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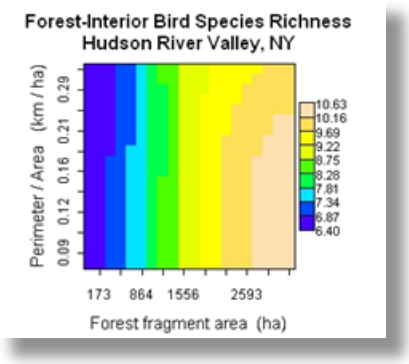
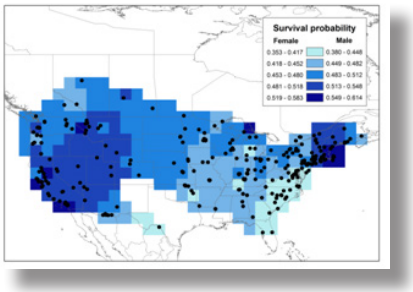
Patuxent Wildlife Research Center

Hierarchical Models of Animal Abundance and Occurrence

The Challenge: Research goals of this project are to develop models, statistical methods, sampling strategies and tools for inference about animal population status from survey data. Survey data are always subject to a number of observation processes that induce bias and error. In particular, inferences are based on spatial sampling – we can only ever sample a subset of locations where species occur --and imperfect detection – species or individuals might go undetected in the sample. Principles of hierarchical modeling can be applied directly to accommodate both features of ecological data. Prior to the development of hierarchical models at PWRC, studies of unmarked populations focused on simplistic descriptions of distribution patterns and temporal trends. Hierarchical models have advanced the field of population ecology by enabling the estimation of demographic and movement parameters that previously could only be obtained using costly field methods. Ecologists can now make inferences about population dynamics at broad spatial and temporal scales using models designed specifically for this task.



The Science: *Estimating density using spatial capture-recapture models:* Many of the species of highest conservation concern are difficult to study because they are elusive and hard to observe in the wild. We have developed a class of spatial capture-recapture models that allow researchers to use cameras and non-invasive DNA techniques to better understand the demography of such species. Our projects include many rare and elusive species such as tigers, European wildcats, jaguars, Andean cats, pampas cats (Fig. 1), ocelots, black bears and wolverines. *Models of animal communitites:* We are developing hierarchical models for understanding structure and dynamics of biological communities. Understanding how species occurrence patterns vary in heterogeneous landscapes is crucial for developing and implementing conservation and management activities. Our methods provide increasingly more realistic estimates of species distributions and species richness. Figure 2 shows expected richness of forest interior bird species as predicted based on forest fragment area and perimeter to area ratio. *Spatial modeling:* We are developing models that encompass spatial and temporal variability in ecological processes, including species invasions, population dynamics rates, and population trends. Figure 3 shows survival probability estimates from a hierarchical spatial capture-recapture model of Common Yellowthroat data from MAPS.



The Future: We are investigating applications of hierarchical models for studying the effects of global change on populations and communities, and extending spatial capture-recapture and community modeling methods to dynamic systems that are subject to recruitment and mortality. We are developing freely available software to implement hierarchical models in WinBUGS and the R package unmarked.

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