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

Allegheny woodrats have soft, brownish-gray fur on their backs. Their feet and underside are white. They have large ears, long whiskers and a furry tail to help them navigate through their environment.

Current Status

Second year of a three-year project

Funding Sources and Partners

State Wildlife Grant Program (T7R13)

Purdue University

Project Personnel

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

Dr. Timothy J. Smyser, Purdue University, Department of Forestry and Natural Resources, Postdoctoral Research Associate

Collaborators:

Dr. Glenn E. Stauffer, Pennsylvania Cooperative Fish and Wildlife Research Unit, Pennsylvania State University, Postdoctoral Research Associate

Dr. Duane R. Diefenbach, Pennsylvania Cooperative Fish and Wildlife Research Unit Pennsylvania State University, Leader and Adjunct Professor of Wildlife Ecology

Dr. Robert C. Lacy, Chicago Zoological Society, Senior Conservation Scientist

Background and Objectives

The Allegheny woodrat *(Neotoma magister)* is a small mammal found in rocky habitats in Eastern deciduous forests. In 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 of woodrats are connected to one another through their limited movement.

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

An Allegheny woodrat consumes some uneaten bait after being released from a trap.

settle in adjacent populations. Very few settle more than 2 miles away. Even the limited exchange of individuals that occurs among populations is critical to maintain 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. The reasons include:

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

3) the most important factor in Indiana, 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 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 Indiana Department of Natural Resources (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 reduced 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 by nearly tripling in abundance. But challenges remain for these populations. Despite genetic diversity having been restored among isolated and inbred populations, the extensive habitat fragmentation that ultimately causes these problems remains unchanged. Distances between many of Indiana's woodrat populations exceed their movement capacity (about 2 miles). Therefore, through the inevitable genetic drift, genetic diversity will be lost and inbreeding will once again be a threat. To maintain the progress made in the recovery of these endangered populations, we need to devise an optimal strategy to artificially reconnect these populations through translocations to preserve healthy levels of genetic diversity.

Methods

To develop an optimal strategy to maintain 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 assess the 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 have built statistical models to describe variation in woodrat abundance and survival as a function of age, sex, genetic diversity, year and site (population). These analyses will allow us to identify the demographic factors most critical in limiting the recovery of woodrat populations. Our next step is to characterize variation in reproductive processes. To do this we will 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. The goal is maximizing the retention of genetic diversity among all populations. Further, we will construct this model to 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 integrating three independent aspects:

1) a demographic model to describe woodrat population processes,

Allegheny woodrats prefer large rocky outcrops with cracks and crevices in forested areas. Ideal habitat is found along the cliffs of the Ohio River in southern Indiana.

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.

As a necessary first step before we can begin building demographic and reproduction models, we recently generated complete genotypes at 11 microsatellite locations for 453 woodrats captured within Indiana from 2010 to 2013 to supplement our genetic database of 389 individuals captured between 2005 and 2009.

In collaboration with Drs. Stauffer and Diefenbach, we have developed demographic models. Specifically, we developed mark-recapture models (developed within both a Bayesian and Maximum Likelihood framework) to evaluate the influence of sex on the probability of capture and the influence of sex, population, year, local population size (abundance), weight and individual genetic diversity (heterozygosity) on annual survival rates. We found that the probability of capture was high but varied substantially between males (about 75%) and females (about 95%). Survival varied by age with low annual survival for juveniles, highest annual survival for 1-year-olds, and then decreasing survival among aged woodrats (2+ years old). Survival was positively associated with weight. Heavier individuals were more likely to survive from one year to the next. We are currently composing the manuscript describing the results. Upon completion of the demographic analysis, we will begin developing and evaluating models to describe changes in reproductive success.

Computer simulation models are a deliberate simplification of the natural world (in this case, woodrat population processes). Using models allows us to ask questions about processes that would be difficult to examine in nature. To develop a computer simulation model, we have completed 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. With the completion of the model plan, we have begun model development in Program VORTEX. Working within the VORTEX platform required an expansion of the functionality offered by the program for complete realization of the project objectives. Accordingly, we collaborated with Dr. Robert C. Lacy, the developer of VORTEX, and have begun expanding VORTEX to meet the needs of this simulation analysis. We will continue to work with Dr. Lacy to expand VORTEX while we refine input-parameter estimates derived from both the demographic and genetic analyses described.

Cost: $189,305 for the complete three-year project.