

RESTORATION OF THE AMERICAN CHESTNUT



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AMERICAN CHESTNUT: THE PAST 100 YEARS

PRE-BLIGHT USES,
BLIGHT INTRODUCTION AND SPREAD,
SPECIES RESTORATION WORK

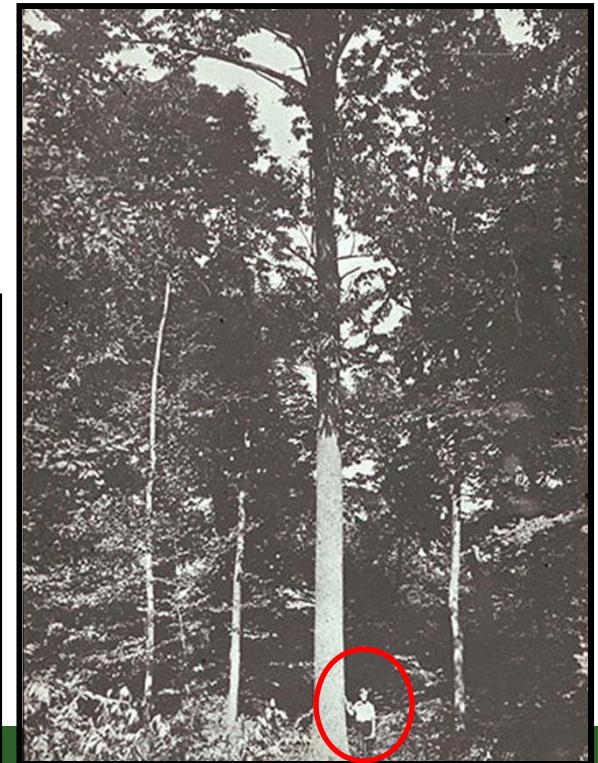
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American Chestnut: The Tree

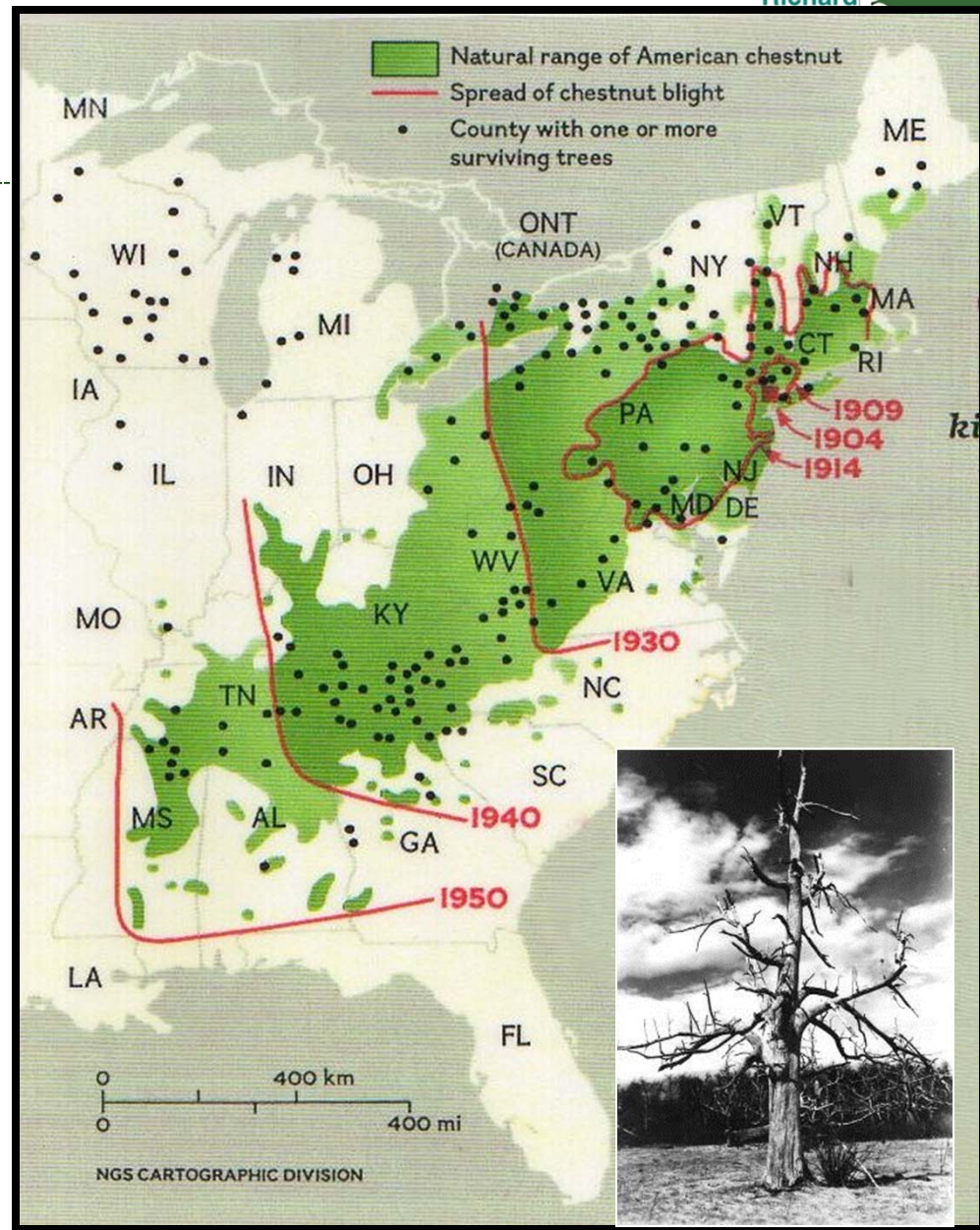


- Major component of eastern forests
- Fast growth, large, extremely rot resistant
- High-value timber species
- Nuts valuable to wildlife
- Tannins used in tanning leather
- Nuts valuable to people and livestock
- Culturally significant



Spread of the Chestnut Blight...

Approximate movement of 20 to 50 miles per year because of American chestnut's density and almost complete susceptibility to the blight.



What is the blight?

A fungal disease caused by *Cryphonectria parasitica*, introduced from Asia.

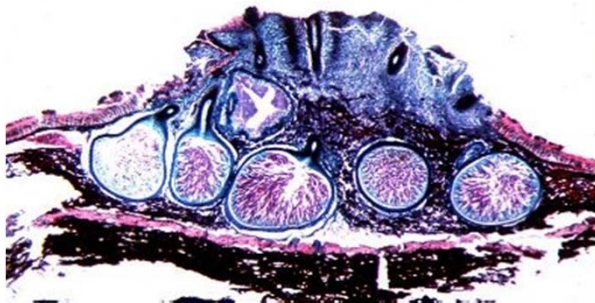
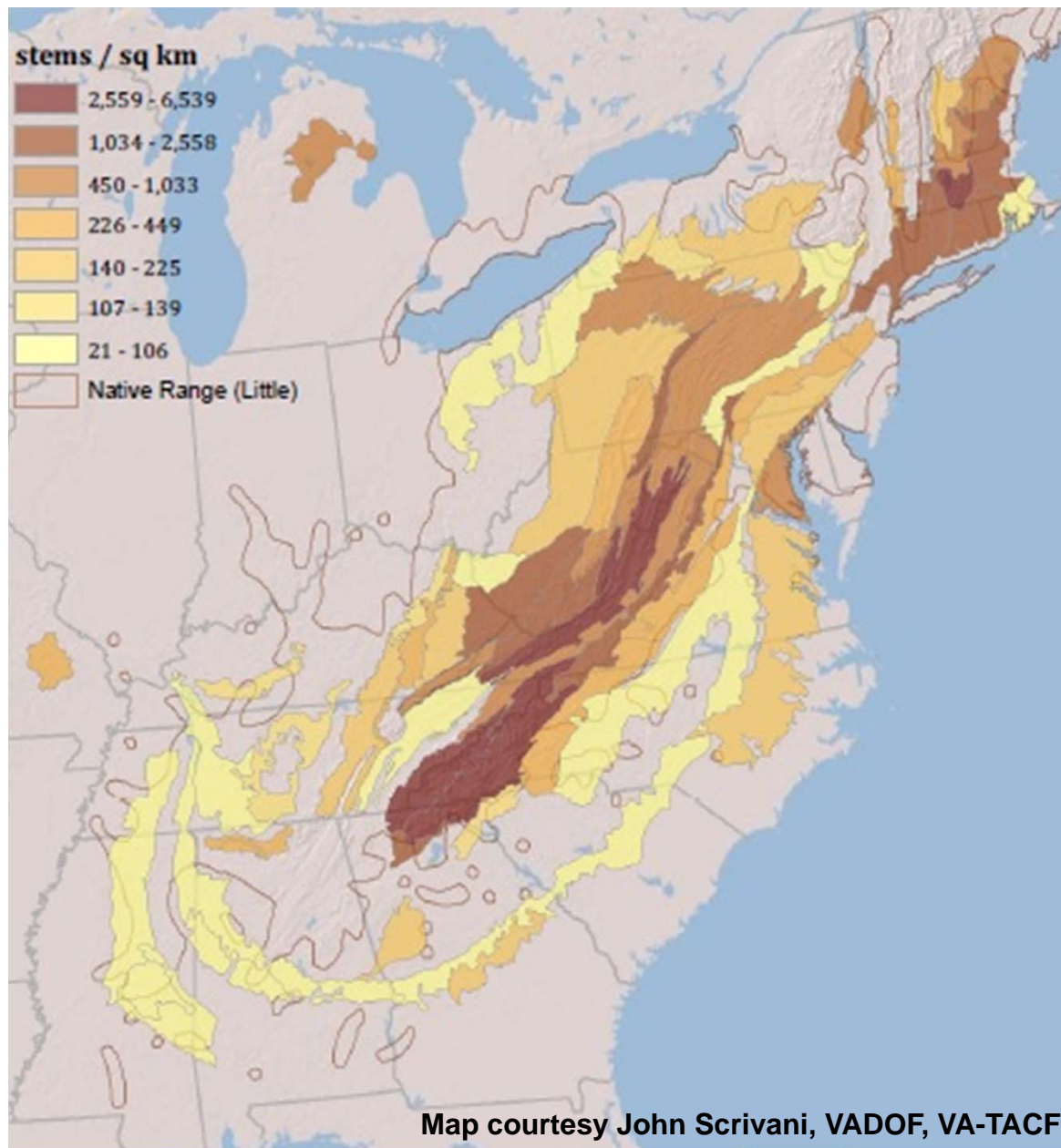


Photo courtesy of Dr. Tom Volk, UW

- The blight fungus enters the tree through the cracks typical of chestnut bark and through wounds.
- It forms a canker and quickly girdles the tree.
- Affects cambium, not roots.





Chestnut Survival Data

FIA 2010 data





Founded in 1983, the goal of TACF is to restore the American chestnut tree to its native range within the woodlands of the eastern United States, using scientific research and a backcross breeding program developed by its founders.

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TACF's BREEDING PROGRAM

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Characteristics of Chestnut Species

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American chestnut (*Castanea dentata*)

Not resistant to blight

Height: 80 – 100 feet ★

Form: Dominant canopy tree
straight trunk ★
few lower branches



Chinese/Japanese chestnut (*Castanea mollissima/crenata*)

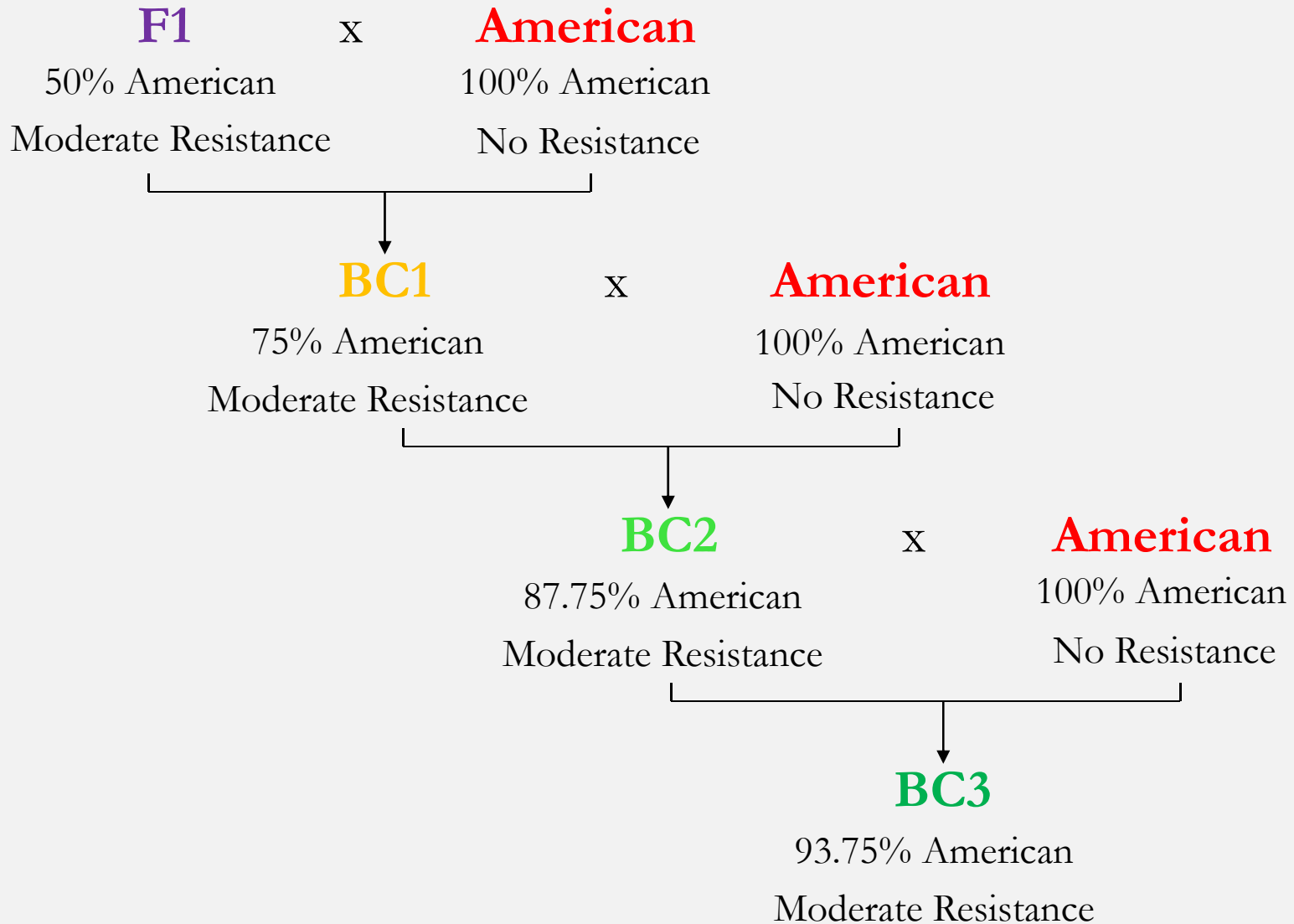
Resistant to blight ★

Height: 40 – 60 feet

Form: Orchard tree
many branches



Backcrossing



Final Stages

BC3 x **BC3**
93.75% American Moderate Resistance 93.75% American Moderate Resistance

At every stage, screened for blight resistance. Only those with acceptable resistance continue in the breeding program.

BC3F2 x **BC3F2**
93.75% American Fully Resistant 93.75% American Fully Resistant

BC3F3
93.75% American Hypothetically Highly Blight-Resistant Seed for Reforestation and Distribution

We Are Not Done!

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- Have been doing restoration since 1983
- Restoration is a feedback loop of breeding, testing, and reintroduction.
 - Starting testing
 - Should move seamlessly into reintroduction
- But breeding will always continue to improve product!

TACF's Restoration Practices

- **Establishment of TACF**

- Structured organization created a network of state Chapters and volunteer-run breeding orchards to develop blight-resistant trees

- **Breeding**

- Developing a tree with adequate levels of blight-resistance and American growth characteristics

- **Testing**

- Evaluating the effectiveness of our breeding program through progeny tests and silvicultural testing in the “real world”

- **Reintroduction**

- Returning the chestnut to our eastern forests

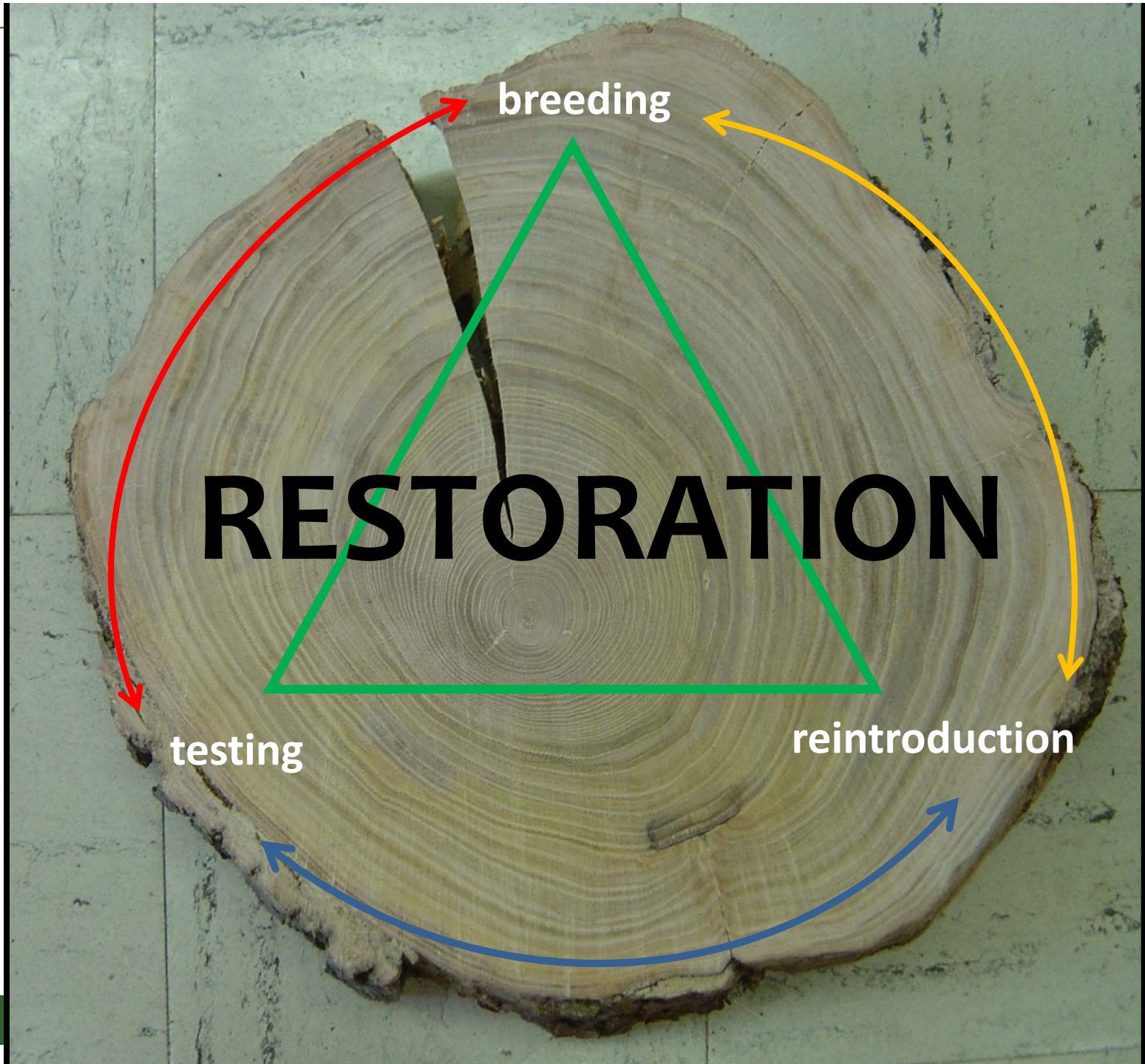
- **Breeding – Testing – Reintroduction** represent TACF's practices in our overall process of restoration

RESTORATION

breeding

testing

reintroduction



TACF Backcross Breeding Program



Meadowview

- Started with ‘Graves’ and ‘Clapper’ sources of resistance
- Produced 4 generations of breeding stock since 1986
- Provides backcross pollen to state chapters
- Working to develop additional sources of resistance
 - More time-consuming, need to start at F1 cross

State Chapters

- Identify local mother trees
- Use pollen from Meadowview to complete final backcross generation locally
- Breed final two intercross generations locally
- Allows state chapters to complete breeding work more quickly, while still incorporating local genetics and adaptations

AMERICAN CHESTNUT: WHERE WE ARE NOW



STATE CHAPTERS
MEADOWVIEW AND TESTING PROGENY
RESEARCH INTO GENE SEQUENCING

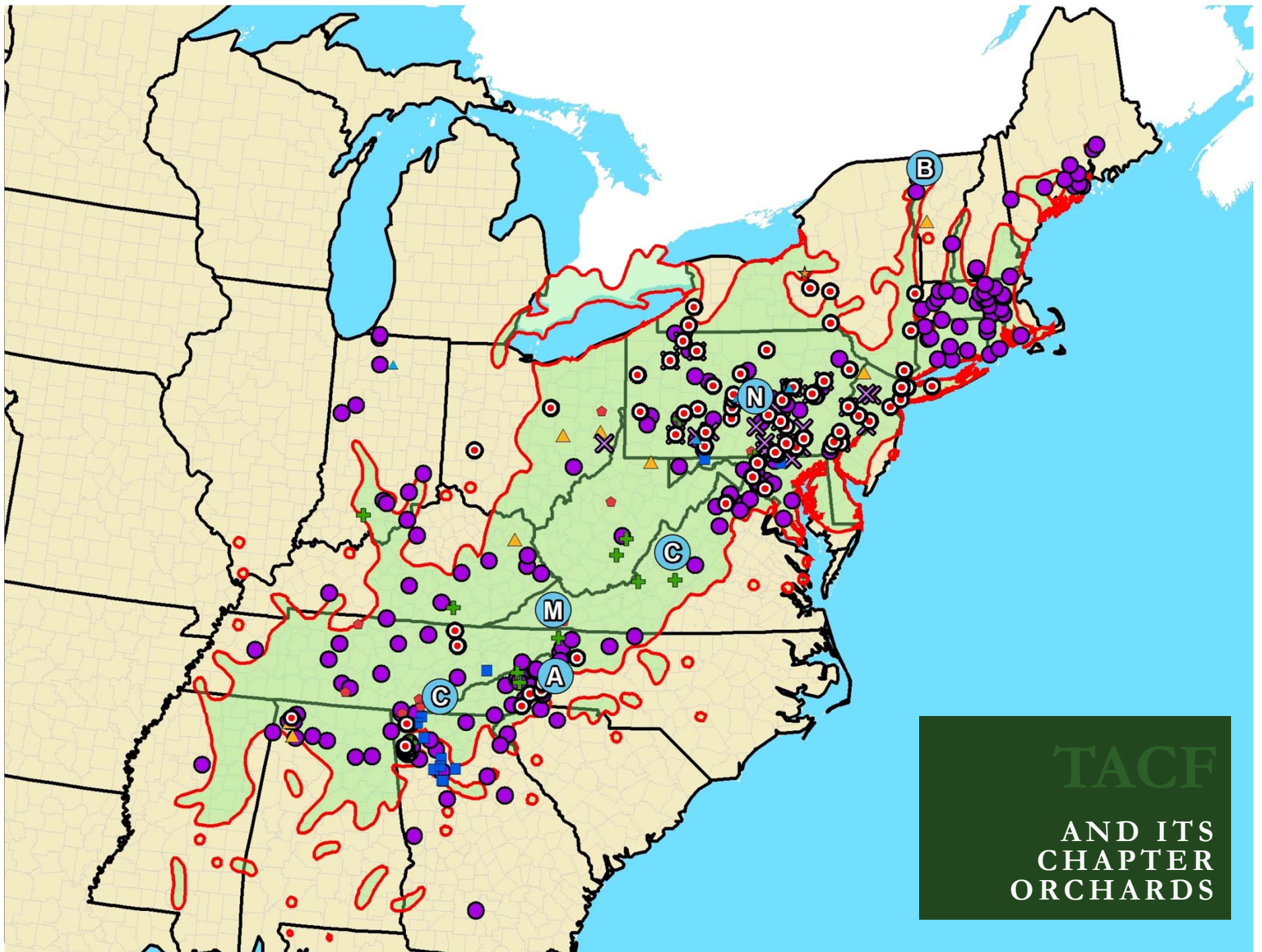
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Today, most chapter states have established orchards, and many are one to two generations away from producing regionally-adapted Restoration chestnuts





TACF
AND ITS
CHAPTER
ORCHARDS



Meadowview Research Farms have over 34,000 trees at various stages of breeding, planted on more than 150 acres of land.



Restoration chestnuts

are beginning to be produced at Meadowview on a scale that is expected to increase over the next few years.

Currently, these seedlings are being grown at the Virginia Department of Forestry's Augusta County nursery.

Progeny Testing Protocol



Testing of the Restoration chestnut seedlings has begun on a variety of sites along the Appalachian Mountain range, using current testing site protocols designed by the TACF.

Planted:

- **Cherokee N.F., NC**
- **Daniel Boone N.F., KY**
- **Jefferson N.F., VA**
- **Asheville, NC**
- **Waynesboro, PA**

Planned for 2011:

- **Bolivar, PA**
- **Hoosier N.F., IN**
- **Monongahela N.F., WV**
- **Rupert, WV**
- **Big Island, VA**

TACF/GP Big Island 2011 Test

8 ft x 8 ft spacing

Replications

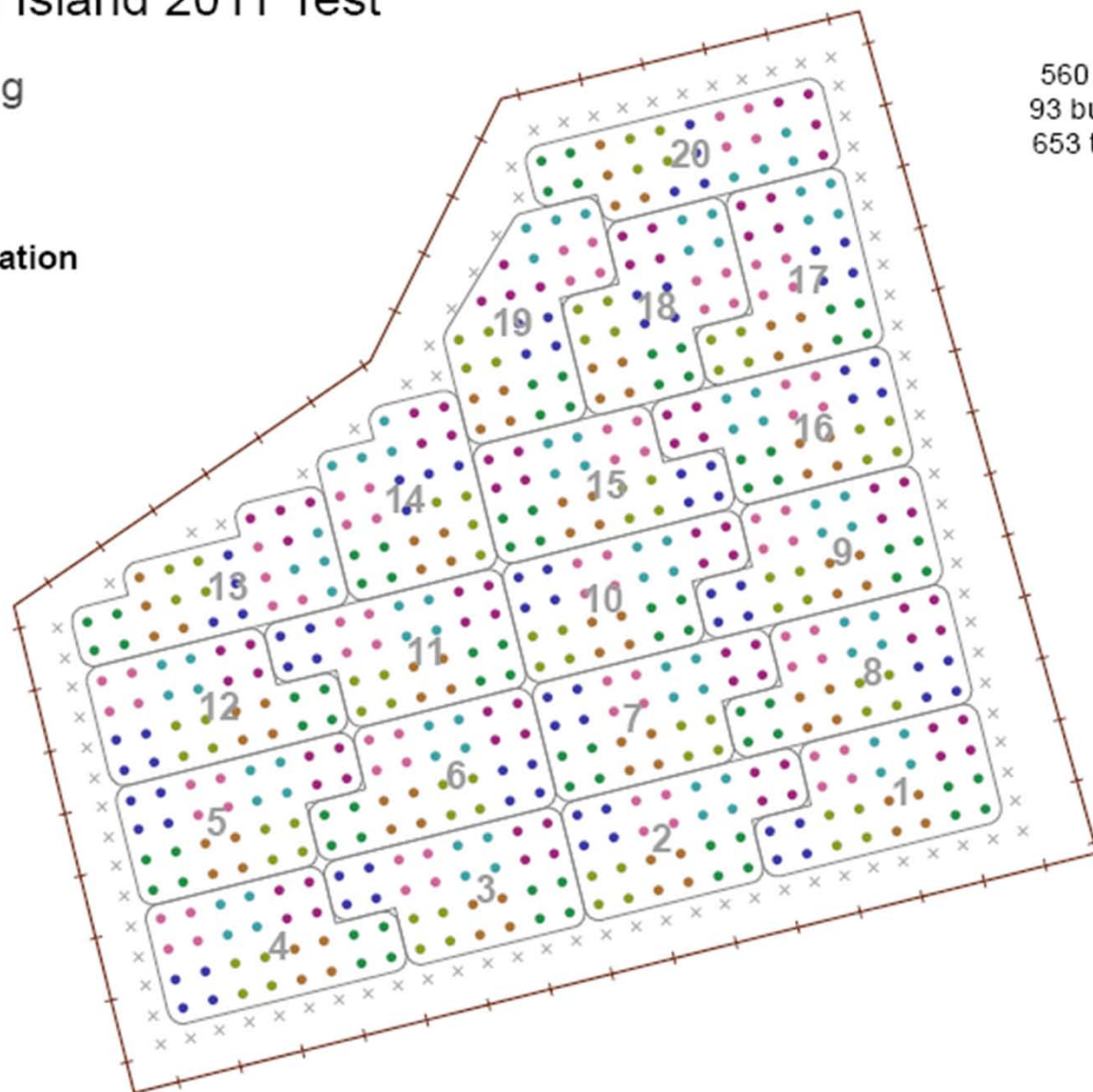
x buffer tree

block within replication

- 1
- 2
- 3
- 4
- 5
- 6
- 7

20 replications
28 treatments
4 tree small blocks

560 test trees
93 buffer trees
653 total trees



John Scrivani
February 10, 2011

0 40 80 160 Feet

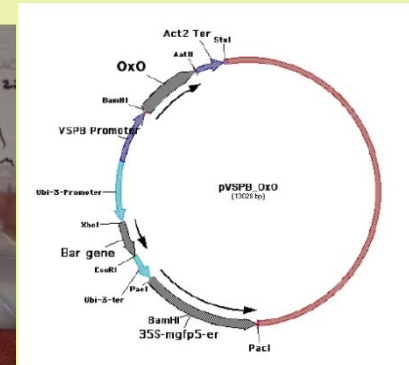


Genetic Engineering

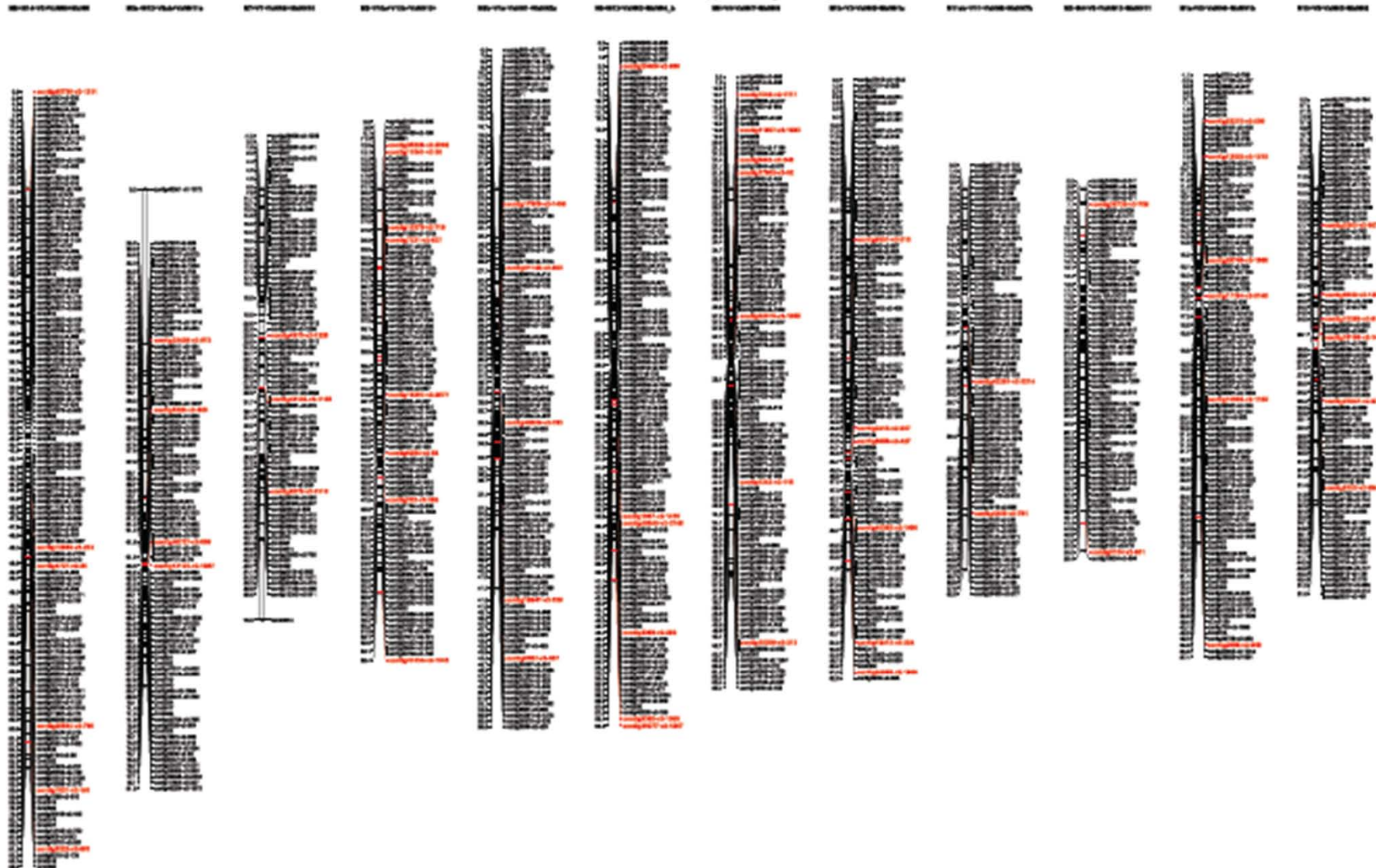
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- First planted seedlings in 2006
- 25+ transgenic events ready to go
- First large-scale plantings – 2010:
 - Syracuse
 - Zoar Valley - near Buffalo, NY
 - Lasdon Arboretum – Somers, NY



CHINESE CHESTNUT COMBINED MAP - mapped configs with species specific SNPs



All the Other Things We Do

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- Mineland Restoration / Reclamation
 - ARRI
- Outreach and Education
 - Chestnut Learning Box
- Hypovirulence Research
- Native Chestnut Conservation
- Other Pests and Diseases
 - Ambrosia beetle,
Phytophthora cinnammomi,
gall wasp, etc., etc.



What Can I Do?

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- Outreach
 - Give a presentation to an interested group in your area
- Make items for auctions
- Start a Restoration Branch
- Plant something
 - Americans
 - Backcross material
 - MSR material
- Help someone at their orchard
- Find Trees – especially new Americans



AMERICAN CHESTNUT: PENDING HURDLES



ECOLOGY AND SILVICS
REALITY OF REINTRODUCTION
STRATEGIES

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Ecological Challenges

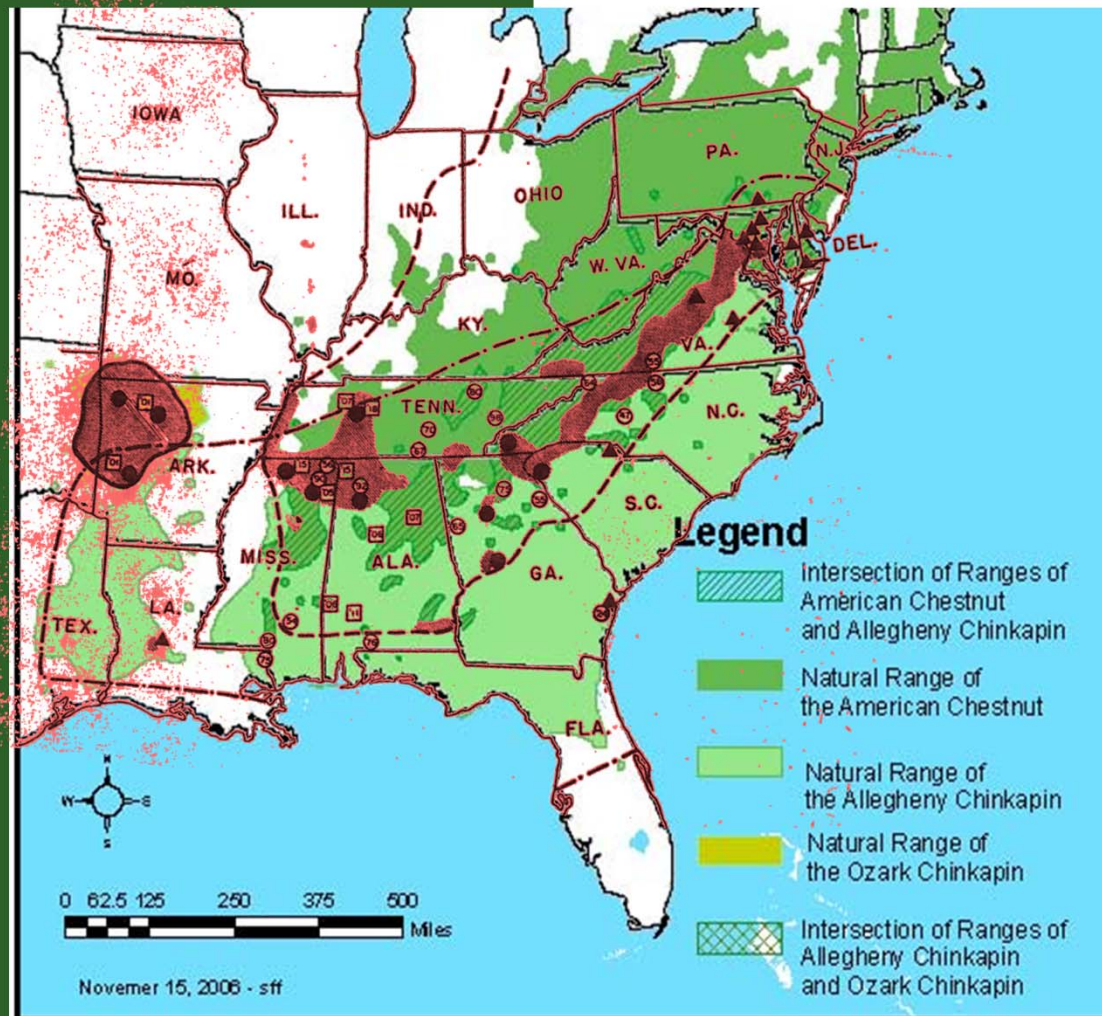
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- Critters
 - Explosive deer populations, among other things
- Invasive competitors
 - Stiltgrass, multiflora rose, bittersweet, honeysuckle, mile-a-minute, kudzu
- Variety of pests
 - Asiatic gall wasp, Japanese beetles, Cicadas, Aphids, Tent caterpillars, Ambrosia beetles, just to name a few
- This disease is still there, as well as others
 - Potential for disease mutation
 - *Phytophthora cinnamomi*

Phytophthora cinnamomi

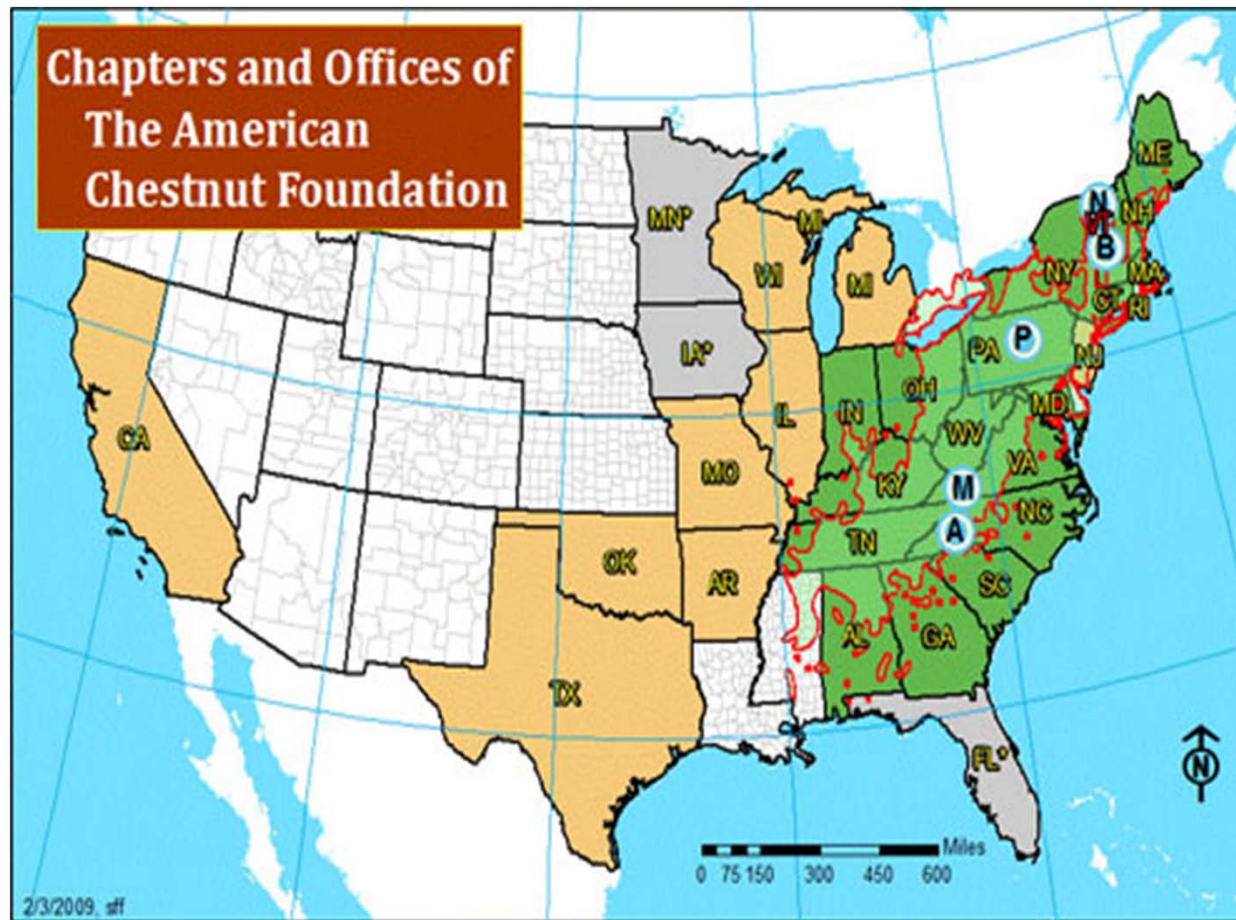
(ink disease/root rot)



- Introduced to US about 200 years ago
- Wiped out chestnut from many low-lying areas in the South
- Most likely eradicated chestnut from piedmont of South prior to introduction of chestnut blight fungus.

Logistical Challenges

How do we physically and fiscally prepare as an organization?



- Alabama
- Carolinas
- Connecticut
- Georgia
- Indiana
- Kentucky
- Maine
- Maryland
- Massachusetts
- New York
- Ohio
- Pennsylvania
- Tennessee
- Vermont/New Hampshire
- Virginia
- West Virginia

Logistical Challenges

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VOLUNTEERS. TACF depends primarily upon its members to support research to develop a blight-resistant American chestnut tree. Currently, over 5,600 members are helping to bring this important tree back to its native range.

Locate flowering American Chestnut trees for pollination and nuts.

Identify prospective “mother trees” for American characteristics.

Pollinate native American chestnut trees using TACF pollen.

Harvest open pollinated American and hand pollinated hybrids.

Seed storage and winter stratification.

Planning orchard locations and selecting prospective growers.

Spring Planting American, hybrid, and experimental orchards.

Orchard Maintenance fertilizing, weeding, watering, inoculation and selecting.

Documentation “We always finish the paperwork!”

All Done by Volunteers



Restoration Branches

Ways to create a
nucleus of

- Put together a committee
- Decide on a project on which to focus
 - Education and Outreach
 - American chestnuts
 - ✦ Germplasm conservation
 - ✦ Wildlife enhancement program
 - PA-TACF MSR/CMS program
 - Regional Breeding
 - Other research



Upcoming Branch Events

- Chestnut De Mayo
 - May 7 at Two Mile House in Carlisle, PA
 - ✦ Buy your ticket today from Susan Smith!

- Western PA
 - June 11 at Freeman Tree Farm in Knox, PA
 - ✦ Buy your tickets from Sara!


- Sewickley Branch
 - June 24, Sewickley, PA

- Raystown Lake
 - September-ish

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Chestnut characteristics

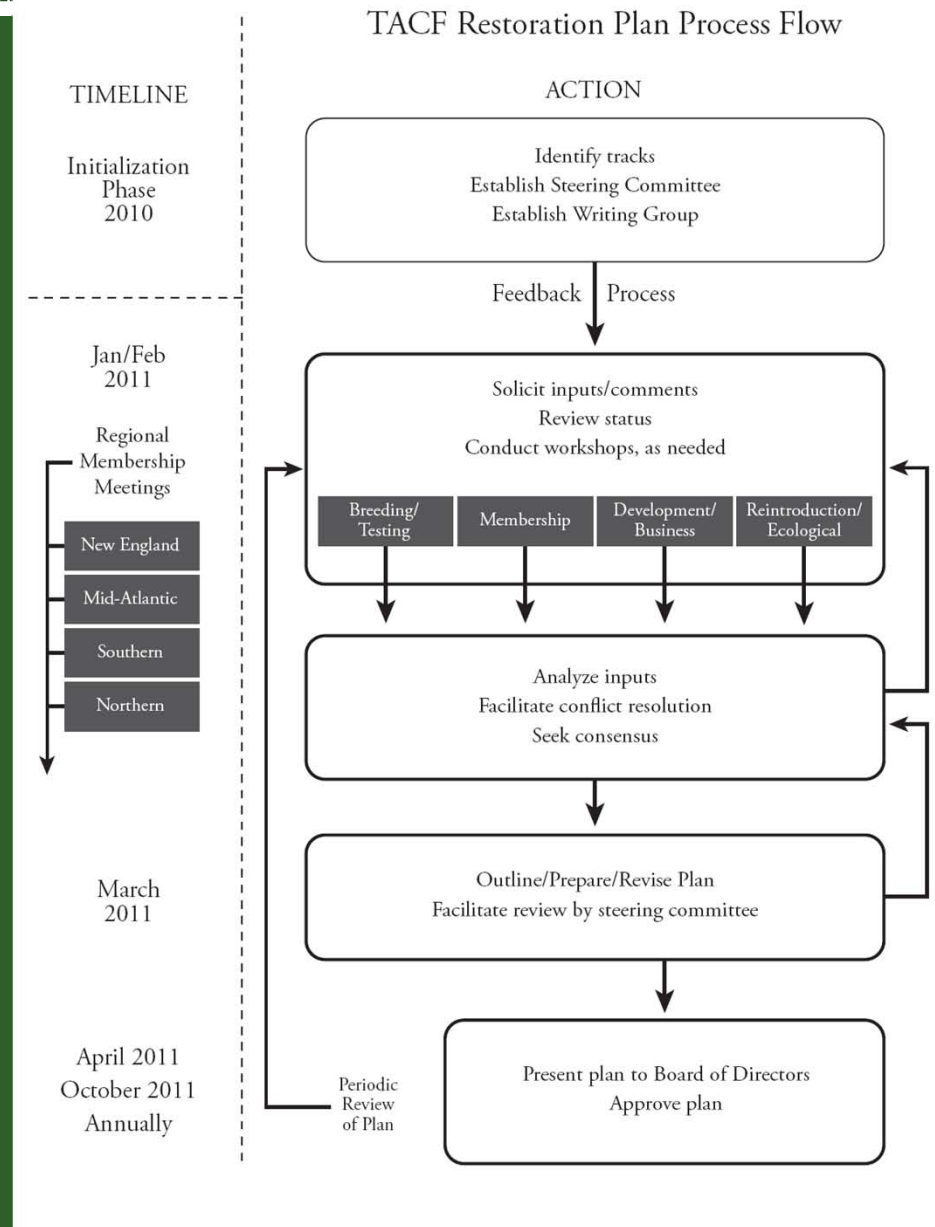
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- What do we think we know?
 - Adapted to a wide variety of sites
 - Seedlings & sprouts able to survive long periods under forest canopies
 - Able to respond rapidly to disturbances
 - Capable of rapid growth and competes well
 - What do we think we don't know?
 - How much resistance is necessary
 - How much “American character” is necessary?
 - How to fit in other technologies?
 - ✦ Genetic modification
 - ✦ Hypovirulence
 - ✦ Etc.



Restoration Process Flow

Series of workshops,
Writing groups,
And reviews
To produce a
restoration plan for
American chestnut.

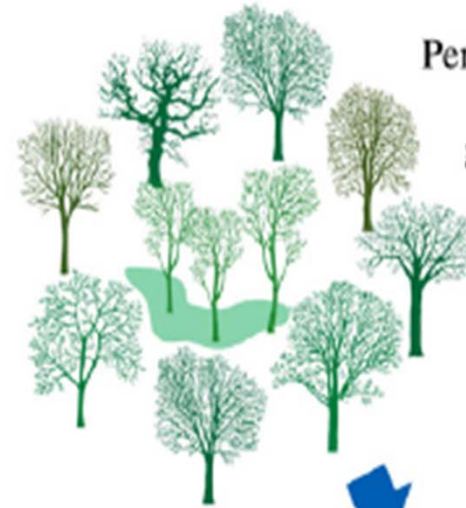
[sfr.psu.edu/public/
chestnut/meetings/](http://sfr.psu.edu/public/chestnut/meetings/)



Establishment of trees in
open fields or under existing
forest canopies

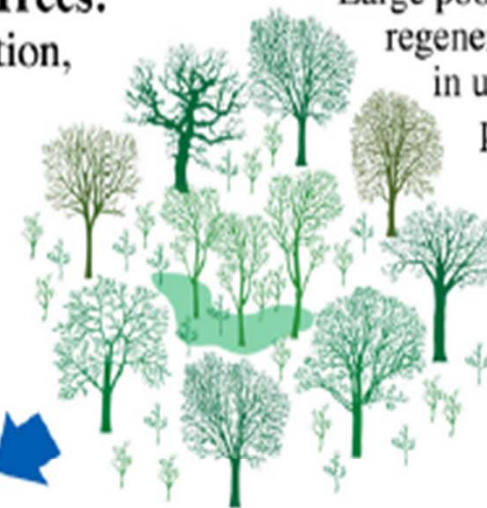


Periodic establishment
of individual or
groups of pioneer
trees in areas
of light gaps



Migration of the Planted Trees:
The Process of Dissemination,
Establishment, and
Development in
Adjacent Forests

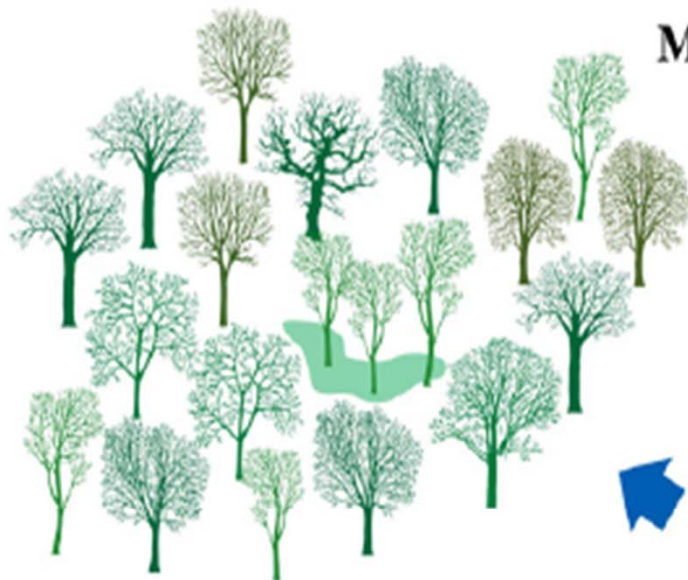
Large pool of advanced
regeneration develops
in understory of
pioneer trees



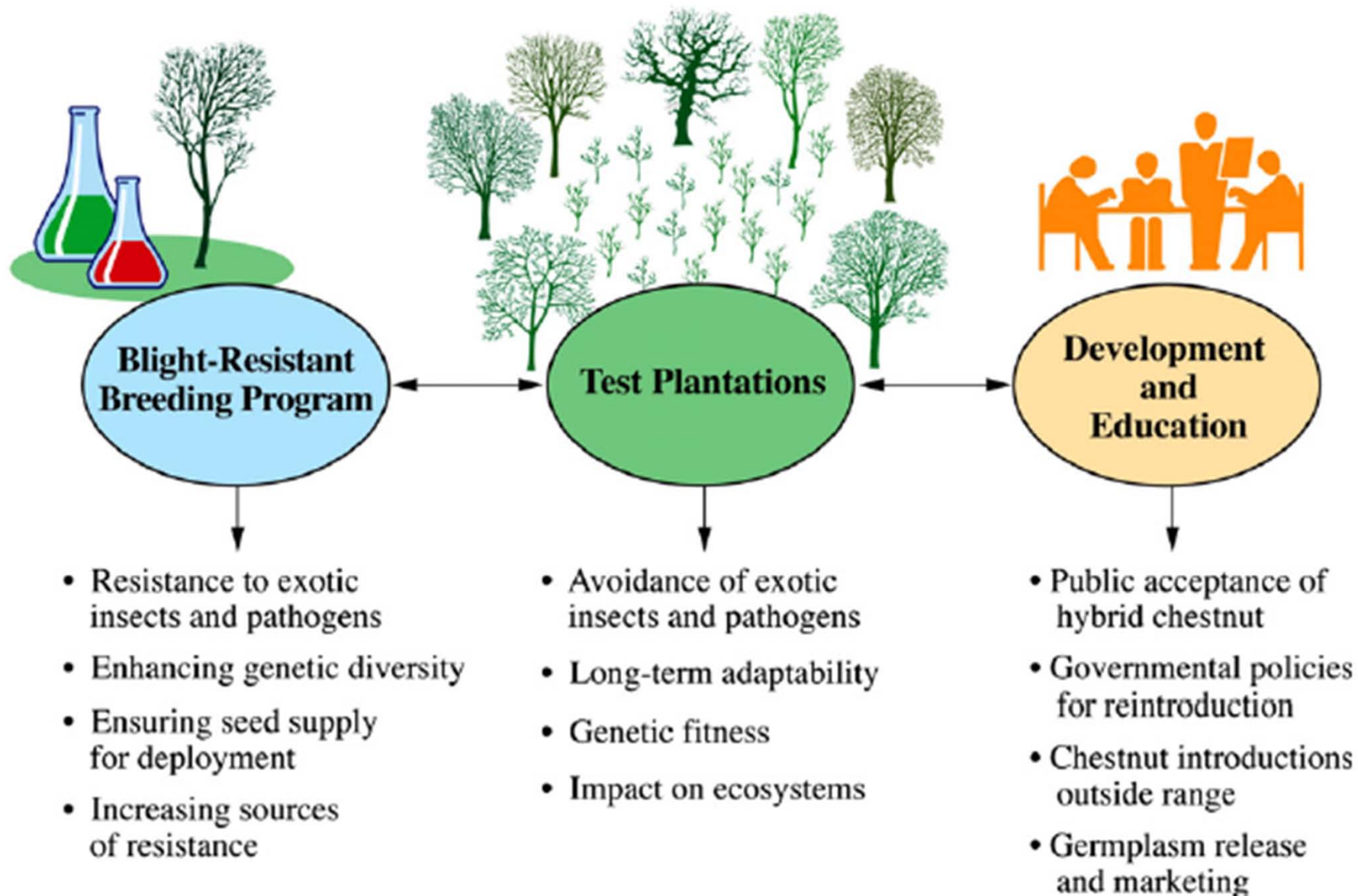
Seedlings released by
disturbance (i.e., logging,
windthrow, fire) and
assume canopy dominance



Disturbance promotes
coppice sprouting of
established trees, maintaining
or increasing stem volumes
and quantities



Jacobs 2007



How Do We Do This?

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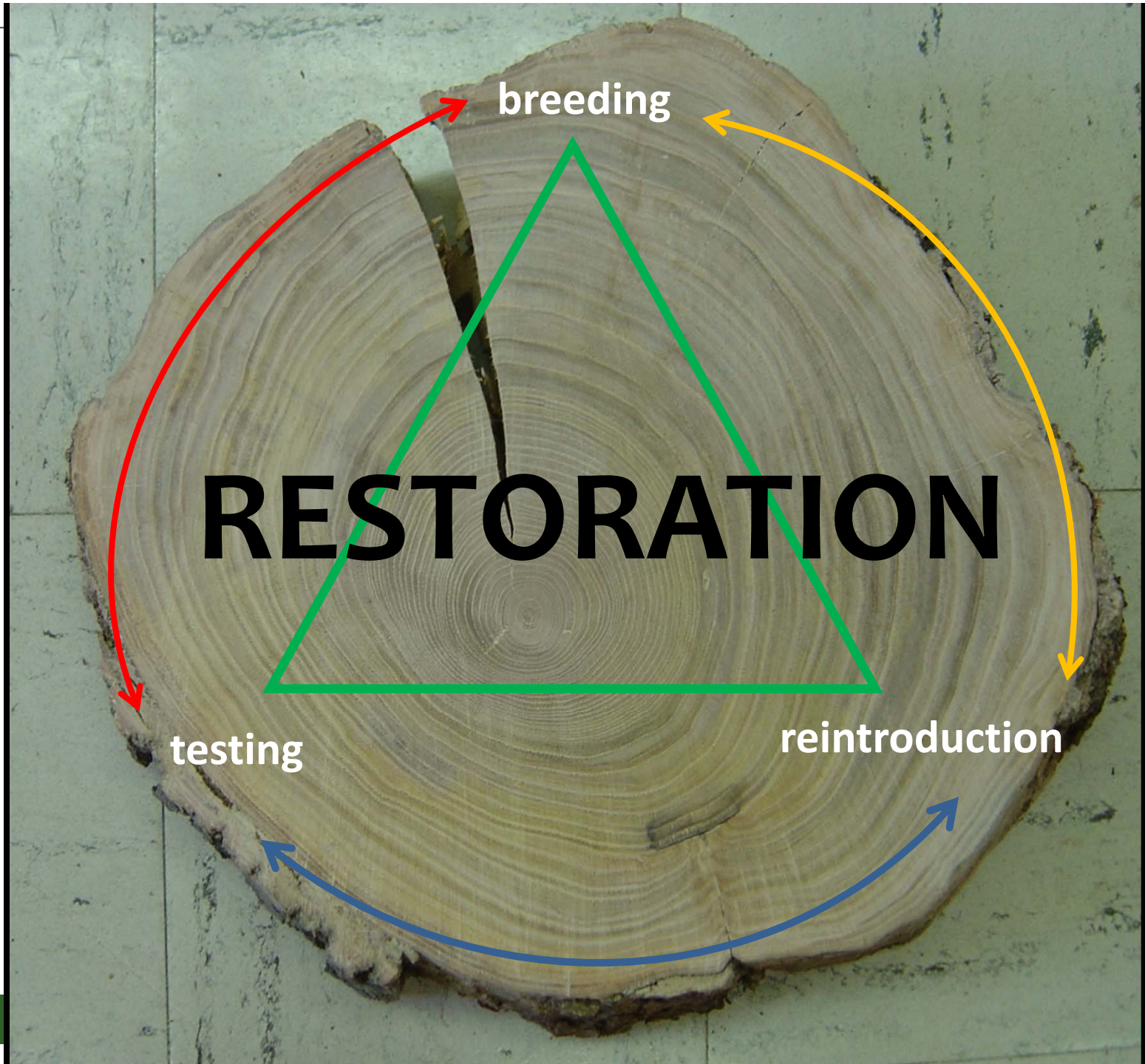
- Habitat Suitability?
- Public vs. Private Lands?
- Put out Many? Put out Few?
- A Mixture of All of the Above
- How do we know we have succeeded?
- How to integrate biotechnology?
- How to integrate hypovirulence?
- Should we save/protect native chestnut populations?
- Who is going to do all of this work?
- Where are we going to get the resources?

RESTORATION

breeding

testing

reintroduction



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King
Mellon
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THE
AMERICAN
CHESTNUT
FOUNDATION®

160 Zillicoa Street, Suite D
Asheville, NC 28801

828-281-0047
fax 828-253-5373
chestnut@acf.org
www.acf.org



Administrative Offices

Asheville, North Carolina

Meadowview Research Farms

Meadowview, Virginia

New England Regional Office

South Burlington, Vermont

North Central Regional Office

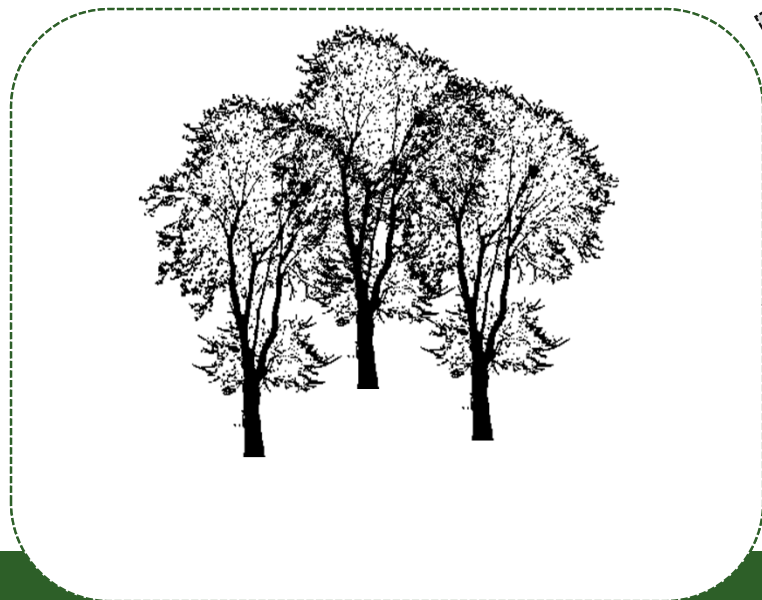
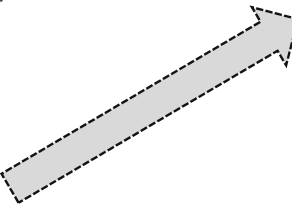
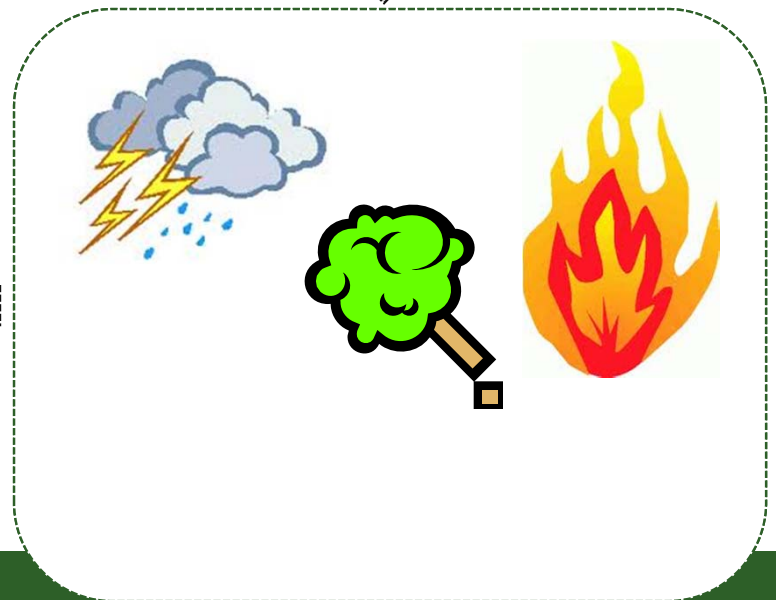
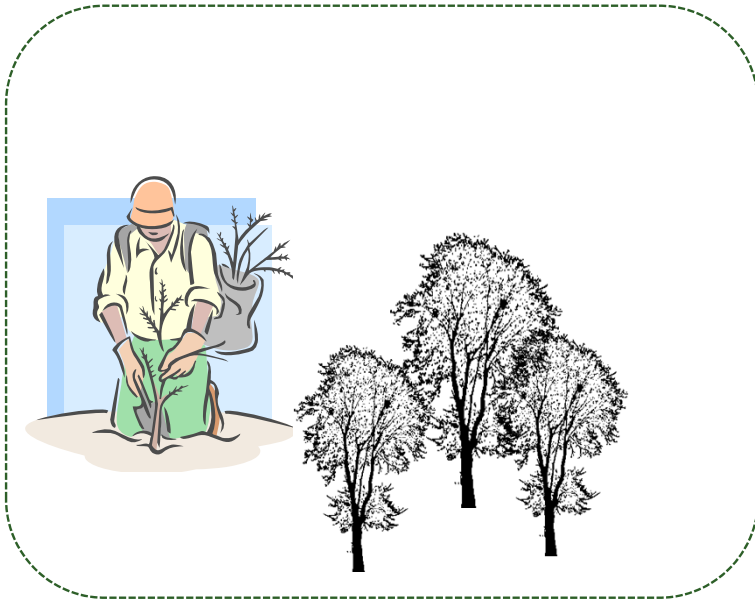
Penn State University

Mid-Atlantic Regional Office

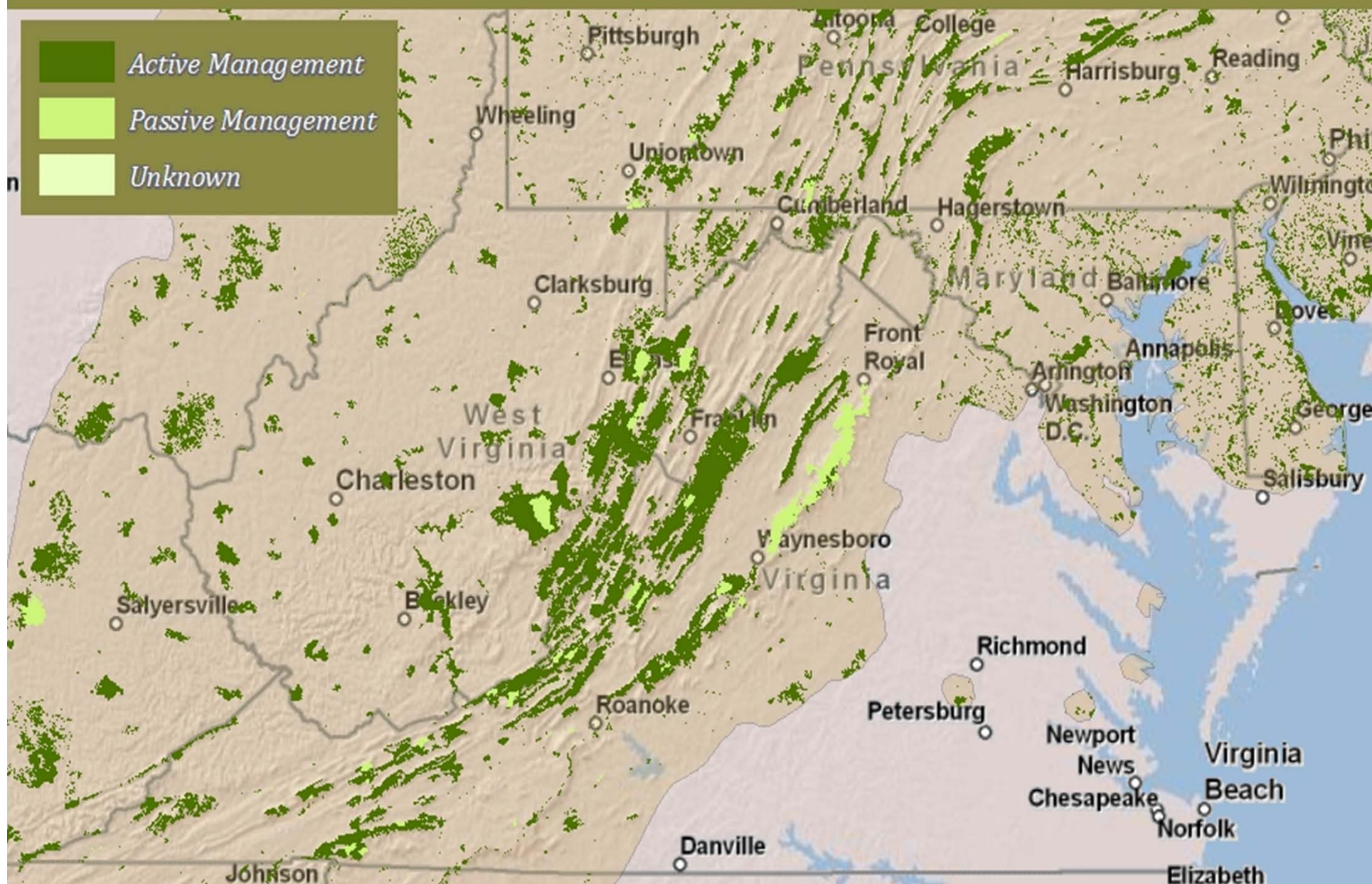
Charlottesville, VA

Southern Regional Office

Meadowview, Virginia



Public Lands in Chestnut Range - VA, MD, WV



Ecological Challenges

- Critters



- Explosive deer populations, among other things

- Invasive competitors

- Stiltgrass, multiflora rose, bittersweet, honeysuckle, mile-a-minute, kudzu

- Variety of pests

- Asiatic gall wasp, Japanese beetles, Cicadas, Aphids, Tent caterpillars, Ambrosia beetles, just to name a few

- This disease is still there, as well as others

- Potential for disease mutation
- *Phytophthora cinnamomi*

- Limitations in genetic fitness

- Natural range = 200 million acres!

- Regional adaptability and logistics

Trees have also been planted on mine land reclamation sites, in partnership with **The Appalachian Regional Reforestation Initiative (ARRI)**.



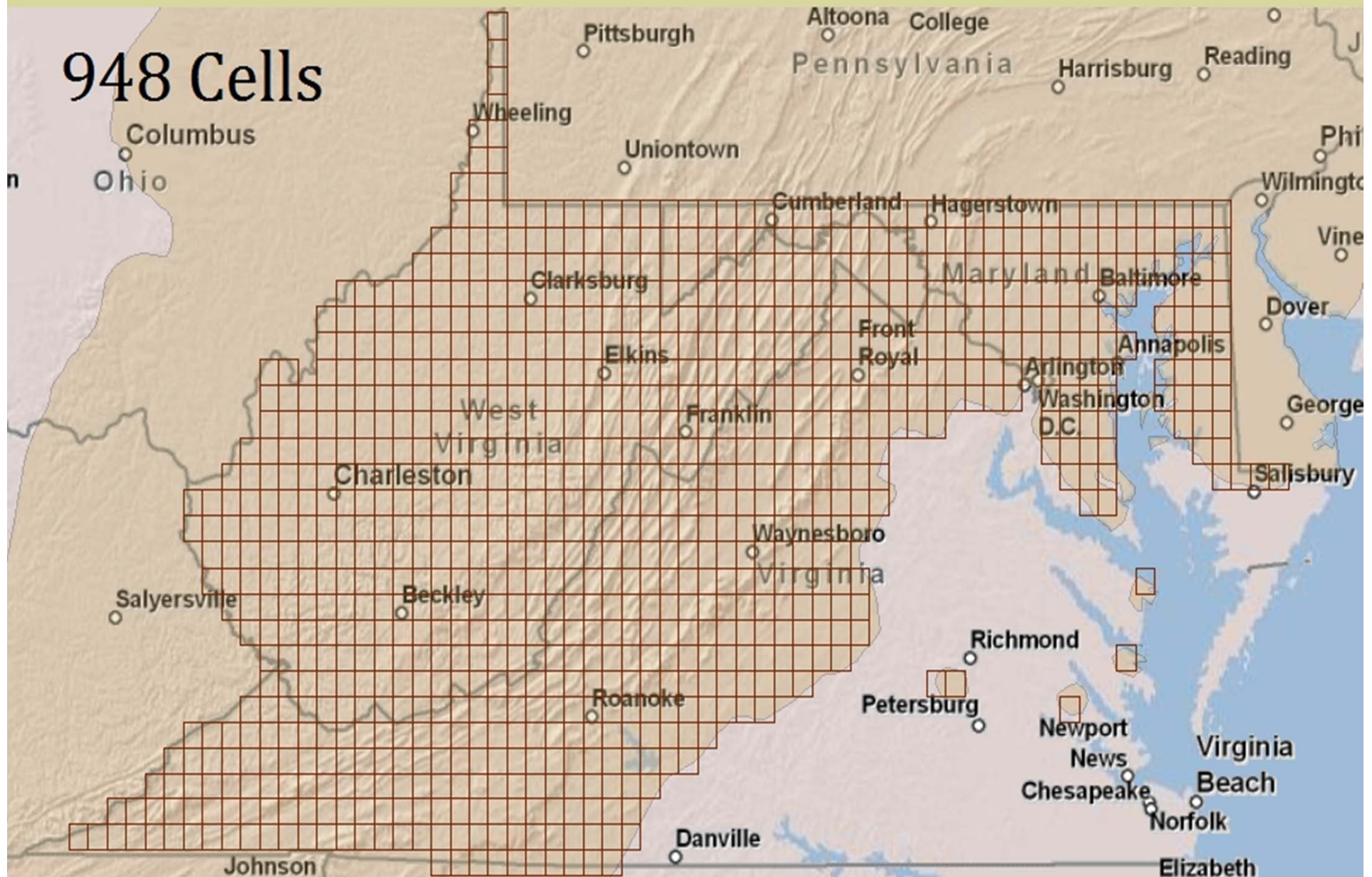
Strategies – Restoration Plan Draft 1



- Planned, carefully dispersed plantings
- Over course of decades, restoration will eventually be completed through
 - Fill-in plantings
 - Naturalization of planted populations

Topographic Map Quadrangles - MD, VA, WV

948 Cells



State	Quads	% of State	Square Miles	Acres (M)
New York	524	55%	33,536	83
New Jersey	130	86%	8,320	
Delaware	39	100%	2,496	
Pennsylvania	798	100%	51,072	
Ohio	434	58%	27,776	
Indiana	109	17%	6,976	

North Central Region

