, on-site visits, publications, and personal knowledge—scientists are amassing data on flora, fauna, climate, research history, facilities, potential human intervention, and other factors. By the end of the two-year study, in early 1976, the researchers hope to have information on the extent, quality, and distribution of existing field sites and to identify a number of ecological reserves that will form the nucleus of a national network.

Blueprints for green lands

The most important single factor in evaluating potential sites is how well the vegetation and other biotic and physical components of a site represent a major ecosystem. To get on with the task, the EER group accepted for preliminary use a basic classification system—one of several which will be used—drawn up by A. W. Kuchler of the University of Kansas denoting the more than 100 natural community types in the United States—for instance, the wheatgrass, bluestem, and needlegrass of a Dakota prairie; the sandpaper bush, Joshua tree, and sages of Arizona and New Mexico; the cedar, hemlock, and Douglas fir forests of the northwest; and the alder-willow shrublands of the northeast.

The group gave high priority to larger sites with the most research options. "In planning for future research needs, it is essential that large-scale representations of the major ecosystem types be secured to ensure the long-term availability of such biological resources," says Brian Bedford of The Institute of Ecology and co-manager of the EER project. "Some such areas may 'stand and wait' until a research need develops; however, it is important that such areas be identified while they are still available."

Another important criterion for site selection is whether or not the area is available for research experiments without possibilities of conflicts arising as to the use of the land in the future. Types and number of facilities are other considerations, as well as the year-round availability and access to and from the site. An important factor, if available, is the long-term history of research at each site—essential in providing baseline data for future studies.
“Further evaluation of the total data on existing research sites will provide us with the basis of a potential network of experimental ecological reserves,” states Bedford. “It will also define the gaps in our present coverage of the Nation’s ecosystem sites.”

Some potential EER areas

One high-quality site considered for the EER system is the H. J. Andrews Experimental Forest in the western Cascade Range of Oregon, about 80 miles southeast of Corvallis. Dedicated exclusively to research, this forest encompasses a complete drainage basis of more than 6,000 hectares (the metric hectare is equivalent to about 2.5 acres). Stands of Douglas fir and Western hemlock, some 350 to 450 years old, dominate most of the areas up to 4,000 feet, interspersed with true fir, mountain hemlock, alder, and patches of meadows. Above this, the Pacific silver fir zone begins. Set aside as a permanent reserve since 1948, the area contains many well monitored mountain streams, watersheds, and forest communities. Studies are being made of such factors as the nutrient cycling of small watersheds; the soil moisture relationships under different vegetative cover; the physical, chemical, and hydrologic characteristics of indigenous soils; the succession of plants after a forest has been logged and burned; the effect of logging on the chemical quality of water; the effect of DDT on ecosystems; and the fluctuations in small mammal populations.

Another established site considered for EER inclusion is the University of Michigan Biological Station, representing the Great Lakes northern hardwoods and pine forests. With a research history going back to 1909, plots of various communities have been monitored: deer, grouse, and grey squirrels with stands of trembling and bigtooth aspen, balsam, beeches, and sugar maples; and porcupines with white pine, red oak, and bracken fern. Aquatic habitats include creeks, rivers, ponds, bogs, sandbars, and beach pools. Most of the site has been left completely undisturbed, except for observational recordings, for the past 50 to 80 years.

Within the northern hardwood area, research programs in the Hubbard Brook Experimental Forest, New Hampshire, began in 1955, with stream-gauging and precipitation monitoring, soil surveys, and studies of snow and frost. In an area of more than 3,000 hectares, watersheds are monitored for water quality and quantity, composition of soils, and types of vegetation.

Research at the Desert Experimental Range of Utah, climatically a cold desert with cold winters and warm summers, reports on life cycles of arid land flora—chisel-toothed kangaroo rats, horned larks, and jackrabbits; desert almond, pinyons, and junipers. Ways to restore depleted desert lands with vegetative species are under study, as well as methods of herding and handling grazing sheep that would prove less harmful to the range and more beneficial to the grazers.

Marine sites are also under consideration for EER. Along the shoreline of North Carolina, the maritime communities of Hobcaw Barony extend from the hardy yaupon at the surf’s edge through southern red cedar and live oak to loblolly pine beyond the salt spray zone to open dunes covered with native grasses such as sea oats. Upland areas include longleaf pine, turkey oak, and live oak. Hobcaw is one of the largest contiguous remnants of the old growth pine forests of the South, set aside for research and educational purposes. Once owned by Bernard Baruch, and now by the Belle W. Baruch Foundation, the marshlands are managed under long-term contracts by the University of South Carolina, and the forests by Clemson University.

Other sites are located across the map—some large and well known; others small and little known even to nearby residents: Friday Harbor Laboratories of the University of Washington; Lake Itaska Forestry and Biological Station of the University of Minnesota; Welder Wildlife Foundation in Texas; Edmund Niles Huyck Preserve, near Rensselaerville, New York; and Oak Ridge Environmental Study Park.

Assortment of lands

Obviously, these experimental ecological reserves are only part of the huge kaleidoscope of reserved terrestrial, freshwater, and marine ecosystems throughout the United States. Some of the largest tracts of natural land, including...
Artificial Environments: Phytotron and Biotron

While there's no substitute for the natural environment for most ecological research, some can't wait for the right conditions to occur or reoccur, and other work encounters overwhelming problems in trying to conduct reliable research under precise environmental controls. Fortunately, it is possible to create artificial environments.

The most common are simple greenhouses, but far better control can be obtained in highly sophisticated facilities called phytotrons—mainly for plants—and biotrons—for plants and animals. With controlled temperature, humidity, carbon dioxide, soil nutrients, wind, light, and atmospheric pressure, these facilities can simulate conditions found anywhere (or nowhere) on Earth. Scientists can "set and reset the calendar" for any season—a hot humid summer, a cold dry winter—or choose their own geographies—high-altitude mountain, salty shoreline, or arid desert.

Among the facilities maintained with NSF help are the two phytotrons of the Southeastern Plant Environment Laboratories (SEPEL) at Duke University and at North Carolina State University, and the biotron at the University of Wisconsin, Madison. These national facilities are available to qualified users for periods as short as days or as long as years. Wild and cultivated plants, insects, and small animals can be handled at SEPEL; Wisconsin can handle even larger animals such as primates, cattle, and man. Conditions are continuously monitored with built-in controls, alarms, backup systems, and failsafe devices to keep the experiments going.

With more than 100 plant growth chambers and nine temperature-controlled greenhouses, SEPEL's phytotrons have been supporting a number of complex experiments in physiology, morphology, genetics, ecology, and crop production. Research results have already given scientists a better understanding of how plants function and grow, and what factors determine the wide variations observed in agricultural crops and wild ecosystems, point out directors Jack Downs of North Carolina State and Henry Hellmers of Duke. Experiments have included the selection of soybean varieties for the world's low latitude areas where two crops a year are possible; the discovery that certain plants, such as Monterey pine, grow faster at a much cooler night temperature than that of their natural habitat; the effect of temperature and photoperiod on sorghum growth; and the delay of flowering of maize, cotton, and sunflowers caused by high concentrations of carbon dioxide.

The biotron at the University of Wisconsin contains 48 rooms in which environments can be programmed to provide normal or experimental cycles of a wide variety of conditions. For instance, points out Assistant Director Calvin Dewitt, temperatures can range from arctic conditions of $-60^\circ$C to desert heats of $60^\circ$C. Winds of speeds as high as 120 kilometers an hour can be blown through glassed-in chambers where researchers can study their effects on animal heat transfer rates or on leaf respiration and evaporation rates. Some of the other work at the biotron includes the development of cross-breeding hardness in corn crops by speeding up the seasons in the laboratory, thus speeding up the growth period and maturation to determine the point at which freezing temperatures would kill off the less hardy corn species. Another experiment on animal behavior simulated a southern California desert, complete with vegetation, normal profiles of soil temperature, and daily cycles of temperature and light. With the biotron, foresters could determine the optimum time for planting greenhouse Douglas fir seedlings along the slopes in Oregon to avoid spring frost killing. And another experiment determined the effects of poor ventilation, inadequacy of light, and heat upon the hardiness of honey bees shipped under various conditions throughout the country.

These facilities attract basic research in environmental bioscience that is difficult or impossible to perform elsewhere. But results of this research must be tempered with the fact that the environments are artificial and may differ from natural conditions in significant ways. For that reason, studies continue to be done to compare controlled and natural environments and to determine their relative values for different kinds of research.
In situ. Taking advantage of the natural setting, this experiment at the Huyck Preserve measures the resistance of leaves to the flow of water vapor.

the wilderness areas, wildlife refuges, national monuments, park lands, and forest reserves, are held by different Federal agencies. Some lands are specifically managed to protect wildlife and plants. Others are open to public recreation—fishing, hunting, camping, boating; or to private lumbering, mining, livestock grazing; or to use for transportation, powerplants, and dams.

About two dozen States are actively identifying and protecting natural areas in their own jurisdictions, such as the New York State Forest, New Jersey’s Pine Barrens, and the Colorado Forest Service’s Aspen Groves. Hundreds of universities and schools maintain their own land reserves, often set aside by private foundations, State agencies, or alumni, and then donated to the institutions. On the city level, the pocket parks, city zoos, edges of creeks, and rivers have been added to the assortment of reserved land.

Private foundations and societies such as the Nature Conservancy, the Sierra Club, the Audubon Society, and statewide private groups have been buying up and “holding” ecological sites to keep them from being lost to expanding human encroachment.

One of the more important functions these areas serve is the perpetuation of a large variety of plants and animals—maintaining gene pools of native species that could help develop new strains of food, fiber, and wood plants as existing strains come under pressure from fast-evolving diseases and pests or short- and long-term changes in weather and climate. Little known, so-called “useless” plants and animals have sometimes been discovered to have important uses. *Penicillin* and *rauwolfia* (source of the drug reserpine) are classic examples. Recently, substances from the obscure plant *Maytenus* and its closely related genus *Putterlikia*, discovered in Africa, have shown promise in the treatment of cancer. The red alder plant, long ignored as a weed, has now been discovered to possess nitrogen-fixing bacteria in its root system that are influential in controlling fungus destructive to valuable conifers such as the Douglas fir of the northwest. From the plated armadillo, scientists are trying to find a cure for leprosy; and a vaccine from snow leopards may help conquer sleeping sickness.

**What’s the next step?**

Once the inventory and evaluation of experimental ecological reserves have been made, data about these sites can be used as a base for field research by different organizations. For instance, the Nature Conservancy can use EER information in its overall inventory on the Nation’s land areas. Federal and private agencies will find EER results helpful in resolving questions of future land uses—such as nature preserves, wildlife refuges, endangered species sites, and gene pool reserves. For individual researchers, such a “bibliography” of diverse sites provides invaluable sources of information.

The work of the EER project is only a start. Other efforts continue to preserve ecosystems and the rich variety of life they contain, to keep the Earth’s long-range ecosystems from being destroyed by short-term urgencies of man’s activities.

No one yet knows what the ultimate environment of America will be. Surely the use of land for food, shelter, highways, and recreation will continue, often at the expense of natural land areas.

“Yet there’s a need to better understand the role of natural areas in our changing environment,” says George Lauff of Michigan State University, co-manager of the EER project. “In order to make wise decisions involving the use of land, a comprehensive inventory of the Nation’s natural areas is needed—first, to see what we have, and second, to provide a baseline for measuring the effects of human modification.

“The inventory now under way,” he adds, “of those research sites with long-term potential for experimental ecological studies is the beginning of an integrated approach to environmental quality and management.”

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