STATE WILDLIFE GRANT PROJECT REPORT—INDIANA

Assisted Migration as a Conservation Tool in the Management of Spatially Isolated Populations: A Case Study in Allegheny Woodrats

Tim Smyser and former DNR employee Heather Walker collect a genetic sample from a captured woodrat.

Current Status

Second year of a three-year project

Funding Sources and Partners

DNR Division of Fish and Wildlife, Wildlife Diversity Program; and Purdue University

Project Personnel

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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 condition creates a structure in which small populations are connected to one another through the limited movement of woodrats among populations.

As a small-bodied mammal, this species has limited movement capacity. Therefore, the few individuals that leave the population in which they were born tend to settle in adjacent populations. Very few settle more than 2 miles away. Even the limited exchange of individuals that occurs among populations is critical for the maintenance of genetic diversity within 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 extinction of the American chestnut, declining oak abundance, and the loss of chestnuts and acorns these species provided, and, the most important factor in Indiana, 3) habitat loss and fragmentation resulting in genetic decline as populations have become increasingly isolated from one another. Due to factors such as road and bridge construction, quarry 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 a process called genetic drift. The rate at which 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 individuals contribute to the next generation, the better genetic diversity is preserved).

Through a collaborative effort between the DNR and Purdue University, we have been working over the past nine years to address these factors and reverse the declining trend for woodrats. Through intensive management, we were able to reduce the prevalence of raccoon roundworm infection among the raccoons that occupied woodrat habitats. This reduced the risk of disease exposure for woodrats. Also, through a series of translocations (i.e., the deliberate movement of a species such as a reintroduction into vacant habitat or supplementation of small populations) from the robust wild populations in Kentucky and from woodrats born in captivity, we have restored genetic diversity to healthy levels for these isolated woodrat populations.

Indiana's critically endangered 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 extensive habitat fragmentation that ultimately causes these problems remains unchanged. Among many of Indiana's woodrat populations, distances between them exceed the movement capacity of the species (~2 miles). Therefore, through the inevitable process of genetic drift, genetic diversity will be lost and inbreeding will once again threaten the persistence of Indiana's remaining woodrat populations. In order to maintain the progress made in the recovery of these endangered populations, it is necessary to devise an optimal strategy to artificially reconnect these populations through the translocation of Indiana's woodrats to preserve healthy levels of genetic diversity into the future.

Methods

To develop an optimal strategy for the maintenance of genetic diversity, we must first understand the rates in which genetic diversity is lost naturally from these populations. Therefore, we are conducting analyses to describe woodrat birth rates and death rates (demographic processes) and variation in the number of offspring produced by woodrats (reproductive processes). Together, demographic and reproductive processes drive the rate in which genetic diversity is lost. Specifically, to characterize woodrat demographic processes, we are building statistical models that allow us to evaluate variation in woodrat abundance and survival as a function of age, sex, genetic diversity, year and site (population). Additionally, we are conducting analyses to identify the factors most critical in limiting the recovery of woodrat populations. To characterize variation in reproductive processes, we will conduct a parentage analysis to identify the mother and father for every juvenile woodrat captured from 2005 through 2013. We will then evaluate the relationship between the number of offspring produced and the five factors mentioned previously.

We are working to integrate our 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. Further, we will construct this model in such a way that it will have broad applicability. By changing some key species-specific parameters, the model could be applied to other endangered species where natural movement of individuals among populations is threatened by habitat fragmentation.

Progress to Date

Completion of this project depends upon the integration of three independent aspects: 1) a demographic model to describe woodrat population processes, 2) a reproduction model to describe variation in reproductive success, and 3) a computer simulation model to estimate the rate in which genetic diversity will be lost from populations and the level of translocations needed to offset these losses. Currently, we have been assisting DNR-led field efforts to document 2012–2013 annual survival rates and collecting genetic samples for parentage analysis. Field efforts were completed at the beginning of November. Upon the completion of field efforts, we began generating genetic data (genotyping) for all woodrats sampled in 2013.

We have been collaborating with Drs. Stauffer and Diefenbach for the completion of the demographic analyses associated with this project. Their involvement not only brings extensive experience in demographic modeling, but also will facilitate the application of understanding gained through our work in the recovery of Indiana woodrat populations to other endangered populations throughout the species' range. With preliminary data collected between 2005 and 2009, we have been working to develop model structures necessary to complete this analysis. With the completion of genotyping for samples collected from 2010–2013, we will use the full data set (2005–2013) to conduct our final analysis.

Like the demographic modeling, completion of the reproductive model depends upon genetic samples currently being collected in the field. In preparation for this aspect of the project, we have been learning to use the software necessary to complete this analysis.

For the development of a computer simulation model, we are first constructing a model plan as a necessary step to translate the concepts of the model into a structure that can be written as computer code and executed as a program. "Models" are a deliberate simplification of the natural world (in this case, woodrat population processes) that allow us to ask questions about processes that would be difficult to examine in nature.

To develop an informative model, we must simplify complex natural systems by indentifying the essential components of the "woodrat population system" and then determine how those components interact to inform the process of interest (i.e., loss of genetic diversity). Additionally, we are identifying attributes of the natural system that we would like our simulated woodrat population to mirror. Once our model is able to match the patterns observed in nature, we will know our model is effectively describing woodrat population processes.