ROLE OF WILD MAMMALS, ESPECIALLY WOODRATS AND BIRDS, IN SEED SURVIVAL: IMPLICATIONS FOR OAK REGENERATION AND CHESTNUT RESTORATION

Current Status
Second year of a three-year project

Funding Sources and Partners
IDNR Division of Fish & Wildlife, Wildlife Diversity Program; Purdue University; The Nature Conservancy

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Background and Objectives
The American chestnut (Castanea dentata) once was the foundation species of much of the Eastern deciduous forest, numerically dominating and defining the ecological function of these habitats. The American chestnut was unique from other mast producers (trees that produce nuts) in both the high quantity and palatability of its annual seed crop. In 1904, the human-assisted introduction of the fungal pathogen chestnut blight (Cryphonectria parasitica) led to the functional extinction of the

An Allegheny woodrat explores an array of available seeds at a feeding station outside his den.
Although blight-resistant chestnuts are 94 percent American chestnut, questions remain regarding their ecological properties, particularly as they pertain to granivores (animal species whose diets consist largely of seeds). It remains unknown whether blight-resistant chestnuts represent an ecological surrogate for the functionally extinct American chestnuts as a desirable and abundant food source for granivores (such as fox squirrel, gray squirrel, chipmunk, white-footed mouse, white-tailed deer, wild turkey, American crow, blue jay and tufted titmouse). Additionally, we have little understanding of the likely responses among the populations of granivore species to the re-establishment of a consistent and prodigious mast producer. Also, preferential seed consumption by granivores that disperse seeds (e.g., the preference of blue jays for acorns of black oaks over those of other oak species) can have profound implications on species composition of the forest. Therefore the shifts in the relative abundances among granivore species and relative preferences of these species for nuts from blight-resistant chestnuts may have important implications for either promoting or limiting expansion of the blight-resistant chestnuts from reintroduction sites.

Given the limited understanding of how the establishment of blight-resistant chestnuts and ensuing increases in mast availability will drive changes among the populations of granivore species, a series of field trials are in progress that will reveal:

1) The preference by granivores for blight-resistant chestnuts relative to other sources of mast (white oak, chinkapin oak, chestnut oak, Northern red oak, black oak, shagbark hickory, pignut hickory and black walnut) commonly available within the historic range of the American chestnut within Indiana;

2) How patterns of seed consumption (and, inversely, potential for germination) may vary across microhabitats as a function of relative abundance/intensity of use by specific consumers and perceived predation risk within these habitat types;

3) How patterns of preference and variable seed consumption rates vary across landscapes and the subsequent impacts to the patterns and rates of blight-resistant chestnut expansion from introduction sites; and

4) How restoration of consistent and prodigious mast resources may impact small mammal population dynamics.

Methods

To meet these objectives, we are conducting the following four independent and complementory seed trials:

1) hard mast preference trials,
2) frequency-dependent mast preference trials,
3) giving-up-density trials, and
4) response of population dynamics of Allegheny woodrats to mast supplementation.

All studies are being conducted throughout forested regions in Harrison and Crawford counties in southern Indiana.

Mast preference trials are addressing patterns of preference by granivores for hybrid chestnuts relative to
other locally available hard-mast food items including white oak, Northern red oak, black oak, shagbark hickory, pignut hickory and black walnut. For these trials we established 30 stations, each consisting of a seed tray passively monitored with a motion-activated camera. At the start of each trial, we presented an array of 63 seeds consisting of equal numbers of the seven seed species listed earlier. Later we used the motion-activated camera to document the pattern and rate in which the seeds were removed by members of the granivore community. Trays for squirrels and chipmunks were left open during daylight hours; trays for mice were left open throughout the night. Closing and opening trays at different times throughout the day allowed us to independently identify preferences of each type of granivore in the community.

After a granivore removes a seed from the tray, it must decide whether to consume the seed immediately or save it for later by burying it in leaf litter or some other available substrate. While we infer preference for the various species of seeds by the pattern of removal from the tray, these two differing seed fates have important implications for forest regeneration. Accordingly, we “tagged” a subset of each species presented to evaluate the fate of the seeds after removal from the tray. Tagging consisted of laterally drilling a small hole through the top of the seed and inserting a wire tied to a piece of fluorescent-colored tape. Seeds were color-coded according to the granivore species for which they were accessible (squirrels, chipmunks or mice). After the seeds were taken from the trays, we visually searched for the tags in the surrounding leaf litter. If a tag was found without a seed, we assumed the seed was eaten, while an intact seed served as evidence of hoarding by the granivore matching the color of the tag.

Patterns of seed preference among granivores have been shown to vary in response to the relative availabilities of seeds of multiple species. Therefore, in our frequency-dependent mast preference trials, we are evaluating shifting patterns in seed predation rates in response to variation in the presented ratios of acorns and chestnuts. These trials will reveal how the restoration of the American chestnut is likely to impact the relative preference for other mast resources. As chestnuts are returned to the landscape, two scenarios of seed preference are possible: 1) consumers may prefer common mast items, such as acorns, which would reduce the loss of chestnuts to seed predation and promote chestnut expansion after initial introductions, or 2) during initial restoration efforts consumers may select novel chestnuts at a disproportionately high rate, hindering restoration efforts by slowing the rate establishment of the new trees and population expansion out of introduction sites. To evaluate this question, we will use methods similar to those described for seed preference trials, but instead of presenting equal numbers of each species of seed on the trays, we will evaluate preferences among three seed species (chestnut, Northern red oak, and white oak) when presented at different ratios. Specifically, we will conduct paired trials for each of these three species (chestnut vs. red oak, chestnut vs. white oak, red oak vs. white oak), evaluating shifting patterns of preference across five different presentation ratios (1:9, 3:7, 5:5, 7:3 and 9:1). The sequence of seed removal by each type of granivore will allow us to assess whether consumer selection of chestnuts is frequency-dependent (that is, dependent on the number of seeds available relative to other types of seeds) and what impact frequency-dependent preference will have for chestnut reintroduction efforts.

The third type of trial, giving-up-density (GUD) trials, was used to evaluate the willingness of a granivore to forage for seeds as a function of predation risk. A small mammal’s perceived predation risk varies across the landscape according to microhabitat characteristics associated with the ability to flee or hide from predators; such attributes include overhead forest canopy closure, density of vegetation in the understory, amount of woody debris on the ground and proximity to the nearest tree trunks. “Giving-up-density” trials are a tool for measuring the density of resources left unconsumed by a forager in an artificial food patch to estimate perceived predation risk. In this case our resource patches consisted of an aluminum pan filled with a known weight of sunflower seeds thoroughly mixed with sand. The amount of sunflower seeds left in the pan reflects a balancing point between the diminishing rewards of continuing to forage in a patch in which food resources are not replenished and a constant level of predation risk. For example, we would expect a squirrel would forage longer (leave fewer seeds in the pan) in an area where it has several options for escape (many small trees with low branches) than it would in an open area with just a few large trees. We presented these resource patches (pans) on elevated platforms or in enclosures to assess the giving-up-density of each type of granivore (squirrels, chipmunks, and mice) independently. Additionally, we monitored each station with motion-activated cameras to confirm species identity and assess time spent foraging vs. the time spent in an upright and alert vigilant stance. Ultimately these trials will allow us to map “landscapes of fear” for consumers and identify specific risky microhabitat types that would be well suited for chestnut introductions.

Before beginning the giving-up-density trials, we sought to quantify each of the microhabitat characteristics that may contribute to a rodent’s perceived predation risk. At the 60 stations distributed across the two sites, we measured the following microhabitat attributes associated with small mammals’ perception of predator risk: 1) we quantified forest canopy closure using a hemispherical camera, 2) mapped the distance from the center of the station (location of the pan) to all trees within a 10-meter radius, 3) measured the height from the ground to the bottom of the tree canopy, 4) estimat-
ed understory density using a 2.5-meter high vegetation profile board, 5) quantify the density of the ground vegetation cover by taking photographs from a “rodent’s eye view,” and 6) measured the length and diameter of all downed woody debris within a 5-meter radius of the station center.

In preparation for the seed trials described, we conducted small mammal abundance assessments at both sites selected for the trials. At each station, we placed two Sherman box traps targeting mice and chipmunks, and a Tomahawk live-trap targeting squirrels.

We trapped small mammals for five consecutive days at each site. We recorded the sex and weight of captured individuals and placed numbered ear tags in each ear for later identification. We found that white-footed mice were present in high densities, while densities of squirrels and Eastern chipmunks were relatively low.

As the final component of these seed trials, we are evaluating the relationship between the extirpation of the American chestnut and the decline of the Allegheny woodrat. Allegheny woodrats are endangered in Indiana and are a species of conservation concern throughout their range. One factor hypothesized to be contributing to the range-wide decline of Allegheny woodrats is a loss of hard mast food resources, a food resource that woodrats heavily depend upon for survival through the winter months. Because oaks are prone to years of mast production failure whereas American chestnuts were a consistent producer of highly palatable seeds, it is possible the restoration of the American chestnut could facilitate the recovery of Allegheny woodrats. To evaluate the relationship between hard-mast availability and woodrat recovery, we are supplementing the winter caches of woodrats by depositing 1 kg of acorns in occupied woodrat den sites. Specifically, the eight woodrat populations were divided equally among the four different mast supplementation treatments: 1) supplemented both years (2011 and 2012), 2) unsupplemented in 2011 and supplemented in 2012, 3) supplemented in 2011 and unsupplemented in 2012, and 4) unsupplemented in both 2011 and 2012.

Contemporaneous monitoring of woodrat populations through 2011, 2012 and 2013 will allow us to discern the effect of mast on such traits as reproductive success, over-winter survival, and population growth. Receiving this pulse of acorns simulates a highly productive oak mast year or expected ambient mast availability once chestnut has been fully restored. To gain additional insight into woodrat seed preferences, we ran an extra set of seed preference trials specifically targeting woodrats. Seed stations were set up outside occupied den sites, and again the pattern and rate of seed removal was documented.

Progress to Date

We have completed GUD trials at two sites and seed preferences trials at one site. Additional seed preference trials and the frequency-dependence trials were scheduled for completion in late fall 2012. Allegheny woodrat live-trapping for population monitoring was conducted in 2011 and 2012 among all sites that were incorporated in the hard-mast supplementation study. Beyond allowing us to quantify the changes in population attributes listed earlier, these surveys also allow us to identify occupied den sites for the delivery of acorns in the next fall. Mast supplementation has now been completed in both 2011 and 2012. Population monitoring in 2013 will allow us to complete this experiment.

Challenges Encountered

The main challenge associated with beginning the series of seed trials has been developing a station infrastructure to both suit our purposes and remain functional. Because of the large scale of the station grid setup, we needed equipment that was manageable to carry yet robust enough to support a foraging squirrel or exclude a persistent one as well as withstand inclement weather. Fine-tuning the motion-activated cameras also presented some difficulty. In order to get the quality of images we needed to document seed selection events, we had to fine-tune camera focal distances and the placement of seed trays under the cameras over several successive test runs. Once our stations were up and running, attracting visitors to them also proved difficult. While mice visited several of our stations, squirrels and chipmunks scarcely appeared. In 2012, we will run our trials at sites where diurnal granivores are known to be present in greater abundance, and we will run fewer stations in any given site in order to spread the trials out further in space and time.

One additional challenge we encountered in 2011 was the availability of seeds for use in our trials. With only a moderate crop of black and Northern red oak and a failure of white oak and hickories in 2012, we had to be creative in locating seed sources. Although we were able to collect some of our seeds from our study sites, we had to obtain most from various distributors and unfortunately had to eliminate two of the oak species (chinkapin oak and chestnut oak) we had originally planned to include in the seed preference trials. We will include these species in the 2012 seed trials.