

Modeling the Interactions Among Urban Development, Land Cover Change, and Bird Diversity - NSF Biocomplexity Program

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Abstract

The interactions between urban development and ecological processes are extraordinarily complex. Urban development evolves over time and space as the outcome of microscopic interactions of individual choices and actions taken by multiple agents. These decisions affect ecosystem structures and functions through the conversion of land, fragmentation of natural habitat use, disruption of hydrological systems, and modification of energy flow and nutrient cycles. Environmental changes at local and regional scales affect human well-being and preferences as well as the decisions people make. This project will develop an integrated model of urban development and land-cover change in the central Puget Sound region that can interface with models representing a large set of ecosystem processes. The focus of this project will be on linking urban development to bird diversity as a test case for an integrated modeling approach. This approach builds on model traditions in urban economics, landscape ecology, bird population dynamics, and complex system science, each of which offers different perspectives on modeling urban ecological interactions. The project will apply Bayesian networks and a multi-agent microsimulation approach because of the potential for those approaches to support complex inference modeling in problem domains with inherent uncertainty. Instead of separately simulating urban growth and its impacts on birds habitats, this project will develop a framework to simulate metropolitan areas as they evolve through the dynamic interactions between urban development and ecological processes and link them through a spatially explicit representation of the urban landscape.

Assessments of ecological impacts of urban growth that are timely, accurate, and transparent are crucial to sound policy and management decisions. Although extensive urban research has focused on the dynamics of urban systems and their ecological interactions, these diverse urban processes have yet to be synthesized into one coherent modeling framework. Simulation models of urban and ecological dynamics have evolved in separate knowledge domains. While both of these research areas deal with human-environmental interactions, they do so with very different emphases, scale, methodology and objectives. This research will investigate how best to model complexity and uncertainty of coupled socioeconomic and biophysical processes in metropolitan regions and their interactions with the policy domain. This project will emphasize the importance of explicitly representing human and ecological processes in modeling urban systems, including patterns, processes, and impacts. Ultimately, this project will assist in identifying answers to questions related to the potential use of public policy to intervene in urban ecological systems in ways that may reduce ecological damage from urban processes while sustaining economically and socially viable urban communities for people. The project therefore should help in the development of tools for policy makers to explore the links between human behaviors and environmental change.