

THE  
**J**ournal  
OF THE AMERICAN CHESTNUT FOUNDATION

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**Special Issue: Wildlife and Chestnuts**

**West Salem Mast Study**

**Seed Preference Among Small Mammals**



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Restore the American chestnut tree to our eastern woodlands to benefit our environment, our wildlife, and our society.

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**About Our Cover Image**

Our cover this month shows some of the many types of wildlife that in one way or another will be impacted by the return of the American chestnut. Clockwise from the upper left: Black bear sow and cub; photo courtesy of www.natureexposure.com. Eastern grey squirrel nibbles on a chestnut in a chestnut tree; photo by Mark Moore. Two wild turkey gobblers cross a sunlit meadow; photo courtesy of The National Wild Turkey Federation. Three American chestnut seeds on the forest floor; photo by Annie Spikes.

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Background photo: Chipping Sparrow on a Chestnut Tree  
Photo by Mark Moore



## It's What's for Dinner

Dr. Kim Steiner and Bryan Burhans

The loss of the chestnut in our eastern woodlands was devastating to small rural communities where the economic base was thin. Harvesting and selling chestnuts provided meaningful income for many rural residents. Chestnuts were even bartered for staples, like butter and milk, that the family did not produce at home.

However, wildlife also suffered from the chestnut's demise. Unfortunately, the field of wildlife management was not even launched until 1933, so we have little information on the effect of this loss on wildlife, and much of what information we have is either anecdotal or extrapolated from available data.

But we do know that the loss of chestnut had a major impact on forest wildlife. The little white-footed mouse, for example, formed an important food base for predatory species like foxes, owls, hawks, and snakes. Without the consistent and abundant nuts from chestnut, these common woodland mammals likely suffered large changes in population levels. And as the number of these mammals ebbed and flowed, this likely had a ripple effect on their predators. With the loss of the chestnut an entire food chain was dramatically altered.

Many other forest wildlife species suffered as well, although some are today at all-time population highs, such as turkey, bear and deer. The wild turkey, for example, is currently at population level 20 times their turn-of-the-century numbers. Although the reason for this increase has nothing to do with the loss of chestnut, it does raise an interesting question: what will the restoration of the American chestnut do to wildlife populations?

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“We do know that the loss of chestnut had a major impact on forest wildlife. The little white-footed mouse, for example, formed an important food base for predatory species like foxes, owls, hawks and snakes.”

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No doubt, the return of the chestnut will be a benefit. The reproductive rates of many species may increase in response to the expanded food supplies provided



Wild turkeys walk through a meadow in early morning light. Studies have shown that wild turkeys have a distinct preference for American chestnut as a food when it is available.

Photo courtesy of The National Wild Turkey Federation

by the tree. With more chestnuts come more white-footed mice, and more white-footed mice provide more meals for predators. More food for deer might mean less browsing on understory vegetation and thus more habitat and food for other species. Perhaps even the loveable Allegheny woodrat, which is threatened or endangered in nearly every state where it is present, might recover to its former numbers. The American chestnut's abundant and nutritious nuts, along with its ability to produce consistently from year to year, will increase the carrying capacity for woodland wildlife.

The return of the chestnut will only represent part of the potential benefit. How we manage our forests will also have a dramatic impact. Oak species currently provide a critical food source for wildlife. However, over the last 90 years, many of our forests have slowly transitioned to shade-tolerant tree species such as ash and maple, a phenomenon that seems to be tied to the systematic exclusion of fire. These shade-tolerant tree species don't offer the same level of wildlife food as oaks. Managing our forests to sustain oak dominance where appropriate – and, where possible, intermingled with American chestnut -- will provide tremendous benefits to forest wildlife.

Chestnut--it's what's for dinner for the critters that call our forests home. Well-managed, diverse woodlands that include chestnut offer the prospect of a bright future for our wildlife.

## Southwest Virginia Restoration Branch Volunteers to Assemble American Chestnut Learning Box Version 2

Submitted by Kathy Marmet, Co-Chair of the TACF Education Committee

A group of Southwest Virginia Restoration Branch volunteers will play a key role in distributing Version 2 of TACF's American Chestnut Learning Box. The new version is due to be released in March.

The American Chestnut Learning Box is a collection of printed materials and physical items, including nuts, burs, leaves, a chestnut "tree cookie," blocks of different types of wood, and tree sections showing inoculation sites and chestnut blight, which offer a hands-on learning experience. The Learning Box was developed by the Education Committee of TACF's Development Cabinet, with the first version distributed to each of TACF's state chapters and regional science staff in 2010. Volunteer Tommie Pratt is coordinating the assembly of Learning



Southwest Virginia Restoration Branch volunteers organized a teacher in-service training, focusing on integrating chestnut education into the classrooms, at Meadowview Research Farms. Here, volunteers Craig Ashbrook and Myra Orr participate in the training along with 10 local educators.

Photo by Tommie Pratt

Boxes with Branch members Myra Orr, Nancy Hagen, and Craig Ashbrook, all of Southwestern Virginia, with support from TACF intern Zach Starsia.

If you are interested in purchasing a Learning Box Version 2, contact Mila Kirkland at [mila@acf.org](mailto:mila@acf.org) or call (828) 281-0047.



Road Scholar participants take a break in the shade of an American chestnut tree at Meadowview Research Farms.

Photo by Fred Hebard

participants. The visit to Southwest Virginia also includes entertainment at the world famous Barter Theatre, sightseeing around historic Abingdon, and a stroll down the Virginia Creeper Trail.

For summer 2013, the dates for this program are June 2-7. If you would like to learn more about participating in the Road Scholar program in Meadowview, visit <http://www.roadscholar.org> and search for keyword "American chestnut."

## Road Scholar Program - Adventure to the Epicenter of American Chestnut Restoration

For almost 15 years, attendees of the Road Scholar program, created by Elderhostel, Inc., have been traveling to the epicenter of American chestnut restoration at TACF Meadowview Research Farms in Meadowview, Virginia, to experience firsthand and personally participate in the tree's amazing comeback story. The Road Scholar program is a non-profit organization that promotes lifelong learning opportunities giving adults and youth the opportunity to travel and participate in educational programs on a variety of topics.

Road Scholar's "Restoration of the American Chestnut Tree" program is hosted by the Southwest Virginia 4-H Educational Center in nearby Abingdon, and during their week stay, scholars assist in performing disease inoculations on backcross American chestnut trees at Meadowview Research Farms, a precise exercise that requires teamwork among two or more



With generous support from Mr. Fred Stanback and his family, Jennifer Santoro will intern this summer with the Virginia Chapter. Photo by Ansel Bubel

### Meet Jennifer Santoro, the 2013 Forest Restoration Intern with VA-TACF

TACF is excited to welcome Jennifer Santoro as the 2013 Forest Restoration Intern, a position made possible by the generous contributions of Mr. Fred Stanback and his family to Duke University's Nicholas School of the Environment. Jennifer is a second-year Masters of Forestry and Masters of Environmental Management student at Duke's Nicholas School of the Environment with a focus on forest restoration, land management, and geospatial modeling.

Jennifer will begin her internship with the Virginia Chapter around third week of May and spend the summer immersing herself in American chestnut biology and restoration by participating in all aspects of the Virginia Chapter program. She will also be assisting with the Appalachian Trail Mega-Transect Chestnut Project, which trains citizen scientists to collect vital data on American chestnut trees growing along the trail.

Encouraged by her father to appreciate nature, Jennifer remembers the first American chestnut tree she found in Helyar Woods on the Rutgers University campus. "I remember being in awe at the green spiky shells," she says. "I am in love with the American chestnut because I feel it is our last remaining connection to the old-growth forests of the eastern US."

### NRCS Conservation Innovation Grant Plantings Expand to Mid-Atlantic Region

Before the snow was off the ground, volunteers in Virginia and West Virginia were planting Restoration Chestnuts 1.0 by the hundreds and adding their states to the list of TACF Conservation Innovation Grant (CIG) restoration sites. On March 2, approximately forty volunteers and organizers gathered at a reclaimed surface mine site in Dickenson County, VA, to plant 625 chestnuts. One week later, a group of thirty-nine planted 625 chestnuts on a site near Cowen, WV.

These plantings are part of a large-scale, multi-year project by TACF to reforest 12 reclaimed mine sites throughout five states (PA, OH, WV, VA, KY), funded in part by a Conservation Innovation Grant from the USDA Natural Resources Conservation Services (NRCS). Over a three-year period, approximately 250,000 seedlings, including more than 14,000 blight-resistant American chestnuts, will be planted by TACF and project cooperators on a total of 360 acres. This project is the largest planting of potentially blight-resistant American chestnut trees in the Foundation's history and marks a milestone in the restoration of this once-dominant native tree.

"This NRCS grant is allowing us to demonstrate how our Restoration Chestnuts 1.0 perform on reclaimed mined lands," said TACF Forester Michael French, who



TACF Forester Michael French gives instructions for planting chestnuts on the reclaimed mine site in Dickenson County, VA. Photo by Matt Brinckman

heads up the CIG project. "TACF, Appalachian Regional Reforestation Initiative (ARRI), and NRCS can show landowners how to return their mined lands to productive forest for wildlife benefits, improved water quality, aesthetics, and future timber values."

We'd like to thank our partners who made these plantings possible: Virginia Department of Forestry, ARRI, Green Forests Work, Southwest Virginia Restoration Branch of TACF, Virginia Boy Scout Troop 604, Glenville State College, WV Chapter of TACF, NRCS, and the USDA Forest Service.

### Coming of Age: The Ozark Chinquapin Foundation Applies for 501(c)3 Status

The Ozark chinquapin (*Castanea ozarkensis*) is a medium-sized forest tree native to portions of Missouri, Arkansas and Oklahoma. It was devastated by chestnut blight in the first half of the 20th century, along with its relative the American chestnut. Over a decade ago, a group of outdoorspeople undertook an effort to restore the species and formed the Ozark Chinquapin Foundation (OCF). They now have several successes under their belt such as pollination crosses yielding potentially blight-resistant seed and the establishment of test plots in Arkansas and Missouri.

Recently, the OCF took their efforts to a new level by establishing a board of directors and pursuing 501(c)3 non-profit status. "As an organized group," says OCF founder Steve Bost, "we will have a wider exchange of ideas, the scope of the group's research will be enhanced,

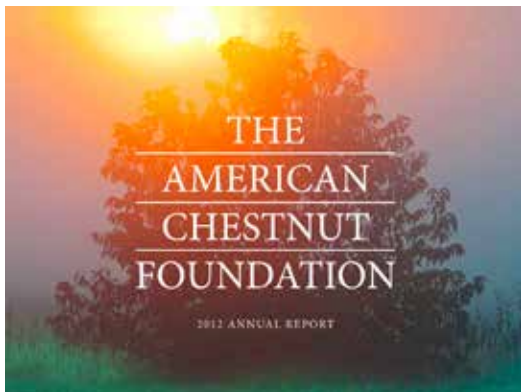


It's a rare sight to see ripe Ozark chinquapin nuts about to fall to the ground and not yet found by birds or squirrels.

Photo by Steve Bost

and the ultimate goal of restoring the Ozark chinquapin to its native range can become more than a dream."

The public can participate by notifying the OFC of fruiting Ozark chinquapins, sharing seed for research, and volunteering time and land for test plots. For more information, visit the OCF website at <http://www.ozarkchinquapin.com> or contact Steve Bost at [stvbost@yahoo.com](mailto:stvbost@yahoo.com).



### 2012 TACF ANNUAL REPORT

The TACF 2012 Annual Report is hot off the presses! Covering fiscal year 2012 (July 2011 to June 2012), the TACF Annual Report is designed to give readers a fast, easy-to-read overview of TACF's projects, goals and progress for the year. If you would like a copy of the report, please call the national office at 828-281-0047. You can also obtain a digital copy online at <http://www.acf.org/annual.php>.

### In Memory of and In Honor of Our TACF Members January/February 2013

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*James Craddock and Thelma Fenster*

**David E. Bowser**

*Thomas Berrett  
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Sarah Mitchell*

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Michael and Sandra Wagoner*

**Charles Wm Ebersole**

*Michael Ebersole*

**William Peifer**

*Mary and Blair Carbaugh*

**Louise Scoval**

*James Scoval*

#### In Honor of

**Stacy Christensen**

*Carolyn Eisenberg*

**David Vaughn**

*Camellia Garden Club*



## TACF Honors Its Volunteers

### Bucky Owen

By Glen and Ann Rea, ME-TACF, and  
Mila Kirkland, TACF staff

Bucky Owen of Orono, Maine, is the force behind the Maine Chapter's wildly successful Restoration Branches. Bucky, and his wife Sue, joined the Maine Chapter of TACF six years ago, and the chapter's mission to restore the American chestnut to the woods of Maine has fit quite well into his life-long commitment to wildlife conservation.

Bucky earned a BS in biology from Bowdoin College and a PhD in ecology from the University of Illinois. He was a professor at the University of Maine for over thirty years, and chaired the Wildlife Ecology Department for a decade. During that time, Bucky played a significant role in restoring both the bald eagle and the Atlantic salmon to Maine, and he has received many honors for his tireless conservation work.

In addition to his work on Restoration Branch events, his leadership and fundraising skills have been critical to the start-up of ME-TACF seed orchards. Bucky also serves on the chapter's board of directors and volunteers



Bucky Owen is well known for his tireless work on behalf of conservation causes including The American Chestnut Foundation.

Photo courtesy of the Atlantic Salmon Federation

his time for their activities, such as pollination, planting, and inoculations. "When everyone is getting tired during a work project," said Ann Rea of the Maine Chapter, "Bucky can re-energize us with a joke, a story, or some encouraging words."

"The word that comes up when you talk about Bucky is 'restoration,'" said Glen Rea, Maine Chapter president. "First the bald eagle and the Atlantic salmon, and now the American chestnut tree. When he gets involved in a project, he contacts his many friends and gets them involved as well."



Georgia Chapter President Joe Nicholson presents Steve Wallin with the Volunteer of the Year award for his dedication to the Georgia chapter.

Photo by Tom Saielli

### Steve Wallin

By Mila Kirkland, TACF staff

Originally from Minnesota but now living in Marietta, Georgia, Steve Wallin occasionally wonders about the work and lives of his fellow Minnesotans. That's what he was researching in 1997 when he came across writings by Charles Burnham, including Burnham's plan to restore the American chestnut using backcross breeding. Steve was reminded of his mother's passion for collecting American chestnut farm furniture in the late 1940s and 50s, and he decided to join TACF.

Steve regularly travels to work in Georgia's state chapter orchards. Just this spring, Steve went to the chapter's Restoration Chestnut orchard near Lake Allatoona for orchard maintenance and mortality replacement. In 2012, he was named the Georgia Chapter Volunteer of the Year.

"Steve is an eager volunteer in helping plant chestnut seeds in our chapter orchards, in collecting wild pollen, or harvesting chestnuts," said Georgia Chapter President Joe Nicholson. "He has driven many miles by himself to help and always shows up with a great disposition."

Steve is retired from 25 years in the Navy and 25 years with Lockheed Martin as an engineer and strategic planner. When he isn't volunteering with TACF, he works on various projects around the house, including building an airplane in his basement. He also enjoys sailing on Lake Lanier.



The white-tailed deer is one of the largest mammals that favors American chestnut as a food when it is available. The bane of chestnut growers, deer will also browse on the leaves and tender stems of the tree.

Photo: Thinkstock/Brandon Smith

## Chestnuts and Wildlife

### **Chestnuts Once Played a Key Role in the Eastern Forest Food Web. What Does The Future Hold?**

Katie L. Burke

Chestnut saplings are a delectable treat to a wide variety of wildlife, as any TACF grower will tell you. Animals of every stripe and feather seem to want to dine on chestnuts. Deer are at the ready to nibble saplings to the ground; voles are quick to find and dine on young, tender roots; and a host of critters including raccoons and crows will get into the act, digging up and ingesting the seed, before it even germinates! This is not, however, strange behavior. It simply reflects the pre-blight era of a century past, when birds and mammals of all kinds depended on American chestnut to provide the largest and most consistent feast in the eastern forest.

Animals that depend exclusively on nuts, or mast, for food are called granivores, and these animals once relied heavily on chestnut in eastern deciduous forests, as did other herbivores and omnivores that partook of the high-fat, high-calorie nuts in the autumn and winter. This group of chestnut consumers included rodents such as the fox squirrel, gray squirrel, chipmunk, white-footed mouse and Allegheny woodrat; birds such as the wild turkey, American crow, blue jay, tufted titmouse, ruffed grouse and the now extinct passenger pigeon; and even larger mammals, such as the white-tailed deer and black bear. Populations of these animals

have all undergone drastic changes over the past century, and many factors appear to be involved: habitat loss, fragmentation, overhunting, decreases in top carnivores. But it makes sense that the loss of one of their main food sources also played a role in these dynamics.

When chestnut declined in eastern forests, and was reduced primarily to a shrub layer by chestnut blight re-infections, other trees grew in its place. Chestnut, a generalist tree that can grow in a wide variety of conditions, was not replaced by one single tree species. In many forests, trees that filled the void left by chestnut included, perhaps fortuitously, other nut-producing trees, such as northern red oak, chestnut oak, hickories and beech. But not all nuts are created equal. Each species differs in timing of ripening and germination, year-to-year crop reliability, nutritional values, size, shell hardness and taste.

American chestnut produced more mast than other forest trees, according to estimates based on pre-blight information. One study, published in 2000 by Seth Diamond, Robert Giles, Roy Kirkpatrick and Gary Griffin of Virginia Polytechnic Institute and State University,

extrapolated that hard mast production decreased 35% following chestnut's decline. This estimate was calculated from the basal area of forest tree species measured first in 1934 and again in 1964 at Coweeta Hydrological Laboratory in western North Carolina. Hard mast production from other forests of similar composition was used to estimate the mast production at this site because few mature chestnuts existed after the blight pandemic, and no one had thought to directly measure chestnut mast production before that.



A gray squirrel sits in a chestnut tree, eating a chestnut. Gray squirrels are among many small mammals that have a mutual relationship with chestnut. Not only do they eat and get nutrition from the chestnut, but their habit of “caching” is one of the primary ways that the seeds get spread to new areas where they can grow.

Photo courtesy of Mark Moore

Brian McCarthy of Ohio University saw the opportunity for collecting this information in West Salem, Wisconsin, which lays claim to a stand of mature chestnuts, one of the few such forests known in North America. His recent study, in collaboration with Keith Gilland of Ohio University and Carolyn Keiffer of Miami University (Gilland, Keiffer and McCarthy 2012), announced that these mature chestnuts produced much higher amounts of mast—on the order of ten to one-hundred times as much—than the next highest nut-producing trees, northern red oaks. Because the West Salem stand is small and was followed for only two years, we still do not know how chestnut mast production varies with environment and climate; nevertheless, the study demonstrates that chestnut could have been a much more important food source than previously believed. “Where oak, hickory and chestnut coexisted, chestnut likely produced over 80% of the hard mast in any given year,” McCarthy (2013) explained.

**Table 1**

Tree	Flowering Time	High-Mast Crop Frequency (years)	Nut Harvest Time
American beech	Apr-May	2 to 8	Sep-Nov
American chestnut	May-Jun	1 to 2	Sep-Oct
Hickories	Mar-Jun	1 to 3	Sep-Oct
Northern red oak	Apr-May	2 to 5	Aug-Oct

Source: Burns and Honkala (1990A).

In addition to producing more mast, chestnut was the most reliable of all the nut-producing trees in the eastern forest. Because of its relatively late bloom, it could produce mast despite late-spring frost, unlike almost all other mast food sources. Many other trees, including oaks and hickories, avoid the effects of granivores eating all their nuts by surprising them with intermittent high-mast years. A series of bad years keeps the animal population in check, so that there aren't enough to eat all of the mast in

a good year. In contrast, chestnut does not fluctuate in mast production as drastically as other mast-producing trees (Table 1).

It's easy to speculate, but we can't replay the past and monitor what was never monitored, such as long-term chestnut mast dynamics and animal population sizes before the blight. With the advent of faster computers in the past few decades, researchers can use computer models to extrapolate potential scenarios, given what we know about which trees were where and who eats what. Harmony Dalglish, now at the College of William and Mary, and Rob Swihart at Purdue University recently used a computer model to test the effects of mast dynamics with and without chestnut on population sizes of four mammals that rely on mast for food: white-footed mouse, eastern chipmunk, gray squirrel and white-tailed deer (Dalglish and Swihart, 2012). They found that without chestnut, population numbers decreased and were also more variable from year to year. Of the four mammals tested, white-footed mouse



Common eastern forest mast. A pure American chestnut (*Castanea dentata*) seed (far left) is pictured along with currently available sources of mast, such as (top to bottom) northern red oak (*Quercus rubra*), chestnut oak (*Quercus prinus*), white oak (*Quercus alba*), black walnut (*Juglans nigra*), chinkapin oak (*Quercus muehlenbergii*), pignut hickory (*Carya glabra*), black oak (*Quercus velutina*), and shagbark hickory (*Carya ovata*).

Photo by Annie Spikes

## Mast Nutrition Facts

If you were offered the choice between eating a chestnut and eating an acorn, which would you choose? Acorns are bitter, requiring soaking before people will use them in recipes and dishes. Their bitter taste is because of their high tannin content. Chestnuts come readymade for eating because they have virtually no tannins. They are tasty. In addition to making acorns taste bitter, tannins also are thought to reduce a mammal's digestive efficiency, particularly with respect to proteins (Vander Wall, 2001). Humans aren't the only species that prefer chestnut to acorns and other mast. William Minser and colleagues in the Department of Forestry, Wildlife and Fisheries at the University of Tennessee showed that American chestnuts are a preferred food of wild turkeys (Minser, Allen, Ellsperman and Schlarbaum, 1995). Preliminary work by Rob Swihart and collaborators corroborates that many native rodents prefer chestnut to many acorns and other mast.

### Nut Meat Nutrients

Tree	Calories per 100 grams <sub>1,2</sub>	Fat (% dry weight) <sub>2,3</sub>	Protein (% dry weight) <sub>2,3</sub>	Carbohydrates (% dry weight) <sub>2,3</sub> **
American beech	568	10.6 %	7.8 %	6.5 %
American chestnut	377	2.3 %	8.4 %	82.9 %
Hickories ( <i>Carya ovata</i> , <i>Carya glabra</i> )	631 to 673	20.0 to 74.4 %	5.9 to 13.3 %	8.8 to 13.0 %
Northern red oak	486	18.9 to 20.8 %	5.3 to 7.0 %	67.1 to 69.1 %
Chestnut oak	431	5.1 to 10.1 %	5.8 to 6.9 %	78.9 to 83.2 %

<sup>1</sup>Krochmal and Krochmal (1982). <sup>2</sup>Vander Wall (2001). <sup>3</sup>Williams (2007).

\*\* Carbohydrates as measured by nitrogen-free extract, which includes starches, cellulose and tannins.

Chestnuts have low fat content but high carbohydrate content, most of which is starch. Fat and carbohydrates are energy-producing molecules important to mammals, but fat conveys double the kilojoules of energy than do carbohydrates. With their higher fat content, acorns provide to an animal more than double the amount of energy compared to chestnut. At first glance, it appears that acorns are a great food source for wildlife—and they are—with the caveat that they are more unpredictable year-to-year, bitter and lower in digestion efficiency in comparison to chestnuts.

Chestnuts also have high water content (44 %) compared to other mast. Higher water content in nuts is associated with higher carbohydrate and protein content but with lower fat content. The water content is especially important for nut dormancy and germination, which affects its palatability to wildlife. "It's not just the chemical composition and the calories that matter. It's not just the tannin content. Differences in dormancy status and physical attributes also seem to be important to the choices of the animals that are eating and dispersing the seeds," Swihart said. Because of its high water content, cached chestnuts may last longer as a viable food source for wildlife than other nuts.

More research is needed on chestnut nutrition and its impact on wildlife populations, but for now the existing information clearly indicates that chestnut trumps other native nuts in flavor, water content (or "shelf life"), starch, digestibility, production and reliability.

populations were the most affected by the loss of chestnut. Population increases in rodents can be a two-edged sword. Higher numbers of white-footed mice and chipmunks for instance, have been associated with reduced outbreaks of gypsy moth, a moth that can decimate hardwood forests, but also with higher prevalence of Lyme disease. Evidence thus far suggests

that chestnut's presence in eastern forests increased mammalian population numbers and maintained their stability.

Restoring chestnut to the eastern deciduous forests could ameliorate the boom-and-bust cycles in small mammal populations that are timed to oak and hickory



What will the effect of the restoration of the American chestnut have on populations of small mammals like the white-footed mouse? Current research is looking for answers to questions like this.

Photo courtesy of Seth Patterson

masting. This added stability could also balance population numbers of top predators that eat these small animals. The passenger pigeon, Carolina parakeet, eastern cougar, red wolf, and Allegheny woodrat, some of the major wildlife extinctions or widespread declines from eastern forests in the 20th century, relied on chestnut for food directly or indirectly. Although the loss of the chestnut may not have had any impact on their decline, the question remains: would these animals be able to survive in today's forest if chestnut mast were restored? The answer to this is elusive. As Swihart (2013) said in a recent interview, "What was competition like 100 years ago? What were predator-prey interactions like then? We just don't know."

Granivores needed chestnut for food, but chestnut also needed them. The granivores spread the seeds and buried them in caches where they could germinate. So, when does granivory result in a net loss (too many seeds eaten) versus a net gain (seeds dispersed and planted)? "The relationship between rodents and chestnut dispersal is conditional on the probability that a seed that is cached by a squirrel or other animal is not recovered," Swihart explained. He is collaborating with Harmony Dalglish, Mike Steele of Wilkes University and Nate Lichti of Purdue University to study factors

influencing seed dispersal and germination. "The question that we have been grappling with is to what extent might the attributes of chestnuts and other seeds influence how often and how far they're moved by these different jays, squirrels and other animals?"

Although chestnut conservationists currently must keep hard-earned backcrossed and blight-resistant chestnuts pampered and protected in orchards, the ultimate goal in restoration is that the tree be part of its ecosystem again, part of the give and take of the food web. To accomplish this goal, chestnut's relationship with wildlife must be understood and appreciated.

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# Seed Selection and Small Mammals

**How an Indiana Wildlife Study May Help Us to Understand the Impact of Chestnut Restoration On The Forest of The Future.**

By Paul Franklin

Rita Blythe arranges tagged seeds on a presentation board in preparation for a preference trial.



In the early morning hours of a cold November day, two women move quietly through the woodlands along the Ohio River in Southern Indiana, setting out a feast for as yet unseen guests. The women are wearing headlamps to facilitate working in the dark, and carrying handheld GPS units to navigate. There are more feasts to arrange – thirty feeding stations in all, scattered throughout the surrounding forest. Hands numb with cold, graduate student Rita Blythe arranges a variety of seeds in numbered holes on a “presentation board” roughly three feet square, while research technician Jen Hoffman calls off positions by letters and numbers, like some early morning forest bingo game, telling Rita which seeds are to go into which holes. Each board takes sixty seeds, and there are thirty boards, which means the women must set and record 1800 seeds before sunrise, when the daytime feeders will become active.

As each feeding station is filled, they turn on an overhead motion-sensitive digital camera to record visitations by squirrels, chipmunks, mice and, if they are lucky, a rare and endangered Allegheny woodrat. The cameras will record each mammalian visitor, but more importantly the camera will show which seeds are selected first and which are left behind.

Although the seeds and the mammals may be small, the questions that this research is trying to answer are large and profound. Some of the seeds on the tray are American chestnuts. The test uses both “pure Americans” from trees like the billions that were lost to the blight, and more advanced and potentially blight-resistant

seeds from TACF’s backcross breeding program, which offer the hope of bringing this once dominant and highly productive food source back to the eastern forests.

In its broadest sense, this study will add to our understanding of how the return of a major food source might impact the ecology of the forest, and in particular, the communities of animals that use that food source. This is not as simple a question as it might seem. The forest today has changed significantly since the American chestnut all but vanished from the scene. “We know that as the chestnut disappeared, it was replaced by other mast-producing trees,” says Dr. Robert Swihart of Purdue, one of the project’s lead investigators, “predominantly oaks, but also beech, hickory, black walnut, and others. Chestnut’s advantage is that it offered the largest and most consistent supply of mast of all these trees. For the past century, wildlife species have coped with acorns as the dominant food resource, and acorn crops can vary wildly in reliability from year to year. So the question is: How could a more reliable chestnut-dominated food source affect patterns of wildlife abundance, competition and predation?”

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Chestnut’s advantage is that it offered  
the largest and most consistent  
supply of mast of all these trees.

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A fox squirrel (*Sciurus niger*) takes off with a black walnut seed selected from the board below. Photo captured by motion-activated camera

But the study is not only about how chestnuts might affect wildlife. It also looks at how, and under what conditions, small mammals may play an important role in facilitating the restoration of the chestnut. Like most forest trees, the chestnut's ability to spread, and therefore survive as a species, depends on dissemination of its seeds to some distance from the parent tree. Chestnut seeds do not drift on the wind or attach themselves to birds and animals for a free ride. Instead the chestnut depends in part on the caching of seeds by small mammals. If the seeds are buried and not recovered at a later date, they have a chance to germinate away from the parent tree.

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Although the seeds and the mammals may be small, the questions that this research is trying to answer are large and profound.

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But how do you learn if a seed taken by a small granivore, such as a chipmunk, has been eaten or cached? The answer is by tagging. "One of the most time-consuming jobs in this study," says Blythe, "was carefully drilling holes in thousands of seeds and attaching a small flexible wire, which has on the end of it a highly visible tag." Each tag contained information on the type of seed, whether the test it was used in was nocturnal (nighttime) or diurnal (daytime), and the feeding station it came from. The researchers regularly searched the area for these tags and when

one was located, they recorded its position and how far it had been taken from the board it came from. "One of the things we want to know more about," says Blythe, "is whether there are differences in how many chestnuts are eaten or cached in different scenarios. Does it matter how much other food is available, or how many of what variety of other seeds are available?"

One of the granivores that is of particular interest in the study is the Allegheny woodrat. "Allegheny woodrat numbers in parts of the eastern forests have dropped significantly," says Swihart. "It may be the most endangered species of mammal in Indiana." Several theories about why the Allegheny woodrat population has dwindled have been suggested, including the effects of parasites and habitat loss. But some have suggested that a contributing factor has been the loss of the chestnut. Currently the researchers are undertaking population studies of the woodrat in southern Indiana, and they are also simulating large-scale mast fluctuations by supplementing woodrat den sites with large quantities of hard mast, to see if this affects the woodrat's ability to survive and reproduce. "The big question," says Dr. Swihart, "is could the restoration of the American chestnut be beneficial to the Allegheny woodrat?"



Different seed types presented in a random order allow a granivore to make choices based on preference.

Photo by Annie Spikes



A seed preference trial set up outside a known woodrat den site.  
Photo by Rita Blythe

“One of the most interesting things to me about this study,” says Blythe, “is studying a natural system as a web rather than a series of interactions pairs. The time component is also intriguing, because we are trying to predict the effects of a major compositional shift in the community we are studying, one that the landscape may not realize for many, many years.”

Studies like this one take effort and dedication on the part of all the researchers. “Setting up our 30-station grid during the 2011 season was a lot of hard work and took my crew and me several days to accomplish,” says Blythe. “We had to carry a lot of bulky equipment into the woods and install it, but we were rewarded with an almost immediate response. On the morning after the first nocturnal trial, we were surprised to see that several stations had been visited by small mammals, and the seeds missing did not appear to be random at all. For example, one board had every chestnut and shagbark hickory missing and everything else was still in place.”

Not all of the target mammals were eager to make an appearance, however. Blythe noted that wild squirrels were particularly reluctant to participate in the experiments. “We learned that the stations needed to be set up and ‘pre-baited’ with attractive bait like apples and peanut butter sandwiches for several weeks before the squirrels became comfortable with the food source and would cooperate in the preference trials.”



These northern red oak (*Quercus rubra*) seeds are tagged with brightly colored tape to allow them to be easily recovered after being cached by a granivore.

Photo by Annie Spikes

The final results of this research will not be available until late 2014. In the meantime, if you are in the southern Indiana woods and come across a board in a cage that holds sixty or so seeds, you can smile knowing that researchers are still probing the mysteries of the forest of the future. “I am drawn to this research,” says Blythe, “because I believe that we cannot fully appreciate natural systems until we understand how they work. We need to think about how they may have worked in the past and how human actions have interfered with their function. Developing an informed vision of how they can work in the future means considering all the factors affected by the positive changes we are facilitating, such as, in the case of this study, how wildlife communities might respond to the restoration of a functionally extirpated tree species.”

*(Ed. The Journal will publish a summary of the results of this study when it becomes available. Our thanks to Dr. Rob Swihart, Rita Blythe, post-doctoral associate Tim Smyser, and their team – Jen Hoffman, Annie Spikes, Kyle Leffel and Kristine Harman– for their efforts on this project. Funding for the study is provided by the Wildlife Diversity Program of the Indiana Department of Natural Resources Division of Fish & Wildlife through the Nongame Fund and the State Wildlife Grant program, with additional support provided by The Nature Conservancy and Purdue University.)*

# Seed Production of Mature Forest-Grown American Chestnut

(*Castanea dentata* (Marsh.) Borkh)<sup>1</sup>

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Mature American chestnut, West Salem,  
Wisconsin. Photo by TACF staff

Foresters, ecologists, and wildlife biologists have known for quite some time that American chestnut was a prolific producer of hard mast. However, since the species went functionally extinct from the canopy prior to the advent of modern ecological methodologies, there was never a study designed specifically to examine the relative production of mast among co-occurring hardwoods. This

study examines the production of seed crops over a two-year period in the West Salem, WI, stand of American chestnut, just prior to it being severely affected by drought and blight. Our data show well over a 10:1 ratio (perhaps as high as 50:1) of chestnut seed production compared to all other hardwoods combined in the stand. These data confirm prior observations and provide practical estimates of mast availability following successful restoration of the species. However, as a caveat, these data are only from one stand, well outside the natural range of the species, that was already experiencing stress (which may have affected normal patterns of reproductive allocation). That said, the estimates are still very encouraging, even when assuming large variation. ~ Dr. Brian C. McCarthy

After decline due to the blight, American chestnut was largely replaced by oaks (*Quercus spp.*) and hickories (*Carya spp.*) (Keever 1973, McCormick and Platt 1980). This generally resulted in a shift throughout the range from oak-chestnut forest to oak-hickory or mixed oak forest. This shift likely resulted in a marked reduction in wildlife carrying capacity in stands previously

dominated by American chestnut (Diamond et al. 2000). The oak species that replaced chestnut in most stands (McCormick and Platt 1980) typically undergo large periodic and synchronous fruiting events resulting in fluctuations in between-year seed crops (Greenberg and Parresol 2000, Lombardo and McCarthy 2008). The actual impact of stand-level reduction in seed production is not well known as no empirical study had been performed prior to the loss of American chestnut from the forest canopy. Anecdotal records of the trees' production capacity are abundant (Davis 2004) but empirical data seem absent from the literature. Numerous vertebrate species (white-tailed deer (*Odocoileus virginianus* Bodd.), wild turkey (*Meleagris gallopavo* L.), Allegheny woodrat (*Neotoma floridana* Baird), and black bear (*Ursus americanus* Pall.)) all utilized American chestnut prior to its decline (Hill 1994, Steele

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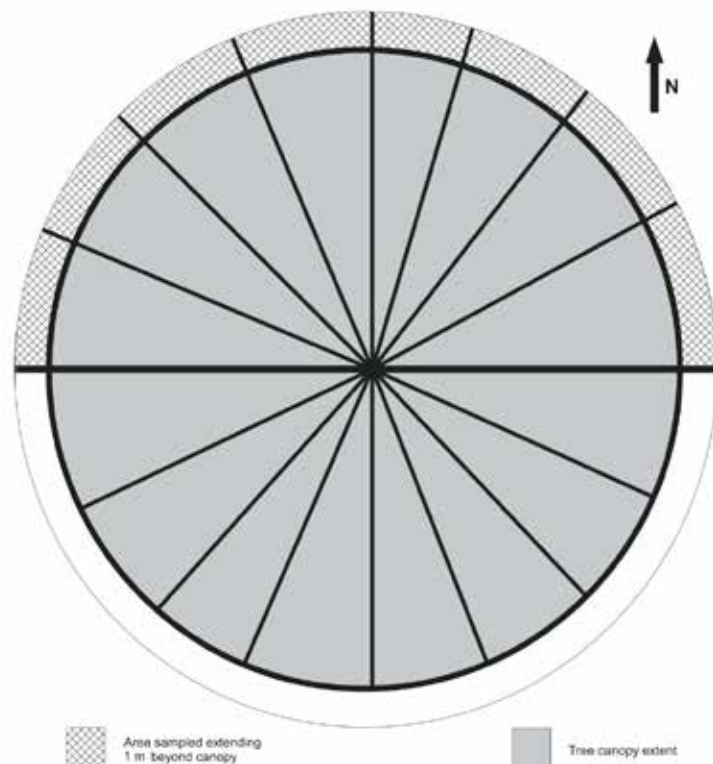
et al. 2005). Populations of these wildlife species have changed dramatically since the loss of American chestnut, due to habitat conversion and other factors, and a solid understanding of the relationship between wildlife populations and chestnut mast is likely to be elusive.

Renewed interest in American chestnut has resulted in more recent research endeavors (e.g., McCament and McCarthy 2005, McEwan et al. 2006, Rhoades et al. 2009), mostly related to determining the silvicultural requirements for successful establishment. However, empirical studies of many aspects of the species' ecology are still lacking in comparison with the oak and hickory species that replaced the chestnut throughout its former range. However, a remnant site in West Salem, Wisconsin, affords the opportunity to study the ecology of mature forest-grown American chestnut *in situ* (Paillet and Rutter 1989).

The goal of this research was to add to the growing body of ecological information about American chestnut, and especially one of the areas with the least amount of data—mast production. Specifically, we attempted to quantify the seed production potential of mature American chestnut trees in a naturalized forest setting. Additionally, we hoped to provide some comparison with other historically co-occurring species with regard to its reproductive potential. As the “Restoration Chestnut” is readied for deployment by The American Chestnut Foundation, our data will provide for estimates of recruitment potential and other population-level processes, as well as a better understanding of the wildlife value of the species.

#### Materials and Methods.

**STUDY SITE.** The study was conducted in a privately owned forest stand located in southwestern Wisconsin, approximately 600 km west of the original range of American chestnut in West Salem (43° 53' N, 91° 049' W). As such, the stand is disjunct from the primary range of both the American chestnut and the blight. The stand is dominated by American chestnut, *Castanea dentata*, and several species of *Quercus* and *Carya* (McCarthy and Keiffer, unpublished data). The stand was established in the early 1900s from seeds transported



**FIG. 1.** Overview of sampling scheme utilized for each tree. Canopy area cover of each tree was measured each year while DBH was measured in 2005 only. The solid grey area indicates the extent of the tree's canopy. The hatched area represents an area 1 m beyond the 1/2 of the canopy of the tree that was sampled to account for falling cupules landing outside the canopy drip line.

and planted by family members from the chestnut's native range (Paillet and Rutter 1989). In the intervening century American chestnut became naturalized throughout about 20 ha of the stand and now comprises ~37% of basal area (McEwan et al. 2006). The site has been extensively utilized for studies of chestnut ecology, blight dynamics and chestnut blight hypovirulence research (Milgroom and Cortesi 2004).

**FIELD METHODS.** Each individual tree was measured for diameter at breast height (DBH) and total height and bole/crown height employing a clinometer (Suunto, Vantaa, Finland). Crown area ( $m^2$ ) was estimated by measuring the radius of the crown at 16 evenly spaced azimuths from the bole beginning at due north and calculating area as a function of the triangles created by the individual radii, yielding total crown cover for each tree sampled (Fig. 1).

First year sampling was conducted October 14–15, 2005, on eleven trees with wholly intact canopies. Some evidence of blight (bole cankers) was visible on these trees but canopy dieback was not evident on any individual. Trees of various sizes were sampled (DBH

23–79 cm) in order to determine reproductive potential over a broad age/size scale. Second year sampling was conducted at the West Salem site November 12–19, 2006. Six of the original trees were sampled; the remaining five were not able to be sampled in 2006 due to land access issues. Three additional canopy trees were added to the sample in the second year making nine total individuals sampled in 2006. Canopy measurements were recorded for all individuals in the second year but DBH was recorded the second year only for newly sampled trees.

Sampling was performed by counting the number of current year cupules (which is easily determined visually) on the ground directly beneath 1/2 the crown to 1 m beyond the edge of the drip line. Cupules remaining on the tree after nut drop were counted as well (for the portion of the canopy above the half sampled). Seed production was determined by assuming three nuts were produced per cupule, which is the standard number in *Castanea dentata* (Farrar 1995). After the cupule count was conducted, a sample of 20 cupules and seeds was collected from below trees where possible to verify the number of seeds in each cupule and to determine a mean individual seed weight (i.e., fresh weight) for further calculations of mast production. Seed production was calculated for each tree by multiplying the number of seeds (extrapolated from the number of cupules counted) per m<sup>2</sup> of collection area by the total measured crown area. In order to compare chestnut production with published records of mast potential for co-occurring species, the number of seeds per tree was converted to the number m<sup>2</sup> basal area (BA) by dividing total chestnut seed production for each tree by the BA of the sampled tree.

**Table 1.** Size and reproductive output of American chestnut trees in West Salem, Wisconsin, utilized for this study.

	Year	
	2005	2006
DBH mean cm (± SD)	38.5 (5.02)	53.3 (18.2)
Height mean m (± SD)	22.7 (2.37)	21.2 (5.5)
Crown area mean m <sup>2</sup> (± SD)	105.1 (49.9)	175.3 (33.3)
Seeds produced m <sup>2</sup> crown spread	36.1 (31.7)	63.6 (21.9)

**DATA ANALYSIS.** Data were tested for normality prior to regression analysis using the Shapiro-Wilk test for normality (Zar 1999). Regression analysis was conducted between DBH and metrics of seed production (i.e., total number of seeds produced in 2005 and 2006 and total mass of seeds produced in both years). Mast production per m<sup>2</sup> BA was compared between years using a simple *t*-test assuming equal variance after log-transforming the values to meet the assumption of normality. All analyses were performed using the R programming language (R Development Core Team 2010).

**Results.** Mean seed weight was estimated to be 2.65 ± 0.4g (SE). Mean seed production per m<sup>2</sup> BA was greater in 2005 compared to 2006 (69,489 vs. 74,825) but did not significantly differ between years  $t = -0.7233$ ,  $df = 14$ ,  $P = 0.4807$ ). Seed production was highly variable among individual trees ranging from 1–91 seeds m<sup>2</sup> crown area in 2005 and 22.2–89.9 in 2006 (Table 1). A significant relationship between total number of seeds produced and DBH was found in 2005 ( $r^2 = 0.89$ ,  $P < 0.001$ , Fig. 2) but not in 2006 ( $r^2 = 0.29$ ,  $P = 0.210$ ). Thus, if a typical stand in which chestnut had become naturalized upon reintroduction attained a basal area of 14.98 m<sup>2</sup> ha<sup>-1</sup> (as was most recently recorded in the West Salem, WI, stand) we would expect 1.04 x 10<sup>6</sup>–1.12 x 10<sup>6</sup> seeds produced per hectare (and using our mean of 2.65 g/seed, this equates to ca. 2756–2968 kg ha<sup>-1</sup> of mast production).

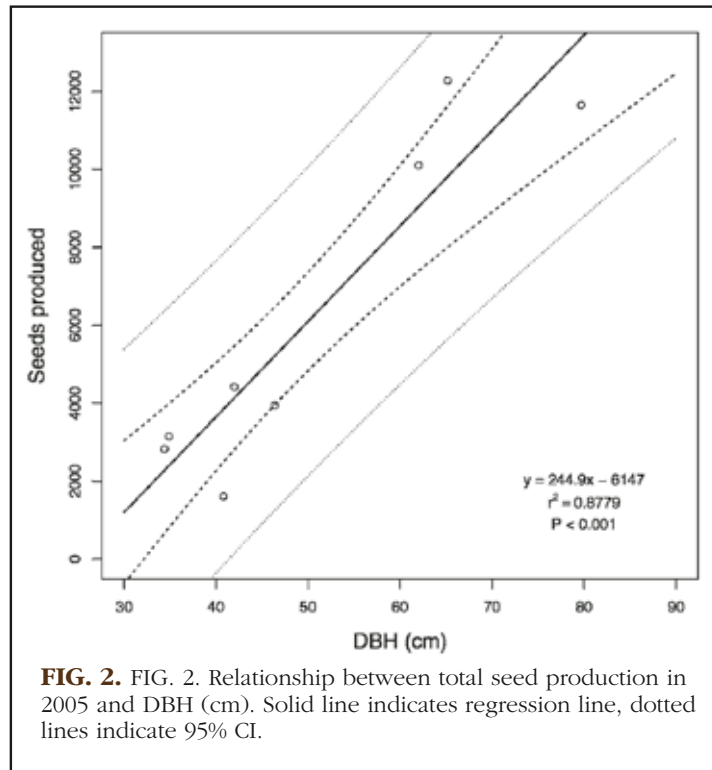
**Discussion.** American chestnut is believed to be a regular seed producer; i.e., it is not reported to undergo the cyclic masting events in the manner of most *Quercus* or *Carya* species. Regular production may be insured by late flowering dates (i.e., typically June) that prevent mast failure due to frost damage (Diamond et al. 2000) and extensive investment in the spiny cupules, which protect developing seeds from predation at least until the seeds are mature (Dalglish and Swihart 2012).

Although this study is composed of a limited number of individuals and spanned only two years (a limited number of trees was available during the period of access), these *in situ* results corroborate Diamond et al.'s (2000) analysis of historic records that suggested that chestnut only exhibited small fluctuations in year-to-year seed production. It should be noted, however, that basal area in the West Salem stand is roughly 5 m<sup>2</sup> ha<sup>-1</sup> greater than estimates of pre-blight chestnut composition in the Appalachian Mountains (Diamond et al. 2000). Although this would lessen the amount of predicted mast output from what was found in this

study by roughly one-third, mast production would still far outstrip the production of the species that have replaced American chestnut (Table 2).

The lack of a drop in seed production was unexpected considering weather conditions and blight progression during the two years of the study. The site experienced drier than normal conditions during the summer of 2006 (37.1 cm precipitation in the growing season 2006 vs. the 45.7 cm previous decade growing season mean [NCDC 2012]), but

these conditions did not appear to affect the seed set of trees in the stand. Studies of seedlings have shown American chestnut to be reasonably drought tolerant during early development (Bauerle et al. 2006) but drought effects on adult fruiting behavior have not been examined. It has been observed in several *Quercus* species that summer drought conditions are significantly related to declines in acorn production (Fearer et al. 2008). In fact, seed production may have been somewhat artificially high in the study years due to a favorable 2004 growing season (May–August Palmer Drought Severity Index 2004 = 2.78) that could have resulted in increased seed production in the following years. Effect of previous year weather conditions has not been



explored in chestnut, but increased seed yields following favorable prior year weather conditions is well studied in other temperate, nut-producing species (Mathews 1955, Koenig and Knops 2002). Although not specifically examined here, these results suggest that reintroduction of American chestnut may help protect forests from a total loss of hard mast in years when drought conditions have lessened the seed output of species that have replaced American chestnut.

Progression of blight damage throughout the stand was noticeably evident during the second year. Susceptibility of the trees to damage from the blight may have increased because of drought stress in 2006. Most studies have shown increased mortality in blighted chestnuts under drought conditions (Griffin 2000, Anagnostakis 2001). No trees sampled in the first year of this study had succumbed to blight by the second year but minor crown damage (in the form of tip dieback) was evident in many of the trees sampled in 2006 and throughout the stand.

Hard mast output is a significant predictor of a forest stand's ability to support "desirable" (e.g., white-tailed

**Table 2.** Reproductive output of species that have replaced American chestnut throughout its original range in comparison with American chestnut.

Species	n	Mean number of seeds per m <sup>2</sup> BA (± SE)	Estimated mast production Kg m <sup>-2</sup> BA (± SE)
American chestnut 2005	11	69,489 (43,983)	2756 (116)
American chestnut 2006	10	74,824 (40,860)	2968 (108)
Black oak*	88	2,045 (966)	5.4 (2.53)
Northern red oak*	111	2,511 (1,097)	17.1 (7.45)
Chestnut oak*	161	1,274 (841)	10.3 (6.77)
White Oak*	155	4,216 (3118)	13.3 (9.67)

\* Seed production values from Greenberg and Parresol 2000.

deer, wild turkey) wildlife species. The decline of chestnut as an integral component of yearly mast output likely lessened the capacity of large tracts of the eastern forest to support wildlife. Comparisons with published seed production data show American chestnut seed production far outstripping the abilities of the *Quercus* species that served as replacements in the post-chestnut forest (Table 2). In our study, American chestnut greatly out-performed black oak and chestnut oak, which are especially common on the dry ridge tops that were formerly dominated by American chestnut. The results here show a nearly 100-fold increase in seed production by American chestnut when compared to chestnut oak and a roughly 50-fold increase when compared to black oak. In addition to producing simply a larger amount of seeds, Steele et al. (2005) reported on American chestnut's higher carbohydrate values and overall palatability when compared with oak and hickory species. The combination of a greater output, highly palatable seed, and non-fluctuating production suggests the importance of American chestnut as a wildlife food source prior to its decline. We hope these estimates of chestnut production in terms of basal area will be of some help for practicing foresters and wildlife managers as well as ecologists interested in the restoration of American chestnut.

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This typical batch of American Chestnut seeds, stored for the winter in a Ziploc® bag, became moldy. Will treating the seeds with bleach or hydrogen peroxide help or hurt?  
Photo by Paul Franklin

## How to NOT Kill a Chestnut

By Kendra Gurney and Sara Fitzsimmons

As many of our members know, there are plenty of ways to kill a chestnut. After all the hard work of pollination and harvest, rodents could get at the newly planted nut in the spring, voles could take out the roots of an established seedling, and of course there is chestnut blight, *Phytophthora* root rot, gall wasp, ambrosia beetle, vandalism, storm damage or just plain bad luck that could lead to the demise of a chestnut tree. But all chestnut trees start as nuts and one of the first potential pit-falls occurs during winter, while the nuts are in storage. Often, surface mold will develop on stored chestnuts. No one wants to lose hard-won chestnuts to fungi so early in the game, and our members have tried a variety of methods for treating surface mold. This got us wondering: Are these treatments effective? Or might the treatment cause more damage than the mold itself?

To begin addressing these questions, we selected two products our members have used to try to abate a developing mold situation on stored chestnuts – household bleach and hydrogen peroxide. It is important to note that we cannot say with certainty that these products are effective at killing mold on chestnuts. However, since both of these treatments are easy to obtain and frequently used, we wanted to find out if either of them has an effect on nut viability. Chestnuts have a hard shell, but it is somewhat permeable and we have worried in the past that baths in household bleach or hydrogen peroxide could be damaging, maybe even more than the mold they were meant to treat.

To look at treatment effect on nut viability we tested household bleach at full strength, 50% household bleach, 25% household bleach, and 5% household bleach. Household bleach is a 6% solution to begin with, so “full strength household bleach” is dilute and 5% household bleach is much more dilute than it sounds (see table). Although bleach is the most common product we see utilized, hydrogen peroxide has been used by

our members as well; we tested full-strength over-the-counter hydrogen peroxide, which is a 3% solution. (This 3% solution is much weaker than the 30% concentration found in some commercial products, but more readily available).

Nuts were exposed to each treatment for 1 minute, 5 minutes, 7 minutes and 10 minutes, while control groups were simply treated in water. This experiment was conducted in two locations – State College, PA, and South Burlington, VT. The nuts used were harvested in the fall of 2011 and treatment was applied in February, 2012. In State College, bulks of 50 nuts were subjected to all treatments, and in South Burlington, bulks of 20 nuts were subjected to the 5% bleach, full strength hydrogen peroxide, and water treatments. To determine the effectiveness of each treatment at killing mold, the nuts were rated for mold severity prior to treatment (0 = no mold; 1 = passable w/o treatment; 2 = worth treating; 3 = severe). The nuts were then rinsed of peat and treated as outlined above.

After the nuts were treated they were repackaged in milled peat moss dampened with water at a 10:1 peat:water ratio. This fresh, damp peat was used to cover all nuts in clean, quart-sized Ziploc® bags (for 50 seed) or pint-sized Ziploc® bags (for 20 seed), with 10 small holes (made with a pencil) in each side of the bags. Controls were rinsed and repackaged in the same manner. The nuts were stored for 4 weeks at 34-36°F, and then rated for mold severity using the same 0-3 scale. The final step was a germination test and all treated and control nuts were potted up in Scott's Miracle-Gro® Moisture Control Potting Mix and germination was noted, as evidenced by emergence of the shoot, every 5 days for 30 days.

What did we learn? We found that the applied treatments had little effect on germination (Figure 1). Nuts in all treatment groups germinated well – even those treated



**Table 1.** Treatments investigated for this study.

Percent Household Product	Percent Active Ingredient	Location of testing
100% Hydrogen Peroxide	3% active ingredient	State College and Burlington
100% bleach	6% active ingredient	State College
50% bleach	3% active ingredient	State College
25% bleach	1.5% active ingredient	State College
5% bleach	0.3% active ingredient	Burlington
Water	N/A	State College and Burlington

with the full-strength household bleach. The most perplexing result is the control treatment –using just water – had the poorest germination rate.

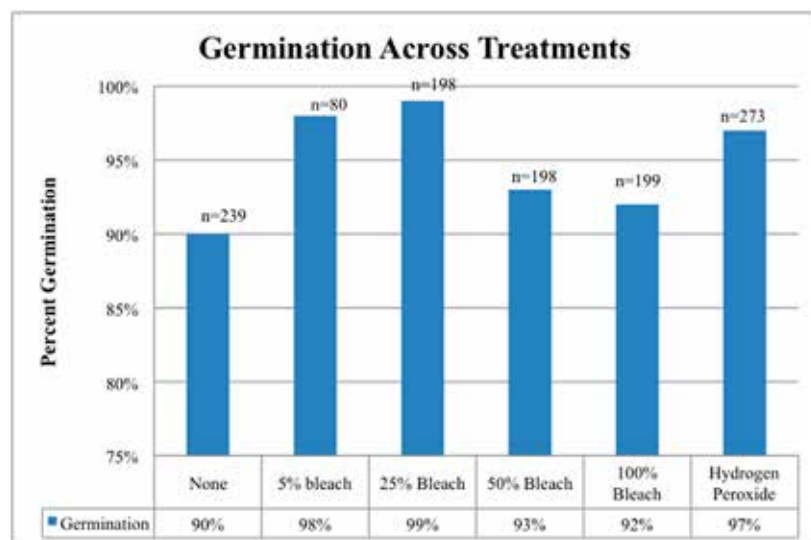
So, household bleach, even at full strength for 10 minutes, did not kill chestnuts. Over-the-counter hydrogen peroxide at full strength for 10 minutes did not kill chestnuts. If we had to pick a “best” treatment in terms of germination, 5% and 25% household bleach or over-the-counter hydrogen peroxide performed the best. Also, in a study looking at 5% bleach, hydrogen peroxide, and a fungicide treatment on white oak, Devine et al. (2010) found no reduction in viability with the application of those pre-storage treatments

Unfortunately we were not able to determine each treatment’s effectiveness for treating mold that has developed on chestnuts. The nuts used were not very moldy to begin with and we did not find any differences in the amount of mold that developed during post-treatment storage? So on this question, the jury is still out, though a bleach solution is sometimes used as a pre-storage treatment to prevent mold on acorns. In a recent review on best management practices for oak in California, McCreary (2009) suggests that bleach treatments are often recommended for acorns, but not necessary as long as the acorns are promptly harvested and properly stored at near-freezing temperatures. Also, in a more recent study looking at 5% bleach, hydrogen peroxide, and a fungicide treatment on white oak, Devine et al (2010) also found no reduction in viability with the application of those pre-storage treatments.

We will continue evaluating these treatments’ effect on mold reduction/mitigation. Good sanitation during harvest (getting the nuts shucked in a timely manner) and storing nuts promptly, packed in slightly damp peat and housed in a cold refrigerator, are still the best tools for successful nut storage. But if mold does start to develop on nuts over the winter, these treatments should not do any more harm than good. We look forward to hearing your experiences!

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**Figure 1.** Percent germination of chestnuts across various treatments. The various soaking times have been combined for each of the treatments shown here.



A hungry meadow vole searches the ground for food. Along with pine vole, they represent one of the most persistent threats to young chestnut saplings. Photo by Tania Simpson

## Voles, Moles and Shrews

### A Retired Forester, Wildlife Biologist and TACF Member Shares His Experience With Chestnuts and Small Mammals.

By Dan Stiles

If you are growing American Chestnut trees, chances are that near the top of your pest list are meadow voles (*Microtus pennsylvanicus*) and pine voles (*Microtus pinetorum*). But there are likely other species of small mammals in the vicinity of your chestnuts, and some are potential foes while others may be allies. This guide is intended to help you know a little more about these sometimes troublesome critters and help you protect your chestnuts from them.

**Meadow voles** are like miniature beavers, partially or completely girdling (consuming the cambium layer) around the base of a tree, or higher up on the trunk if there has been significant snowfall. It does seem meadow voles are programmed to gnaw off or girdle any seedling/sapling tree or shrub growing in a field or meadow, including newly planted American chestnut tree seedlings! Meadow voles love thick ground cover and fields of grass. They have a tough time surviving

where the vegetative cover has been removed. Winding runways in grassy fields that look like two-inch wide trails where all vegetation has been clipped off are sure signs that meadow voles inhabit the area. These trails are easy to spot, especially after the winter snow has melted. Therefore, no ground cover means little food, exposure to cold weather and no place for them to hide from predators. If an area has no ground cover, it is not attractive to voles, which is why we recommend that if you mulch around the base of a tree (to conserve moisture and control weed growth) you keep the mulch well back from the trunk, so that voles cannot tunnel under it right up to their favorite snack.

**Pine voles** love to dine on the root systems of young trees. Their diet consists of bulbs, tubers (they love potatoes), seeds, vegetable garden plants and, of course, the roots of trees. Pine voles are small rodents - four or five inches long with a short tail and a rather large



Northern short-tailed shrew. Shrews are small but strong for their size and very aggressive. Photo by Andrew Jackson

head. They can dig, of course, but their front feet are rather delicate, so they prefer light soils. Their fur is soft and brown and their eyes and ears are quite inconspicuous. They multiply rapidly when conditions are favorable - two or three litters each year is considered usual. Living underground all of their lives, they are not much concerned about predators, other than shrews and perhaps snakes. In fruit orchards where trees are slowly dying, pine voles are often suspected of being the cause, and sometimes they are. Pine voles do sometimes girdle major roots, chewing away the delicate cambium layer that helps transmit nutrients, causing the trees to wilt and leaves to turn yellow. If the problem goes unchecked, the tree may be killed. Occasionally, pine voles will also roam above ground to clip or girdle seedlings of young hardwoods, thereby killing them.

### **The Problem With Moles is the Holes (and Tunnels)**

There are three common species of moles within the original range of American chestnut trees. Moles are great diggers of tunnels that also provide safe, convenient passages for mice, voles and shrews to follow. They are often falsely blamed for root damage to trees, shrubs, vegetable gardens and flowerbeds. Although some physical damage may be caused by their powerful digging apparatus, it is generally pine voles, who later explore the tunnels, that injure trees by girdling the delicate roots.

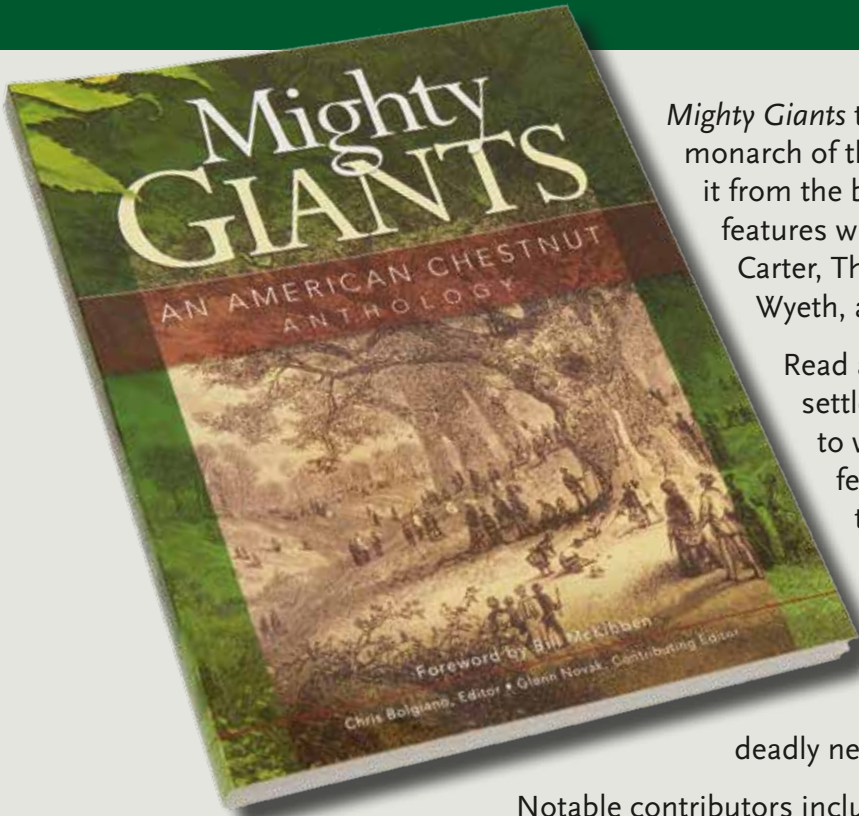
Moles are fascinating creatures. Fossils of moles in North America date back millions of years, so they are nicely programmed to survive. We very rarely see them because they spend most of their time underground. Eastern (*Scalopus aquaticus*), Hairy-tailed (*Parascalops breweri*) and Star-nosed (*Condylura cristata*) moles are much bigger than a mouse or vole, but smaller than a chipmunk. They have dark, soft fur and extra large, powerful front digging paws. Moles are insectivores, meaning they will feed on many types of insects or grubs that spend time underground. They also love earthworms. They dig tunnels with their powerful front paws hoping to stumble onto something to eat, or they travel in existing tunnels to consume insects that have fallen into them. If you stand quietly on a mole-infested field or lawn, you can sometimes see the ground move where a mole is tunneling. In the spring and summer their tunnels are close to the surface. In cold weather they tunnel deeper, a couple of feet down. Moles have a high metabolic rate, so they need to keep digging in fields, forests and in orchards to find earthworms and grubs. Occasionally moles forage on the surface of the ground, where they are vulnerable to predation.

### **There's No Taming a Shrew**

Ferocious and incredibly strong for their tiny size, shrews are nonetheless often beneficial to chestnut growers, for the simple reason that they will occasionally kill and eat young meadow and pine voles. Some people recognize shrews as the funny looking "mouse"

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that their house cat killed, carried into the house, but refused to eat. The scent glands of shrews produce an odor that turns off the appetite apparatus of house cats (if they are not too hungry), although snakes, opossums, raccoons, hawks, owls and foxes are not all that fussy. No one should ever try to pick up an injured short-tailed shrew (*Blarina brevicauda*), because their bite is painful and their saliva is poisonous enough to paralyze and even kill a mouse. They predominantly eat insects, but earthworms and seeds are also included in their diet. Shrews are voracious, aggressive, plentiful and seemingly fearless. If they were the size of a German shepherd, humans would be in serious trouble! Shrews are sometimes known to take short “shrew naps,” falling asleep at a moment’s notice, sometimes in the process of foraging. They are also quick moving, high-strung animals patrolling day and night in tunnels just below the surface of the ground or through the heavy leaf litter on the surface. So, next time your cat brings home a shrew for you to admire, be aware that these are truly incredible creatures. And, be thankful they are so small!

### Protecting Trees

My five Restoration Chestnut 1.0 seedlings are situated in a field that also has thriving populations of moles, mice, shrews and voles. Each of my seedlings is protected by a five-inch diameter tube of half-inch hardware screen (called “rat wire” in many regions) buried four inches deep around its base and extending about a foot above the ground. Many growers make this tube out of rolled aluminum roof flashing, and either method offers dependable protection against the ravages of voles and mice. But it has to completely encircle the seedling without gaps, because a hole as small as a dime is an open invitation to wriggling rodents.

Although I do not use chemical repellents, TACF’s Southern Regional Science Coordinator Tom Saielli has



A meadow vole, short-tailed shrew, and white-footed mouse side by side. Photo by Dan Stiles

had good luck with them. “Several years ago I used a mole and gopher repellent that contained castor oil, which is toxic to small rodents; it seemed to stop my vole problem,” says Tom. “I recommend using it in conjunction with keeping the surrounding grass cut very short and a physical barrier around the seedling, such as a plastic or aluminum tube.”

Voles also love to travel under mulch or loose leaves and debris that can collect around the base of a tree, so I keep mulch back at least a foot from the trunk of the tree and twice a year I remove leaves or any vegetation growing around the base of these seedlings, creating an inhospitable territory for meadow voles. When the growing tip of my seedling reaches the top of the rat wire tube, I add two additional protections. First I surround each seedling with a twelve-inch diameter circle, four feet high, of two-by-four-inch vinyl covered wire. This will protect against hungry rabbits and groundhogs. Second, I add an additional tube eighteen inches in diameter and five feet high, made of heavy duty concrete reinforcing wire with six-by-six inch openings to protect against browsing deer - which are a serious problem in most areas of the chestnut’s range.

These layers of defense not only protect against animal ravages, but they also help keep my seedlings from becoming short and branchy. This is their third growing season and three of my five seedlings are approaching nine feet tall!



With their powerful clawed forepaws, eastern moles are natural underground engineers. The tunnels they dig are often used by pine voles who use them to find and devour tender root systems. Photo by Kenneth Catania, Vanderbilt University

## Chestnut Butter

Recipe and photos by Josephine Malene Kofod, founder of “A Tasty Love Story,” a food blog about whole, organic and seasonal food.

Find more of her recipes at <http://atastylovestory.com>.



### Ingredients

*Makes about 1 cup*

- 1 cup baked and peeled chestnuts
- ½ cup walnuts
- 2 tbsp sunflower oil
- ½ tsp salt
- 3 tbsp water

We all know the classics: peanut butter, almond butter and some maybe cashew butter; but do any of you know chestnut butter? I for sure hadn't tried it before and that's why I absolutely needed to experiment with it. Since chestnuts are very different from other nuts, especially in their fat content, I needed to make the butter in another way than the classic ones, which requires nothing but the nuts and a brilliant food processor. So I have teamed up the chestnuts with walnuts, giving the butter a very healthy fat profile due to the content of omega 3 & 6 fatty acids in both walnuts and chestnuts, and then adding water and a little sunflower oil to ensure the perfect texture.

You can push this butter in many different directions. For a sweeter spread you can add dates or honey and different spices, e.g. cardamom or vanilla. You could also add cream cheese and dates to give it a fresh twist (trust me – it is actually delicious), or maybe add garlic, herbs and lemon to make it a savory spread or snack dip? Everything is possible.

My version is just the basic recipe for a 'plain' chestnut butter, and it is very mild and creamy. I think it is delicious with jam or honey and banana slices. It is not as distinctive in its flavors as peanut butter, for instance, which makes it very suitable to play with and to add all sorts of new and different flavors. And it is more healthy and less calorie-dense than all of the other nut butters!

### Directions

1. Preheat oven to 400°F. Use a sharp knife to cut a cross in the top of the chestnuts, place them in a baking pan, and roast for approximately 30 min. While they are hot, use a knife to remove the shell; it can be a little tricky, but it will be worth the effort!
2. Use the same baking pan to give the walnuts a little roast in the still-hot oven, approximately 5-7 minutes until they look slightly golden and oily.
3. In a blender add all walnuts and chestnuts and blend to very fine texture. Then add oil and salt, and 1 tbsp of water at a time and pulse until the perfect creamy texture is reached. Season to taste. Keep the butter in a jar in the fridge for up to 2 weeks or maybe more.

# Chestnut Moments



## **Chestnuts, Sleep**

By Danny Adams of Ferrum, VA

Appeared in the Winter 2007 edition of  
*Appalachian Heritage Magazine*

Mountain husks with children  
underneath slowly dying,  
Chestnuts, sleep:  
you nature-betrayed sentinels  
of aging memories  
choked in adolescence  
rising tilted above your  
ubiquitous mountainsides  
conquered by oaks,  
yet we give you no rest.  
With arms wrapped with hands unmet  
around your rotting bark  
we peer into  
your hollow poisoned veins  
and touch, and mourn,  
learn, and hope.  
My children  
are robbed of you  
except as windblown saplings  
bearing optimistically green leaves,  
discovered on hikes,  
genesis of tears,  
leaving us only  
to whisper,  
Tomorrow—let us  
disturb your sleep  
just a while longer  
so you might wake again  
tomorrow.



<http://www.fs.fed.us/r8/chestnut/>

