Where the Grass Never Stops Growing

HARPENDEN, U.K.—A 16th-century manor house with manicured lawns and nonchalant tabby cats in the heart of rural England seems an unlikely place for one of the world's longest running experiments. But Rothamsted Manor and its ecological research station are far from ordinary. "There are no other long-term studies of this kind in existence," says David Tilman, director of the University of Minnesota's Cedar Creek Natural History Area.

One experiment, in particular, has inspired Tilman and generations of ecologists that came before him. The Park Grass experiment, which analyzes how grassland communities respond to variations in nutrient levels, has been paying scientific dividends since the 19th century. "Any ecologist who has wandered through Park Grass in summer couldn't help but generate a whole series of novel ecological hypotheses," says Tilman.

Park Grass was the brainchild of Rothamsted's former owner, John Lawes, who had made a fortune from a patented process for producing phosphate fertilizer. He started nine long-term ecological and agricultural experiments between 1843 and 1856. While one experiment was abandoned in the late 1800s after a severe nematode infestation, the other eight have continued to this day.

Lawes divided the 2.8-hectare Park Grass plot, originally native grassland, into sections to test the nourishing effects of inorganic fertilizers such as sodium nitrate and ammonium sulfate against those of traditional farmyard manure. These treatments have remained largely unaltered since 1856, although some plots have been further subdivided and limed or have had treatments halted to assess whether they might revert back to wild grassland. Realizing that his experiments appealed to scientists as well as farmers, Lawes upon his death left a substantial endowment to keep the work going. "He was an incredibly foresightful man," says Tilman. The endowment still funds the experiments.

The fertilizers have had a profound effect on the diversity of the plant communities, says Peter Lutman, a weed ecologist at the Institute of Arable Crops Research at Rothamsted. Plots with heavy applications of nitrogen now have few species, sometimes only one or two grasses. Untreated plots, meanwhile, have maintained 50 to 60 species of grasses, broad-leaved plants, and leguminous plants.

Park Grass's longevity has taught ecologists some unique lessons. "Plenty of so-called 'long-term experiments' are in fact showing transient dynamics," says Jonathan Silvertown, a plant ecologist at the Open University in Milton Keynes, U.K.. Park Grass, on the other hand, has shown that a grassland community, after its nutrient balance is altered, takes up to 60 years to reach equilibrium. Says Silvertown, "This is very frustrating for the average researcher experiencing a normal [career] of 40 years!"

Deep roots. This 1932 map of the Rothamsted estate depicts Park Grass and other experiments that continue to this day.

Park Grass and other Rothamsted experiments also offer invaluable archives of dried plant material. "It's like a well that ecologists can dip into whenever they want to test a new idea," such as possible mechanisms of competition or theories on ecological stability, says Tilman. Others use archival samples as controls for studies on the accumulation of pollutants such as PCBs; much of the material was collected before such contaminants even existed.

Most ecologists agree that Lawes's legacy is likely to yield many more insights—making the continuation of the experiments all the more vital. "Long-term data sets of this kind," says Tilman, "have a tendency to surprise you."

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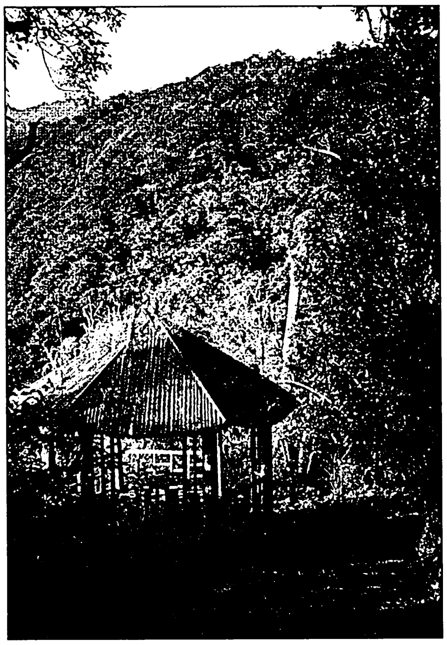
information still used in global carbon models. The IBP, says forest ecologist Jerry Franklin of the University of Washington, Seattle, offered "incredible lessons in the need to be able to look at responses over a long period of time."

Whereas most countries lost enthusiasm for funding such work once the IBP ended, Franklin and the U.S. National Science Foundation's Tom Callahan persuaded NSF top brass in the late 1970s to continue supporting an IBP-like effort. Their argument was that scientists would pursue long-term experiments only if they had long-term funding. NSF held several planning workshops and in 1980 christened a new network of five sites the LTER.

Each of the now two dozen sites must collect data on basics such as weather conditions, nitrogen and carbon levels, and vegetation growth measured by clipping and weighing leaves, twigs, and roots. Beyond these core tasks, the sites undertake research tailored to their regions: probing the ecology of hantavirus in the southwestern U.S. desert, for instance, or studying how increased water flow from the Florida Everglades restoration will change the region's food web.



Going global. U.S. ecology sites have inspired sites worldwide, including Taiwan's subtropical Fu-shan Forest.

A 10-year review chaired by Oregon State University ecologist Paul Risser urged the program to involve social scientists to probe more assiduously how humans alter ecosystems as well as search for solutions to environmental problems (*Science*, 15 October 1993, p. 334). In response, NSF added the Phoenix and Baltimore sites to plumb such questions as how neighborhoods contribute to watershed pollution and which species thrive in cities (*Science*, 22 October 1999, p. 663). Four coastal sites were also folded into the LTER program to give it more depth.

Prodded by the Risser panel, the LTERs have stepped up efforts to exploit their massive data troves. Some of the current work is aimed at developing software that can yoke together disparate databases, to eventually allow scientists to type in search terms related to topics such as climate and gather information from all the sites. The network also agreed to a policy in 1997 requiring investigators to post most data sets on the Web within 2 to 3 years. Anyone who wants to use them needs only notify the owners by e-mail and cite the source. "People had a lot of con-

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