Current Status

Second year of a three-year project

Funding Sources and Partners

DNR Nongame Fund & Wildlife, State Wildlife Grant (T07R10) and Purdue University

Project Personnel

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Research Technicians:

Crystal Bevis, captive woodrat husbandry and behavioral analysis, October 2011–present

Trey Smith, captive woodrat husbandry and behavioral analysis, August 2011–present

Jennifer E. Hoffman, monitoring survival of captive-reared and wild-caught woodrats, April 2011–present

Colleen Neiner, captive woodrat husbandry, May 2011–August 2011

Savanna Niec, captive woodrat husbandry, January 2009–May 2011

Jessica Rodkey, captive woodrat husbandry, November 2010–August 2011

Kristen Bahleda, captive woodrat husbandry, October 2009–May 2010

Jennifer N. Hoffman, collection of woodrats from Pennsylvania, October 2009

A woodrat released from the captive breeding program explores its new home in the wild.
Background and Objective(s)

Allegheny woodrats (*Neotoma magister*) are a species of conservation concern throughout their range, with population declines attributed to habitat fragmentation, loss of hard-mast resources, mortality as a result of parasitic infection by raccoon roundworm (*Baylisascaris procyonis*), and loss of genetic diversity and inbreeding depression. Mirroring the range-wide pattern of decline, the abundance of Allegheny woodrats within Indiana has decreased precipitously over the past 30 years. Population monitoring has indicated that, between the early 1980s and 2006, woodrat abundance declined by more than 50 percent, while 13 of 19 subpopulations were extirpated.

Recently, extensive management efforts have been undertaken through a partnership between Purdue University and the Indiana Department of Natural Resources to address some of these concerns for woodrat populations in Indiana. As part of these recovery efforts, we distributed medicated baits throughout woodrat habitats to passively deworm resident raccoons, thereby reducing or eliminating the threat of roundworm infection for woodrats. Additionally, woodrat translocations were conducted in 2007 and 2008 in which individual woodrats were captured from genetically diverse populations in Kentucky and Tennessee, and released into suitable habitats in Indiana. Specifically, woodrats were either released into: (1) previously occupied but currently vacant habitats to re-establish populations (reintroduction) or (2) genetically and numerically depressed populations (supplementation) to improve levels of genetic diversity and the likelihood of maintaining viable populations.

While genetic diversity improved in response to these supplementations, expansive geographic distances between occupied woodrat habitats inhibits the movement of individuals among populations. The spatial isolation of populations results in genetic diversity being lost over time, allowing a lack of genetic vigor to once again threaten the long-term persistence of the species throughout the state. To further address the concerns associated with the loss of genetic diversity among spatially isolated Allegheny woodrat populations, a captive breeding program was established to:

1) Facilitate the retention of the genetic diversity still present within unsupplemented Indiana populations as well as the genetic diversity that was introduced into Indiana through recent translocation efforts.

2) Restore genetic diversity in spatially isolated Indiana populations to levels found within healthy, robust populations. Specifically, we will use optimized mate pairings among woodrats collected from the various isolated Indiana woodrat populations and individuals collected from Pennsylvania to produce genetically diverse offspring. The later release of captive-reared juvenile woodrats into Indiana populations will be used to simulate natural gene flow (the movement of individuals among populations). The inter-breeding between captive-reared individuals and members of the wild populations should help to restore healthy levels of genetic diversity and provide for the long-term persistence of woodrat populations.

Methods

Nine individuals (two males and seven females) were collected from Indiana in 2009 and six individuals (two males and four females) were collected in 2010. Additionally, four woodrats (three males and one female) were collected from genetically diverse populations in southwestern Pennsylvania in 2009.

Captive woodrats are housed independently in wire mesh enclosures (3 feet × 2 feet × 1½ feet) with an external nest box (9 inches × 9 inches × 9 inches). Woodrats are fed a high-quality diet consisting of a mix
of leafy greens, frozen mixed vegetables, a seed mix, acorns, mealworms, and rodent block. Water and timothy hay are provided ad lib.

Male and female enclosures are joined to one another via wire mesh tubes (referred to as “howdy tubes”). One of the two paired individuals has access to the howdy tube, which allows it to interact with the other individual through a wire mesh door. When interactions indicate both individuals are sexually receptive, under the supervision of managers, the wire mesh door is opened to allow the individuals to mate. After approximately a 38-day gestation period, females give birth to two or three pups that remain together as a family group until the pups reach independence after 60 to 65 days.

After weaning, juveniles are released into suitable woodrat den sites within occupied habitat. Immediately before release, we conduct live-trapping at potential release sites to ensure that woodrats are released into vacant den sites. Additionally, about one pound of rodent block (equivalent to about a one-month food supply) is placed within the release site to help ease transition from captivity to wild. Juvenile woodrats born over the winter are held in captivity until April 1 to ensure that woodrats are released into an environment with abundant food resources.

In the first year of the release program (2010), captive-reared woodrats were marked with uniquely numbered ear tags that allowed us to identify them if captured during later live-trap population monitoring assessments. To give us greater resolution of post-release survival, all individuals released in 2011 were fitted with radio-collars. This technology emits a pulse at a specific radio-frequency such that we can use a directional antenna to identify where the woodrat is residing and whether it is still alive. Further, we were interested in determining whether survival rates differed between captive-reared and wild-caught woodrats. Therefore we radio-collared a parallel sample of wild-caught juvenile woodrats and monitored their survival as well.

**Progress to Date**

From February 2010 through October 2011, 13 litters composed of 31 pups were born to seven different dams and three different sires. Of the captive-reared individuals, eight were released in 2010, and 16 were released in 2011. An additional five individuals were born too late to be released in 2011 and will be released in spring 2012. Two juveniles perished before release; one dependent juvenile died of injuries associated with an apparent en-
A radio-collared woodrat at its den site with fresh vegetation cached by the woodrat in the foreground.

A wild-caught Allegheny woodrat is returned to its den site after radio-collaring.

richment accident (2010) while the second weaned individual died of a gastrointestinal infection (2011). In addition to the 24 juveniles that have been released into the wild, five of the original 13 founders were returned to the wild in summer 2010 and in fall 2010 were replaced with six individuals removed from populations throughout Indiana.

Of the 13 individuals (8 juveniles, 5 wild-caught adults) released from the captive population in 2010, one captive-reared juvenile woodrat was captured and one wild-caught adult was captured during 2011 monitoring. In 2011 our intensive monitoring of survival via radio-telemetry revealed differences in the rates and patterns of mortality between captive-reared and wild-caught juveniles (see graph of survival rates for detailed differences between groups). Of the 16 captive-reared juveniles released during summer 2011, radio-telemetry monitoring revealed that four of these individuals survived through the reproductive season (through the 72-day monitoring period), with three of these individuals surviving into fall. From our parallel sample of wild-caught juvenile woodrats, six of the 16 radio-marked individuals survived through the 72-day trial period, with all six surviving into fall. Of the 23 individuals that perished across both groups, mammalian predation accounted for 35 percent of losses and avian predation accounted for 13 percent. The remaining 52 percent was attributable to unidentified causes.

In the captive-breeding facility, we recently developed a closed-circuit television system that allows us to address a number of behavioral questions by passively monitoring woodrat behavior. We use this system primarily to characterize life-history attributes, which would be difficult, if not impossible to address in the wild, and secondarily to evaluate woodrat engagement with various enrichment items in our effort to continuously improve animal well-being. Specifically, we have placed cameras in the nest boxes of lactating females to document patterns in female provisioning from birth through separation (60–65 days), rates of pup growth, and the attainment of developmental milestones (i.e., eyes opening, eating solid food, independently leaving the nest box). To date, we have collected video data on the development of three litters (seven juveniles). The second element of our behavioral research focuses on the response of juveniles to the presentation of various environmental enrichment devices. A rigorous enrichment program is particularly important for juvenile woodrats given that they are more likely to develop detrimental,
stereotypical behaviors than wild-caught adults. Also, by using enrichment to stimulate juveniles in a way that encourages the expression of the full breadth of behaviors exhibited by wild woodrats, we hope to promote post-release survival and reproductive success.

Challenges Encountered

We have had challenges associated with the captive maintenance of Allegheny woodrats. However, we have learned through each of these experiences, improving the quality of care we provide to maximize the well-being of the captive population. We have had minimal mortalities during the program, losing the two juveniles described above and two founding males brought into captivity with the establishment of the program. With lessons learned through the loss of the two adult males, we have modified our woodrat housing to further improve animal well-being and minimize the risk of losing additional individuals.

Given that woodrats are imperiled in the wild, one of our goals with the establishment of the captive breeding program was to minimize the costs to wild populations associated with the removal of individuals. Accordingly, some of the founders of the captive population had sustained injuries in the wild that likely would have been lethal but could be managed in captivity, allowing them to make a positive contribution to woodrat recovery. An ongoing challenge has been managing the special needs of these individuals. Through the tenure of the captive breeding program, we have worked closely with the veterinarians at Purdue’s Lab Animal Programs, and the Small Animal Veterinarian Teaching Hospital to address the health needs of all members of the captive population and maximize their well-being.

Our intensive assessment of post-release survival in 2011 revealed substantial mortality during the first two to three weeks after release. Currently we are considering alternative strategies to ease the transition from the laboratory to the wild for these captive-reared individuals. We hope that by minimizing mortalities through the initial settlement phase we will improve overall survival for the captive-reared individuals, which should help us attain our numeric and genetic goals for the recipient wild populations.

Cost: $631,457.19 total for 2 years