MANAGING GENETIC ISOLATION DUE TO HABITAT FRAGMENTATION: A MODEL-BASED TOOL FOR USING ASSISTED MIGRATION AS AN AID TO RECOVERY OF ALLEGHENY WOODRATS

An Allegheny woodrat poised on a ledge in a southern Indiana cave. (Photo by Kevin Kazacos, Purdue University.)

Current Status

First year of a two-year project

Funding Sources and Partners

IDNR Division of Fish & Wildlife, Wildlife Diversity Program; and Purdue University

Project Personnel

Principal investigator, Dr. Robert K. Swihart, Purdue University, Department of Forestry and Natural Resources, professor and head

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Collaborators:

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Background and Objectives

The Allegheny woodrat *(Neotoma magister)* is a small mammal found in rocky habitats distributed throughout Eastern deciduous forests. Within Indiana, woodrats are restricted to the cliffs that overlook the Ohio River in extreme southern portions of the state. These unique rocky habitats often are patchily distributed both throughout the species' range and along this river corridor. This creates a population structure in which small woodrat populations occupying disjunct rocky habitats are connected to one another through the limited movement of individuals among populations. As a small-bodied mammal, this species has limited movement capacity. Therefore, of the few individuals that leave their natal population, most settle in adjacent populations and few ever

disperse more than 2 miles from their natal population. Even limited exchange of individuals among populations is critical for the maintenance of genetic integrity within these small woodrat populations.

Over the past 40 years, Allegheny woodrats have declined rapidly both within Indiana and throughout much of their range due to 1) increased mortality associated with raccoon roundworm, a common parasite carried by raccoons, 2) reduced food availability due to the functional extinction of the American chestnut, the declining oak abundance, and the loss of the rich food resources these species provided, and, most importantly in Indiana, 3) habitat loss and fragmentation resulting in genetic decline as populations become increasingly isolated from one another. Due to pressures on habitat caused by road and bridge construction, quarry and residential development, or habitat degradation, many of Indiana's remnant woodrat populations are now separated by distances greater than 2 miles. Without woodrats moving among populations, genetic diversity inevitably is lost through the process of genetic drift. The rate in which this genetic diversity is lost depends upon population size (larger populations have greater potential to maintain genetic diversity) and relative reproductive success of individuals (the more evenly that individuals contribute to the next generation, the better genetic diversity is preserved).

Over the last eight years, through a collaborative effort between the Indiana Department of Natural Resources and Purdue University, we have been working to address these factors and reverse the declining trend for woodrats. Through intensive management efforts, we reduced the prevalence of raccoon roundworm infection among the raccoons that occupied woodrats habitats, thereby reducing the risk of disease transmission. Also, through a series of translocations from robust wild populations in Kentucky and from woodrats born in captivity, we have restored genetic diversity to healthy levels for these isolated populations.

Indiana's critically imperiled woodrat populations have responded positively to these management efforts, nearly tripling in abundance, although challenges remain for the future persistence of these populations. Despite genetic diversity having been restored among isolated and inbred populations, the landscape configuration that created those problems remains. Among many of Indiana's woodrat populations, distances to the nearest occupied woodrat habitats exceeds the movement capacity of the species. Therefore, through the inevitable process of genetic drift, genetic diversity will be lost and inbreeding will once again threaten the persistence of Indiana's remnant woodrat populations. In order to maintain the progress we have made in the recovery of these imperiled populations, it is necessary to devise an optimal strategy to artificially replicate natural patterns of movement among populations to preserve healthy levels of genetic diversity in the future.

Methods

To develop an informed strategy for the translocation of woodrats for this purpose, we must first understand the rates in which genetic diversity is naturally lost from these populations. Therefore, we will conduct two analyses to describe woodrat demographic processes and variation in reproductive success, the two elements that drive the rate of genetic drift. Specifically, to characterize woodrat demographic processes, we will evaluate variation in woodrat abundance, recruitment and survival as a function of the following factors: 1) age, 2) sex, 3) heterozygosity, 4) mast availability, 5) year, and 6) site (population). Additionally, we will conduct sensitivity analyses to identify the factors most critical in limiting woodrat populations. To characterize variation in reproductive success, we will conduct a parentage analysis, probabilistically identifying dams and sires for every juvenile woodrat captured from 2005 through 2012. We will then evaluate the relationship between reproductive success of individual woodrats and the following factors: 1) age, 2) sex, 3) heterozygosity, 4) mast availability, 5) year, and 6) site (population). This analysis will allow us to describe inter-individual variation in reproductive success, which directly influences the rate of genetic drift.

We will integrate understanding of woodrat demographic and reproductive processes to identify optimal patterns and schedules for translocating woodrats among populations over successive generations, with a goal of maximizing the retention of genetic diversity among all populations. Flexibility within the model will allow us to stipulate the frequency with which translocations should occur as a function of anticipated resources available for continued monitoring and translocation efforts. Further, this model also will allow us to quantify the genetic benefits of restoring previously occupied woodrat habitats. We will construct this model in such a way that it will have broad applicability, so that by changing some key species-specific parameters, the model could be used to address numerous contemporary challenges for species conservation.

Progress to Date

With the project just underway, we are beginning to compile the necessary data to conduct these analyses. We have begun collaborating with Drs. Stauffer and Diefenbach on the demographic analyses. Drs. Stauffer and Diefenbach have extensive experience in demographic modeling to contribute to the project. Their involvement will facilitate the extrapolation of understanding gained through our work in the recovery of Indiana woodrat populations to other imperiled populations throughout the species' range.