Kellogg Biological Station (KBS)

KBS joined the LTER Network in 1988 to represent the intensive row-crop ecosystem. The site is located in the northeast portion of the US corn belt, in southwest Michigan. Research at KBS is directed towards understanding ecological interactions underlying the productivity of intensively managed annual and perennial field crops. These include corn, soybean, and wheat rotations as well as forage crops such as alfalfa and biofuel crops such as poplars. Contrasts with unmanaged forest and successional (old field) sites provide important points of comparison for gauging the effects of intensive management on the ecology of organisms in modern field crop ecosystems.

An organizing question for KBS LTER research concerns the role of biodiversity in the agricultural landscape, and in particular the functional significance of diversity with respect to ecosystem function. To the extent that agronomic management reduces the structural complexity of various biotic communities within the crop ecosystem, primary questions become:

- what are the key features of the row-crop ecosystem that regulate biotic complexity,
- what – if any – are the ecosystem-level consequences of reduced complexity,
- to what extent can we manage complexity to lessen the need for external subsidies, and
- what is the impact of differential ecosystem management on the larger landscape.

One of the thrusts of KBS LTER research is to address questions related to this biotic simplification, i.e. to the patterns, causes, and consequences of changes in community complexity as a function of row crop management. We focus on three major taxa of central importance to row-crop ecosystem function: soil microbial and invertebrate communities as they affect organic matter dynamics and biogeochemical processes; aboveground consumers – mainly insects and pathogens in various trophic levels – as they interact to affect yield; and plants as they compete for limiting resources and provide habitat for other organisms. The consequences of changes in complexity will be expressed at the ecosystem level as changes in primary productivity and nutrient cycling.

Site Description and Characteristics. KBS is 1600 ha of cropping systems, successional communities, and wetlands and lakes located in southwest Michigan in the eastern portion of the U.S. cornbelt, 50 km east of Lake Michigan (42° 24' N, 85° 24' W, elevation 288 m). Surrounding KBS is a diverse, rural-to-semirural landscape typical of the U.S. Great Lakes and upper Midwest regions. The diversity of land use, soil and vegetation types, and aquatic

habitats within a 50-km radius of the Station is high. Most of southwest Michigan is on the pitted outwash plain of the morainic system left by the last retreat of the Wisconsin glaciation, circa 12,000 years BP. Soils in the area developed on glacial till, and include well- and poorly-drained alfisols, mollisols, and entisols. Most regional soils are sandy loam and silty clay loams of moderate fertility; principal KBS soils are Typic Hapludalfs. Land use around KBS ranges from urban (Kalamazoo, with a metropolitan population of 160,000 is 20 km south) to rural; vegetation ranges from cultivated and early successional old fields to older growth oak-hickory and beech-maple forests; and aquatic habitats include more than 200 bodies of water within 50 km spanning a wide range of morphometry, geochemistry, and trophic state. Cropping systems in the area are typical of the U.S. cornbelt -- mainly corn/soybean rotations with wheat of varying importance, and alfalfa as an important forage crop. KBS crop yields are typical of yields elsewhere in the North Central Region. Annual rainfall at KBS averages 900 mm y^{-1} , evenly distributed seasonally with about half falling as snow; potential evapotranspiration (PET) exceeds precipitation for about 4 months of the year. Mean annual temperature is 9.7 °C.

Research Focus.

LTER research at KBS is conducted at three scales: at the level of individual crop and successional ecosystems, including a subset of larger fields under commercial management; at the local watershed scale, which includes streams, wetlands and riparian areas; and at the regional scale, which extends throughout the north central region. Most research is conducted within an 11-treatment factorial design. At the main experimental site are six different cropping systems represented as 1 ha plots in each of 6 replicate blocks. Four systems are annual crop rotations (corn – soybean – wheat) managed conventionally, with no-till cultivation, with reduced inputs, or organically. Two systems are perennial crops, one a leguminous forage (alfalfa) and the other a woody biofuel (fast-growing poplar clones). Also part of the design are an early successional community, abandoned from agriculture in 1988, two mid-successional communities, one historically-tilled and one never tilled; and an old-growth forest site, all replicated 3-6 times in the landscape. This design provides a wide range of communities with the same pedogenic history that differ in key ecological characteristics such as plant diversity, productivity, litter quality, microclimate, and management intensity. This allows us to test specific hypotheses from which we can infer the ecological mechanisms that confer productivity in row-crop ecosystems – mechanisms that can then be tested with specific manipulative experiments. Baseline measurements are taken from all 11 community types.