Environmental Case Study
GIS and Landscape Ecology

Landscape ecology investigates spatial processes and patterns in ecological systems, such as habitat fragmentation, landscape diversity, and the effects of surrounding land uses on waterways. How can we identify and monitor those processes and patterns? Geographic information systems (GIS) are an important tool for investigating spatial questions in ecology.

What is a GIS? It is software that makes maps from spatial data. Spatial data might be elevation data, locations of animal observations, or boundaries of habitat areas. By mapping these data, scientists can investigate relationships among them. You may have used a GIS: Online mapping services such as MapQuest use digital data representing roads, cities, landmarks, and addresses to make maps on demand. You might make a map showing the distance, direction, and driving routes between your location and a destination. An ecologist would use GIS to show the number of animal observations in a habitat type, to measure the mean size of habitat fragments, or to monitor movements of animals among habitat patches.

Landscape ecologists are often explicitly interested in human roles in ecological systems. The Baltimore Ecosystem Study (BES) is a multidisciplinary landscape ecology project aimed at understanding how human-dominated ecosystems differ from, and are similar to, natural ecosystems. Using a watershed in Baltimore, Maryland, researchers have mapped and measured the effects of settlement density on biodiversity, water quality, wetland habitats, and other environmental conditions.

In one study, BES researchers mapped suburban, urban, and undeveloped areas in subwatersheds, then calculated fertilizer inputs to streams from each type of land use. Fertilizer is important because excess nutrients, especially nitrogen and phosphorus, are important pollutants in river systems. By mapping elevations, they could calculate slopes in sub-watersheds; using digital maps of land cover, scientists could measure the amount of impervious (paved or built) surfaces, then calculate the rate and volume of storm runoff from streets to waterways. Contrary to expectations, they are finding that urban neighborhoods introduce significantly less nitrogen into streams than suburbs do. In some cases, urban nutrient inputs are not much greater than those from an undisturbed forest. Sediment runoff (such as sand and silt) is greater in urban areas, though, leading to faster erosion of streambeds and destabilization of stream-side vegetation.
There is growing interest in how landscape features and landscape diversity affect ecosystems such as the streams in Baltimore. GIS data recording land uses around stream reaches were central to this study. Many other questions about the interaction of features in landscapes, and the effects of human developments on natural processes, are best answered with GIS data.