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Analyzing Land-Use Change at Different Scales in Central Georgia

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ABSTRACT

Growth and development in a region affects the environmental quality of its immediate area and surrounding localities. Such effects are of great concern on military lands because of their ecological importance and the proactive management approach of the military. Military installations support a number of endangered and threatened plant and animal species, and habitat preservation is of prime importance. Yet the survival of these species must be considered in relation to human use of environment and at various scales of resolution. Therefore, the used field experiment to test local impacts, remote sensing data to document changes over time for the entire installation, and the Regional Simulation Model (RSim) to simulate the effects of growth and development in a five-county study region surrounding Fort Benning, GA. Changes in air and water quality, noise conditions, and habitats of keystone species are analyzed under different scenarios. Currently implemented scenarios are population growth, a proposed road improvement program, and a new military training facility within Fort Benning. Growth rules are applied to the land cover as part of each scenario. Different components of RSim model the effect of such land cover change on environmental and ecological qualities.

KEYWORDS: Fort Benning, indicators, land use change, military land, simulation model

INTRODUCTION

The Fort Benning Military installation is home to a number of rare and threatened plant and animal species. At the same time military training occur on the installation which results in some areas being cleared or trampled. Yet, natural resource management and military activities here have to be carried out without jeopardizing any plant or animal species - threatened or endangered as well as maintaining appropriate quality of noise, soil, and air (Efroymson et al. In press). The conservation of the habitat of species and environmental

quality is of great importance to planners and developers on the installation and also in the region around it.

APPROACH

Selecting appropriate ecological indicators for the region was our first task. One of the biggest challenges in selecting ecological indicators was determining the criteria for their use. Therefore, we did a thorough analysis of the scientific literature and talked with resource managers and other researchers at Fort Benning in order to develop a list of criteria for indictor selection (Dale and Beyeler 2001). Then field studies confirmed our hypothesis that a suite of ecological indicators is needed to characterize key environmental conditions at Fort Benning (Dale at al. 2004). This suite captures spatial and temporal scales of interest and includes the following soil microbiology (Peacock et al. 2001); vegetation indicators (Dale et al. 2002); stream chemistry, physical conditions and biota (Maloney et al. In press); and landscape indicators (Olsen et al. In press). In general, many ecological impacts can be captured by the proportion of a watershed that is denuded (bare ground on slopes greater than 3% and under roads).

The creation and use of roads is one of the main causes of land clearing. Furthermore, roads and vehicles change the environmental conditions in which they occur (Forman et al. 2003). One way to categorize these effects is by the spatial scale of the cause and the impacts. Roads may be viewed from the perspective of road segments, road networks, or roads within political boundaries such as counties. Our work on the effects of roads within central Georgia in the southeastern United States allowed us to examine the environmental impacts at four spatial scales that include the Fort Benning Military Reservation. These scales are a second-order catchment, a third-order watershed, the entire military installation, and the five-county region surrounding Fort Benning. The military reservation supports both infantry training as well as habitats for rare species that occur within longleaf pine (*Pinus palustris*) forests. The five-county region includes the city of Columbus, several small towns and suburbs, as well as agricultural and forest land.

The analysis involved different treatments at different scales (as described in detail in Dale et al. In press A). Impacts from an experimental path made by a tracked vehicle were examined in the catchment. Land-cover changes discerned through remote sensing data over the past three decades were considered at the watershed and installation scales. A regional simulation model was used to project changes in land cover for the five-county region. Together these analyses provide a picture of the how environmental impacts of roads and vehicles can occur at different spatial scales. Following tracked vehicle impact with a D7 bulldozer, total vegetation cover responded quickly, but specific plant species recovered differentially. Soils were compacted in the top 10 cm and are likely to remain so for some time. Examining the watershed from 1974 to 1999 revealed that forest conversion was highest near unpaved roads and trails. At the installation scale, major roads as well as unpaved roads and trails were associated with most of the conversion from forest to nonforest land.

For the five-county region, most of the conversion from forest to nonforest is projected to be due to urban spread rather than road impacts. To create these projections, we used the Regional Simulation model (RSim), a scenario based growth model that indicates the changes in land cover, air and water quality and habitat of species as a result of various growth and development activities (Dale et al. In press A)). These simulated changes are useful to quantify the risks and problems associated with military use and development.

The analysis can be placed in the context of the five-county region around Fort Benning, Georgia, USA. Anthropogenic influences on the region have been long and intense (Dale et al. in press B). Only 4 percent of the native longleaf pine (*Pinus palustris*) forest remains intact. Besides the loss of species, habitats, and ecosystem services associated with longleaf pine forests, environmental concerns of the region include air, water, and noise pollution. To understand how anthropogenic developments affect these environmental concerns, we are developing a Regional Simulator (RSim) to project future developments and their impacts on environmental conditions. RSim is being applied to the five-county region around Columbus, Georgia, where a mix of federal and private ownership leads to complicated land management issues that will likely become even more difficult as Columbus continues its projected growth along the northern border of Fort Benning. Potential effects of this growth on noise and air pollution, water-borne nutrients, and habitats for focal species can be simulated using RSim.

The knowledge of potential futures for the area allows decision makers to better consider options for environmental protection. A main lesson from this analysis is that regional simulation models are a cost-effective way to assess long-term environmental implications at different scales of resolution. These results lead to questions about appropriate metrics of road impacts.

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