ASSESSMENT OF THE ROLE OF INTERSTATE HIGHWAYS AS BARRIERS TO GENE FLOW AND METAPOPULATION PERSISTENCE IN MAMMALS FROM INDIANA

Ph.D. student Cecilia Hennessey sitting a genemapper computer

Current Status

Fourth year of a five-year project

Funding Sources and/or Partners

State Wildlife Grants (T07R04), Purdue University, DNR Nongame Fund

Project Personnel

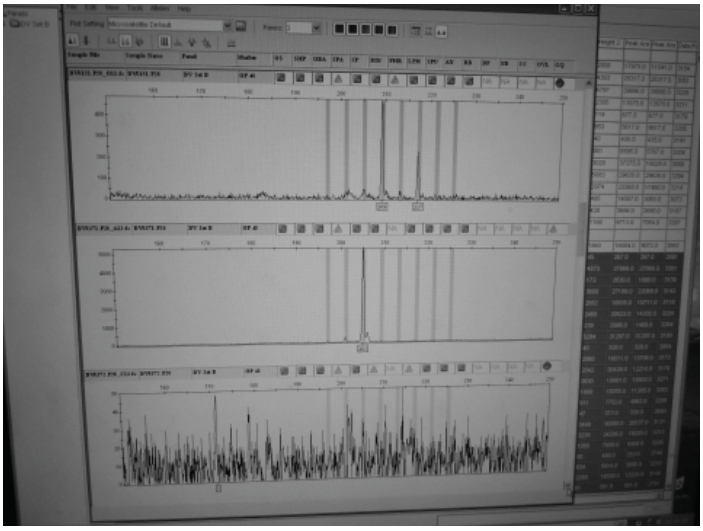
Pat Zollner (principal investigator)
Gene Rhodes (co-principal investigator)
Cecilia Hennessy (Ph.D. graduate research assistant)
Matt Beard (Ph.D. graduate research assistant)
Tricia Tsai (Ph.D. graduate research assistant)
Melissa Mills (undergraduate modeler)
Roxanne Pourshoushtari (GIS technician)

Background and Objectives

The main goal of this project is to determine whether interstate highways in Indiana are restricting the movements of wild animal species of various sizes, which may result in declines of these species due to losses in genetic diversity. We will investigate the ability of six mammal species to cross the interstate by analyzing genetic information and movement patterns of wild populations.

Methods

During the first three years of this study we live-trapped six common species of mammals, including raccoons, opossums, gray squirrels, fox squirrels, chipmunks and white-footed mice, from forests on opposite sides of interstate highways in Indiana. We selected



Scoring opossum alleles on genemapper computer

Telemetry trailer at Clark State Forest

Telemetry tower being set up at Seymour west site

forests that were separated by the interstate, but otherwise have good habitat for these species. These are so-called "paired" sites, because each site actually has two parts—one on either side of the interstate. We used box traps, which are like wire cages, to trap the animals. We marked the captured animals with numbered ear tags, and we took a small genetic sample from each animal, usually a tiny piece of the tip of the ear. Collars containing radio telemetry transmitters were attached to adult chipmunks, gray squirrels, fox squirrels and raccoons at a subset of locations. We took the tissue samples back to the wildlife genetics research lab at Purdue University to extract DNA and determine the genetic characteristics of each individual.

Combining the genetic information with location data will help us determine the effect the interstate has on the local populations by allowing us to look for evidence of genetic exchange between populations on either side of the road. Animals that are related share a lot of the same DNA, and the more related they are, the more DNA they have in common. Therefore, a population of animals is likely to share DNA at a relatively high rate because there will be a lot of relatives living near each other. Populations on either side of an interstate can be compared for evidence of gene sharing and relatedness. During this past year we worked hard in the lab on extracting the DNA from most of these field samples and measuring that DNA so we can estimate the degree of relationship between animals that live on opposites sides of the highway.

In coming months we will use this information to determine if the interstate is separating two populations, or if the animals on either side are actually one population. If the former is true, then the interstate may be creating a barrier to animal movements. This effect may be more evident in species that are more reluctant to cross over roads or to use culverts to cross under roads (such as chipmunks and squirrels) than species that are not as reluctant (such as raccoons and opossums). However, if the animals from either side of the interstate are determined to be one population, then the animals are successfully crossing the interstate and gene flow is occurring.

Detailed data on the movement patterns of animals from the telemetry transmitters help us understand the day-to-day response of these animals to highways. That understanding of those daily movement responses, in combination with the genetic data, is critical to building computer models that we will use to predict the consequences of interstate highways in Indiana on the long-term persistence of viable populations of wildlife. The radio telemetry collars provide us detailed data on the movement patterns of the animals we are tracking at each grid. Animal locations are estimated using six automated telemetry receivers and towers mounted on trailers. This system allows us to estimate the location of each collared animal within a grid once every couple of minutes. During the past year our towers were moved between two of our study sites (near Seymour and Columbus, Ind.) where the towers collected intensive data

on the locations of animals for weeks at a time. At the same time we deployed traffic-counting devices at each of these locations to collect data on how many cars were moving along those highways while we tracked animal movements. Back in the lab we will analyze the recorded movements of the animals to determine if there are consistent patterns in how frequently these animals turn or move slowly or quickly. We compare the movement patterns of these animals when they are close to highways to times when they are not.

We have already used aerial photography images to create detailed maps of the habitat at our study sites. We have also constructed a simulation model that uses these maps and rules for how wildlife species move and respond to highways. This model will help us predict how permeable highways should be for different species. This computer program allows us to simulate the movements of thousands of virtual animals and to estimate the strength of the barrier effects of different highways for different species. This past summer we set up the maps for all of our study sites and the rules for all of our wildlife species. We are now running these computer simulations. In the coming months we will compare the predictions of the computer models with the genetic data to investigate the details of how highways restrict the movement of different wild animal species.

Progress

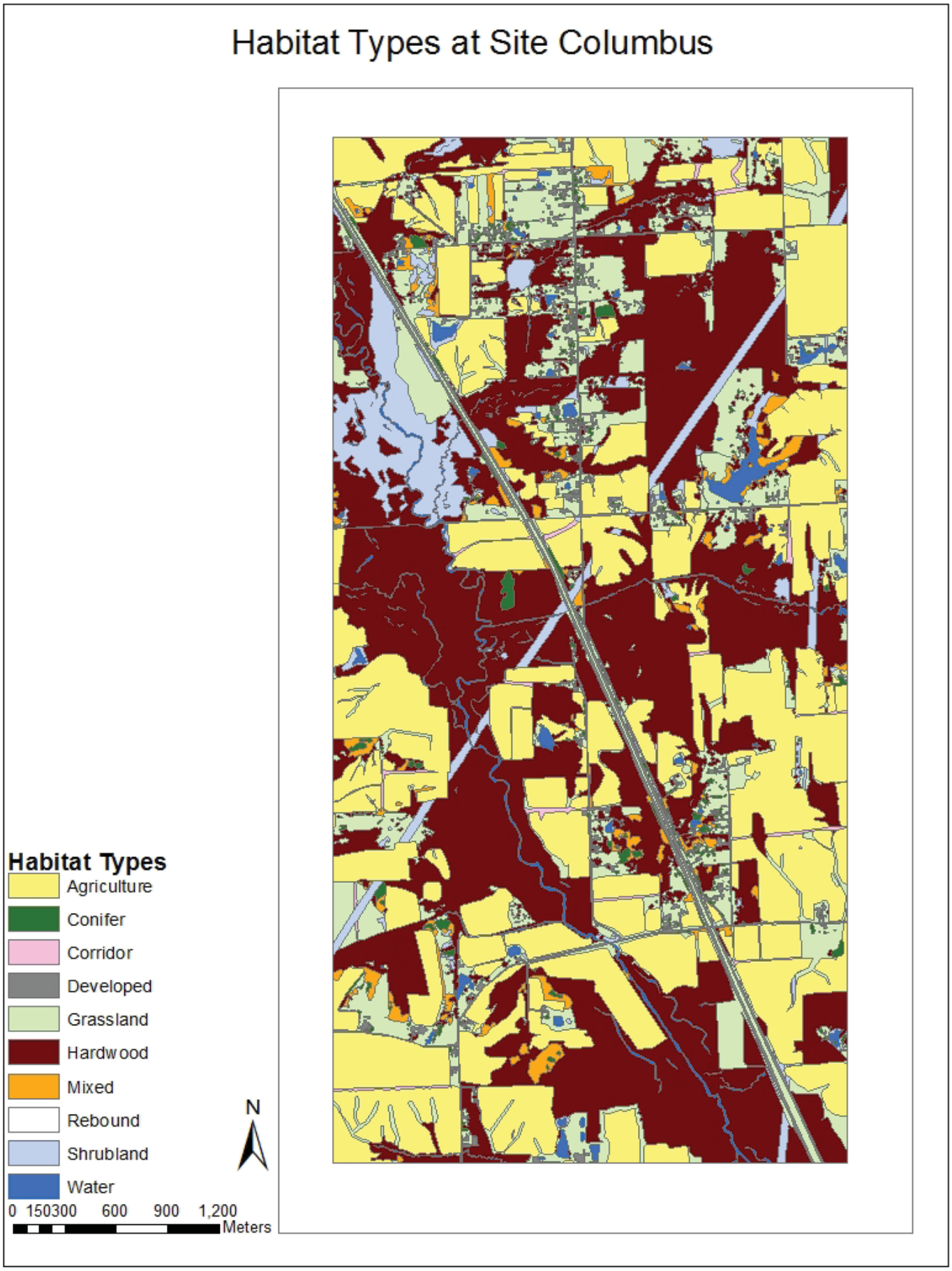
This past year all three of the Ph.D. students working on this project passed their qualifying exams, so they continue to progress toward completing their degrees during spring or summer 2012. Matt Beard finished collecting all of the movement pathway data on wild mammals with the telemetry towers. Cecilia Hennessey presented a poster on the analysis of the barrier effects of highways upon chipmunks at the annual meeting of the American Society of Mammalogists. These genetic analyses demonstrate barrier effects of highways for chipmunks at three sites but also suggest that highways do not pose a barrier at two other sites. This fall Cecilia is measuring the differences between these locations on the ground to assess what features (e.g., culverts) might be facilitating dispersal by chipmunks at some locations and not others. Cecilia has continued to work hard in the lab extracting DNA from tissue samples and nearly has her lab work completed for all species. This fall she has also collaborated with numerous land owners and local hunters near our study sites to get additional tissue samples from squirrels. These additional samples are invaluable at ensuring that we get data from enough squirrels at enough sites to accurately assess the barrier impacts of highways. Tricia Tsai and Melissa Mills (a senior wildlife major at Purdue) have analyzed the trapping data and obtained estimates of the local density of each wildlife species at each of our study sites. These density estimates are important data for setting up the simulation model. Mills also started working on applying the movement simulation model to our species at our study sites. She finished setting up the maps for the computer simulation model and the

Matt Beard setting up telemetry tower during winter conditions

rules for the wildlife species to follow in that model. She has nearly finished running these models for raccoons and is about to progress onto running these models for chipmunks and squirrels.

The future of this project includes an early November oral presentation that Pat Zollner will make at the national meeting of The Wildlife Society describing the movement-simulation model that we have created and are using for this project. In December Cecilia Hennessey will make an oral presentation at the Midwest Fish and Wildlife meetings that will use the genetic data to compare the barrier effects of highways upon chipmunks, raccoons and opossums. By the end of November Henessey will have finished collecting supplemental squirrel samples. She should completed work on her last tissue samples by the end of December. All three Ph.D. students involved in this project will be analyzing data and writing dissertation chapters during early 2012. All should complete their degrees between April and July 2012. The chapters of these respective dissertations will provide useful to share with our funding partners at the conclusion of this project in 2012.

Cost: $1,042,067 for the complete five-year study



Example input map created for simulation model of Columbus site