

TACF Recurrent Genomic Selection Strategy

& How New York Can Get Involved

79th Annual NYS Woodsmen's Field Day
August 21, 2026
Lia Heintjes



Today's Talk

- Introduction
 - American Chestnut
 - TACF-NY
- Part 1 – Recurrent Genomic Selection (RGS)
- Part 2 – How New York Can Get Involved



Lia Heintjes

NY Chapter Board Member

Bachelor's Biotechnology at SUNY-ESF

Master's Urban Sustainability at CUNY CCNY

- ISA-Certified Arborist
- Built rooftop gardens in the tristate area
- Former NYC urban forester
- Current Climate Policy Analyst
- CCE Master Forest Owner Volunteer

Interested in:

- Prescribed fire science + ecology
- Indigenous history, sovereignty + forest stewardship
- Obtaining practical certs (Game of Logging, etc.)
- Strengthening place-based community resilience



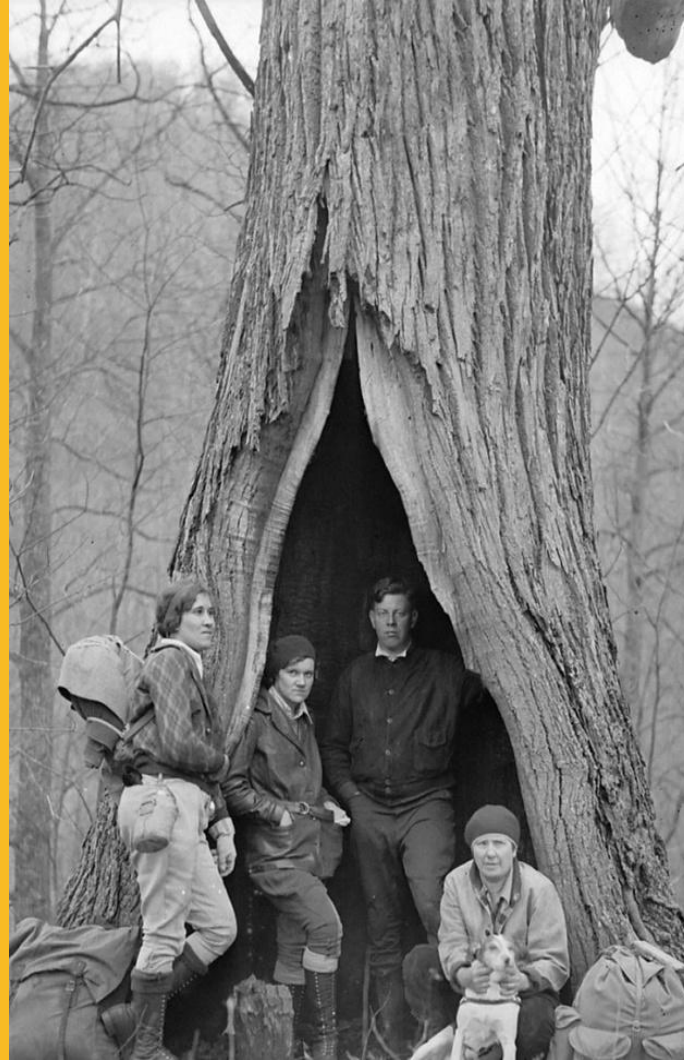
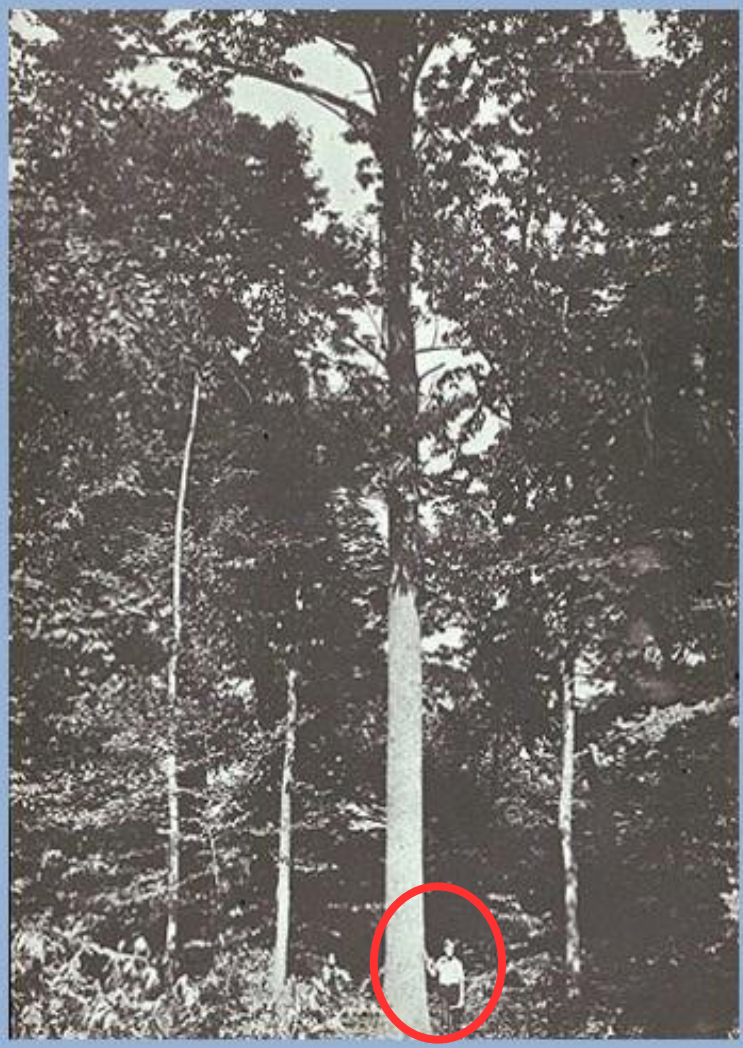
I am a volunteer
(not paid)



Let's Do
This

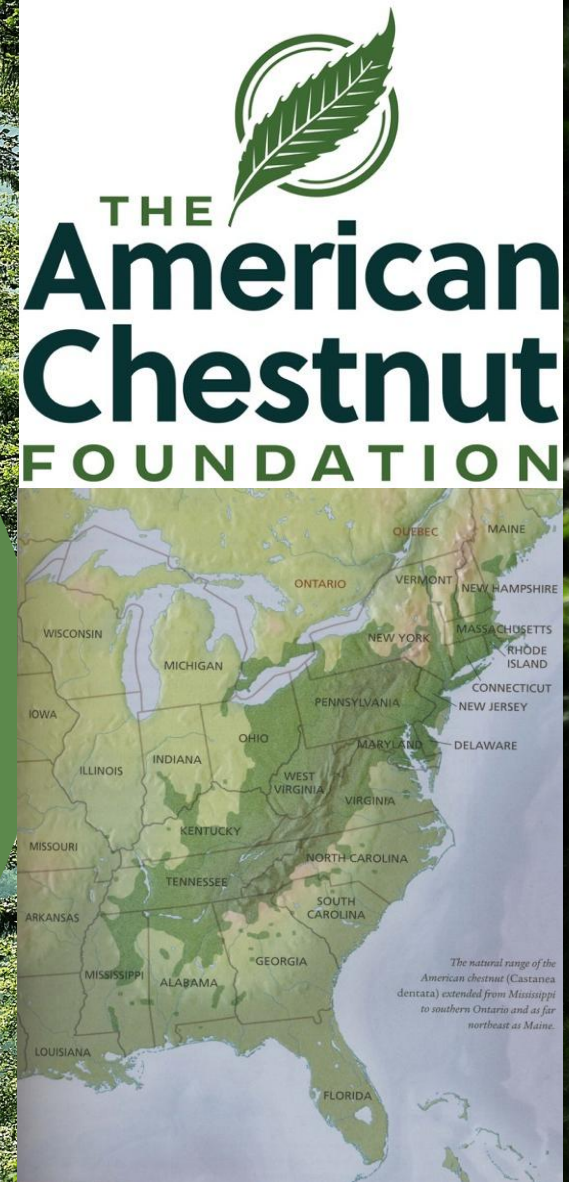


The American Chestnut Icon of the Eastern Forests



Cherokee tilī
Onondaga o-hi-yah'tah
Tuscarora číhtkēr
Algonkian chechiniquamin
Ojibwa kitchijawemin
Mohegan-Pequot wôpum
Narragansett wompimineash
Catawba yerupeh
Choctaw oti
Chikasha osak
Mohawk aotishò:kwa
Lënapei woa'peem
Mohican wapeminskink
Muscogee-Creek otowóskē
Cree ᄃᄅᄁᄂᄃᄅ ᐆᐆᄃ
Powhatan opomens

**TACFs mission
is to return the
iconic American
chestnut to its
native range.**



Historic Uses

- Food source
- Lumber
- Leather making
- “Chestnutting” was a social function
- Culturally, economically, and ecologically important

“The cradle to grave tree”

(Brewer 2018; Davis, 2021; Anagnostakis 1987; Lunsford 1999; Thomas 1991)



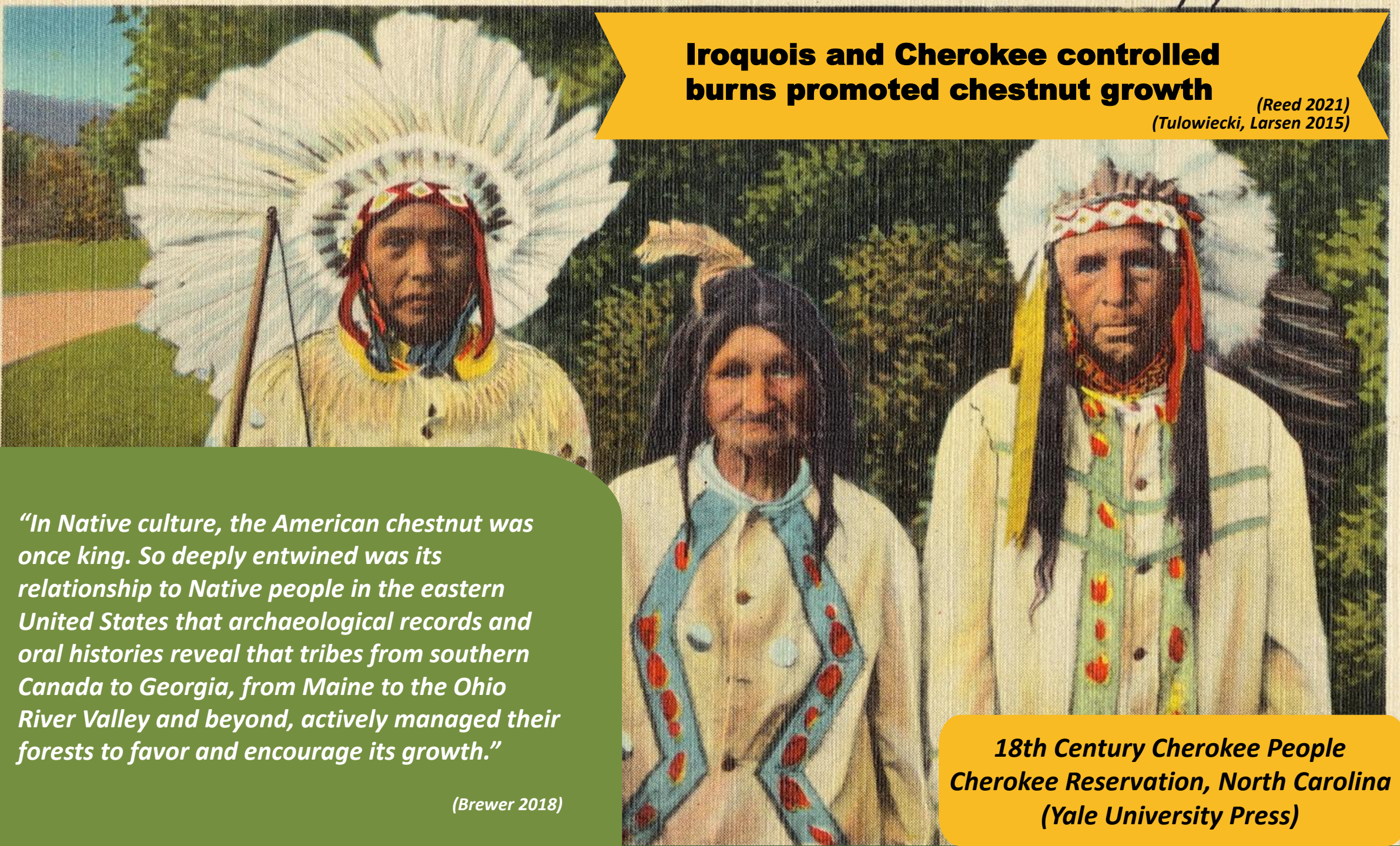
Iroquois and Cherokee controlled burns promoted chestnut growth

*(Reed 2021)
(Tulowiecki, Larsen 2015)*

“In Native culture, the American chestnut was once king. So deeply entwined was its relationship to Native people in the eastern United States that archaeological records and oral histories reveal that tribes from southern Canada to Georgia, from Maine to the Ohio River Valley and beyond, actively managed their forests to favor and encourage its growth.”

(Brewer 2018)

**18th Century Cherokee People
Cherokee Reservation, North Carolina
(Yale University Press)**



Ecological Role of the Chestnut

- Many species depended on the American chestnut
- Elimination of chestnut mast affected and resulted population decline
- Chestnut impact on the understory
 - 38+ species were documented growing near chestnuts



Chestnut Bee (endangered)



White-tailed deer



Wild Turkey



Blue Jay



Chicken of the Woods



Black Bear



Passenger Pigeon (extinct)



Hairy Fairy Cap (projectnoah.org)



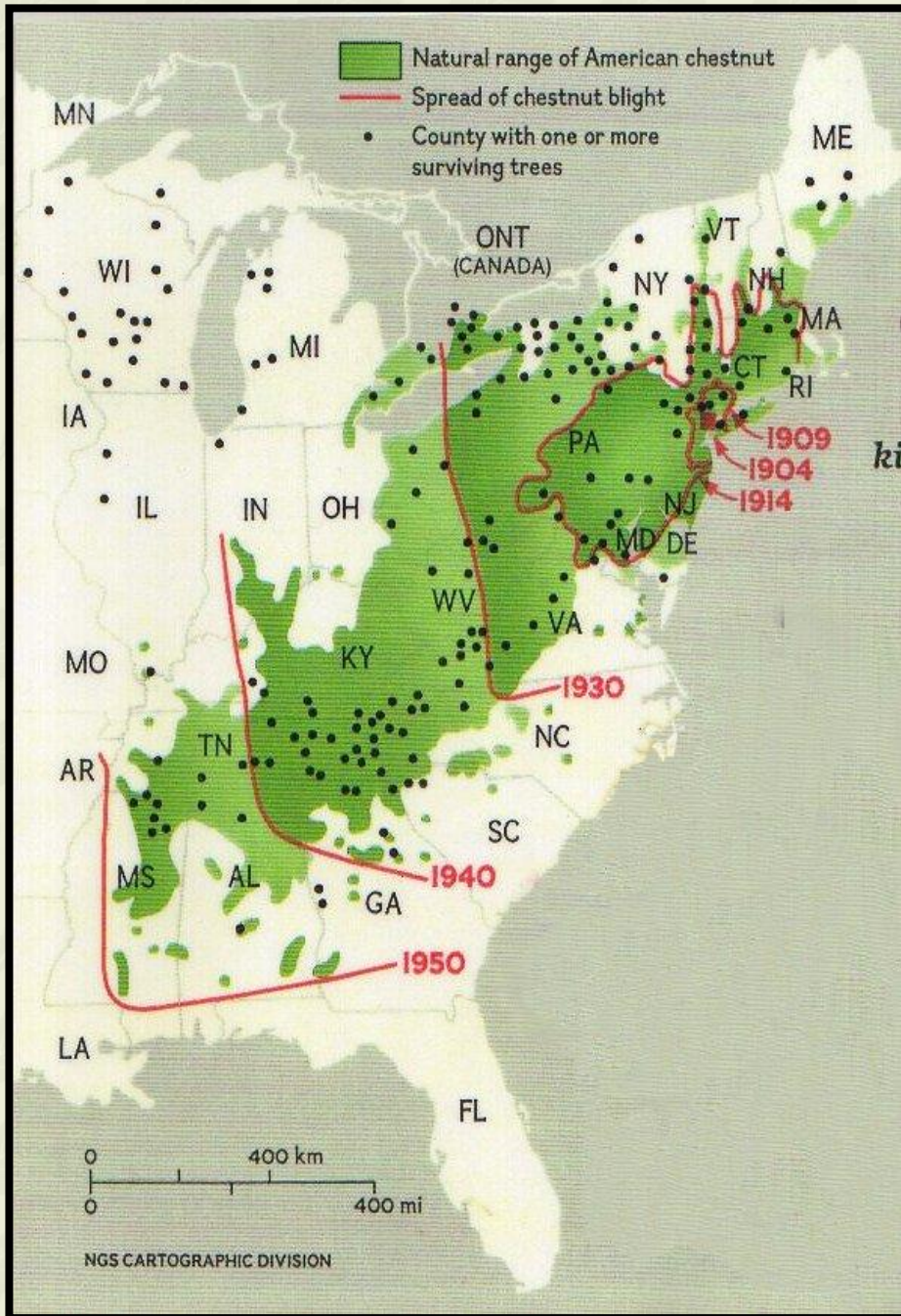
Gray Squirrel



Cooper's Hawk

(Jacobs and Severeid 2004; Ellison 2005; Davis 2021)

THE BACKSTORY



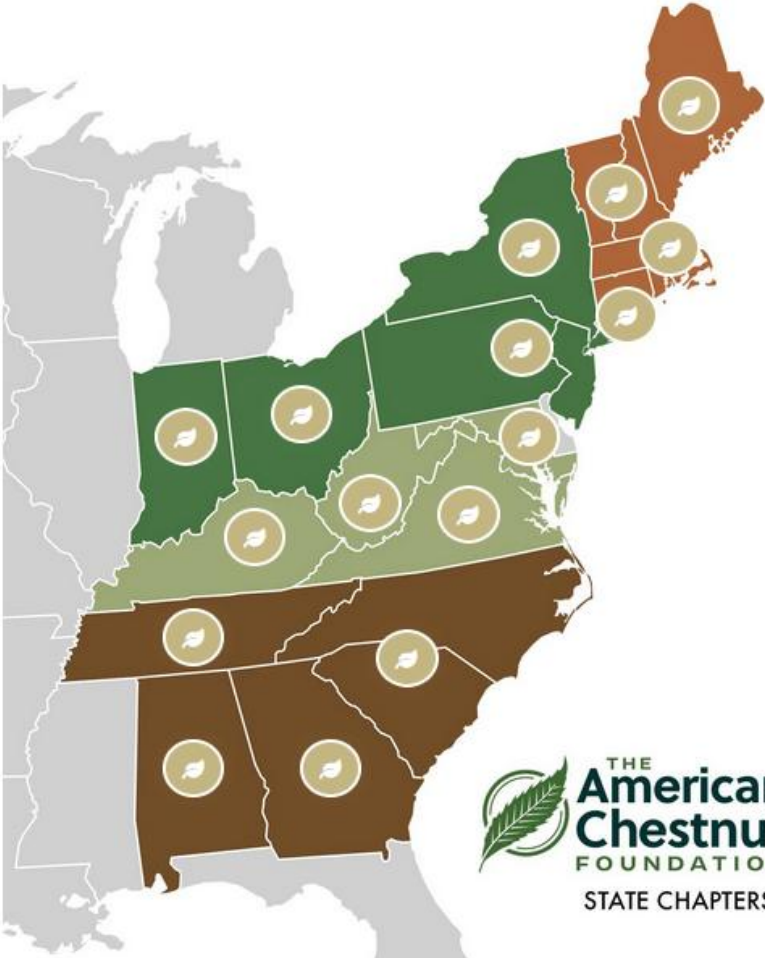
In 1904, blight was discovered on the chestnut trees at the Bronx Zoo, NYC

By 1950, blight had spread throughout the species range

Cryphonectria parasitica: A fungal pathogen that infests the bark of the American chestnut and girdles the stem



Introduction to TACF – Chapters & Volunteers



New England Region

- Connecticut
- Maine
- Massachusetts/Rhode Island
- Vermont/New Hampshire

North Central Region

- Indiana
- New York
- Ohio
- Pennsylvania/New Jersey

Mid-Atlantic Region

- Kentucky
- Maryland
- Virginia
- West Virginia

Southern Region

- Alabama
- North Carolina/South Carolina
- Georgia
- Tennessee

CONTACT TACF STATE CHAPTERS

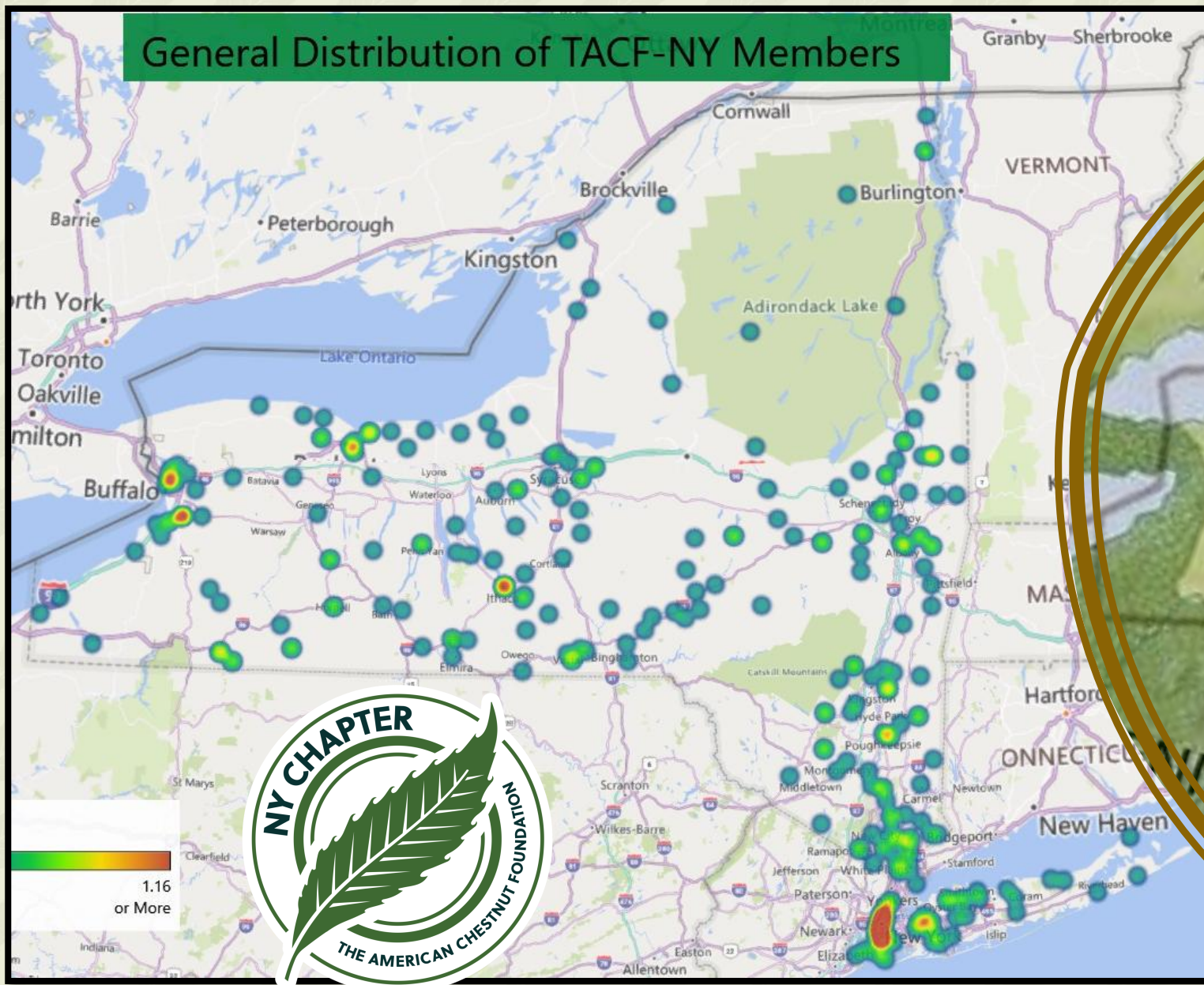




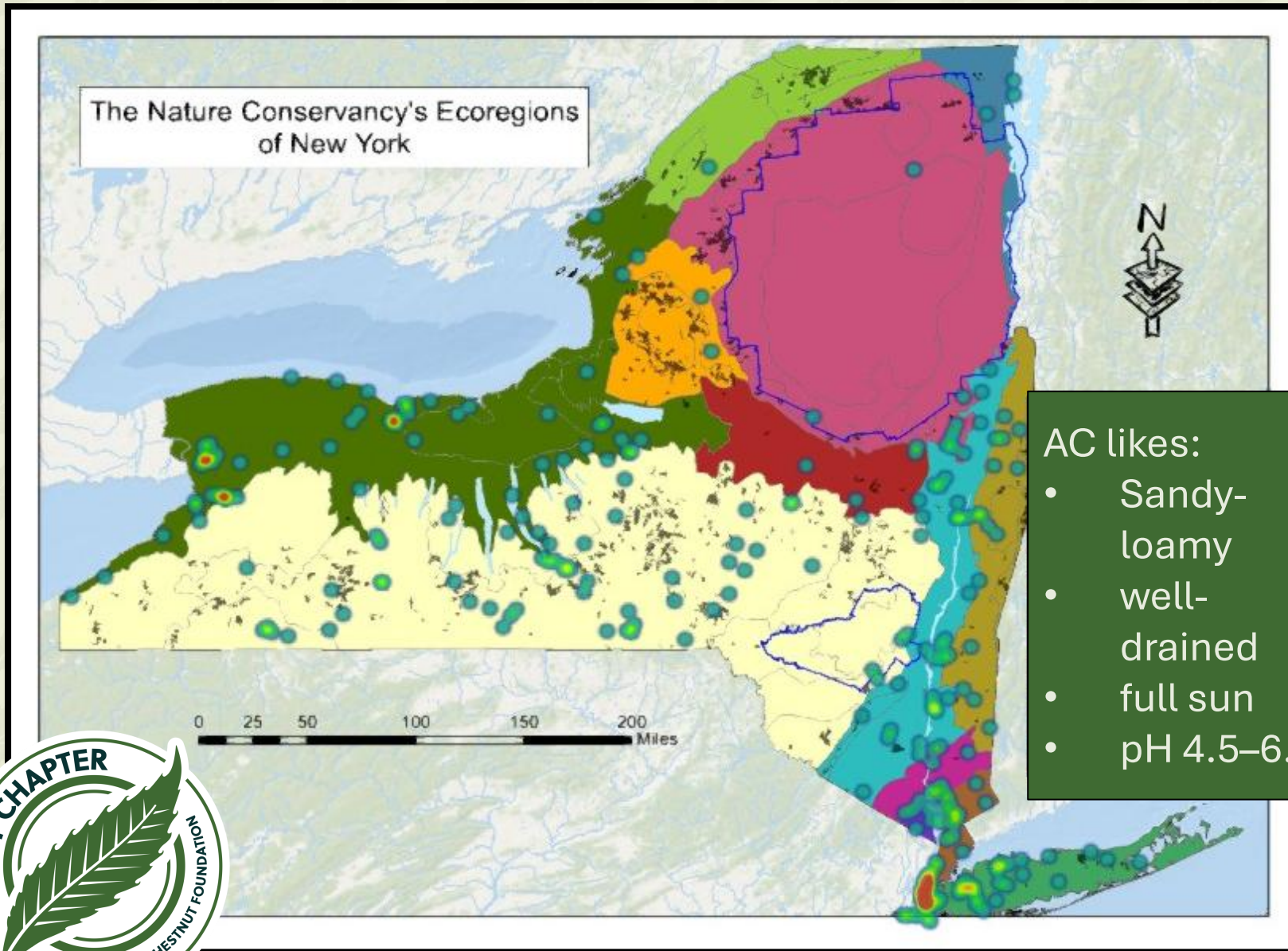
The NY Chapter from a Tree-eye View



NY's membership matches ACs historical range



People are deeply connected to place



AC likes:

- Sandy-loamy
- well-drained
- full sun
- pH 4.5–6.5

ECOREGION LEGEND

State Forests

MAJOR Ecozone

ZONE A APPALACHIAN PLATEAU
ZONE B GREAT LAKES PLAIN
ZONE C MOHAWK VALLEY
ZONE D HUDSON VALLEY
ZONE E TACONIC HIGHLANDS
ZONE F HUDSON HIGHLANDS
ZONE G TRIASSIC LOWLANDS
ZONE H MANHATTAN HILLS
ZONE I COASTAL LOWLANDS
ZONE J ST LAWRENCE VALLEY
ZONE J TUG HILL PLATEAU
ZONE K ADIRONDACK MOUNTAINS
ZONE L CHAMPLAIN VALLEY



Restoration is a Process, Not a Product

Historic Blight Control Attempts



Immediate Response

Removing healthy trees to control spread
(Lunsford 1999)



Early 1900s

Search for an ecological replacement in China, breeding, irradiating chestnuts



1920s - Today

Breeding,
Biotechnology and
Diversity

TACF's Recurrent Genomic Selection Science Strategy

Slides From: Jared Westbrook,
TACF Director of Science



Blight Resistance is a complex trait

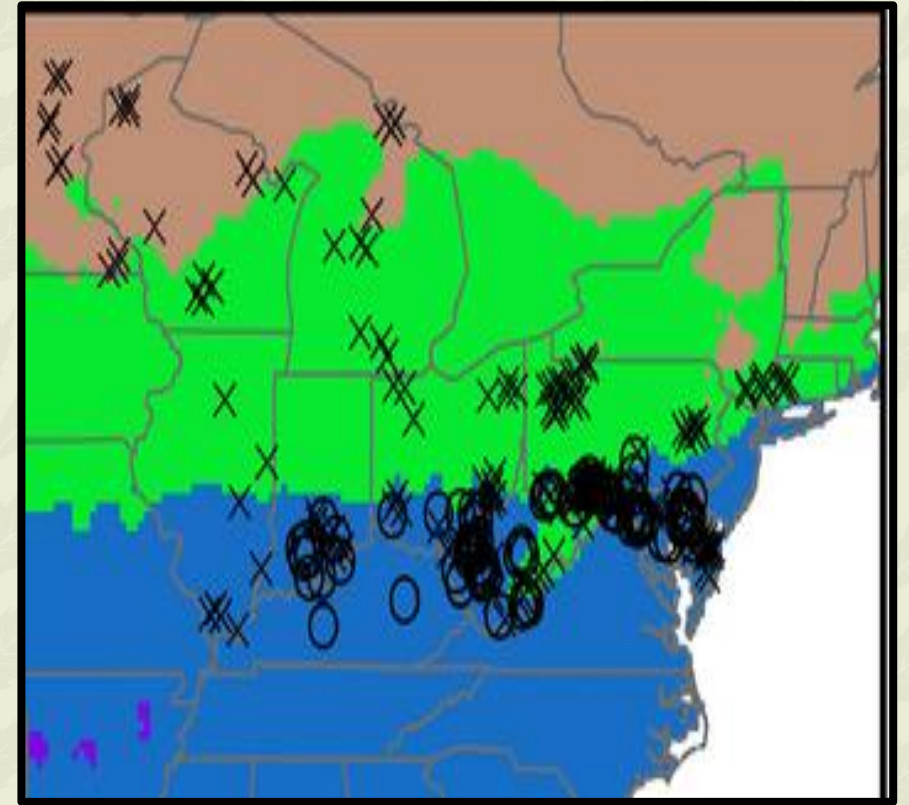
American Chestnut – State College, PA



American Chestnut – Lykens, PA



Blight is not the only challenge to AC restoration



Phytophthora root rot (PRR) caused by soil-borne pathogen *Phytophthora cinnamomi*

Predicted range of *P. cinnamomi* by 2080 (Burgess *et al.* 2017)

The North American and European *Castanea* species are susceptible, while the Asian species are resistant



The challenge: disease resistance and forest competitiveness



50 foot tall
90 year old
Chinese chestnut
< Capture disease
resistance
chestnut for long
term survival

>120 foot tall
120 year old
American chestnut

Retain forest >
competitiveness
of American
chestnut



Photo: Anna Spoul-Lattimer (Teurven Arboretum)



Steps for Recurrent Genomic Selection

The evolution of our breeding program

1. Select parents

A. Inoculate



B. Rate



C. Genotype & Phenotype



2. Cross together



The RGS cycle for chestnut

Step 1. Controlled pollinations



Average for parents:

- blight resistance > 70
- American chestnut ancestry > 70%

20 – 30 crosses x 3 regions

50 - 100 seeds per cross

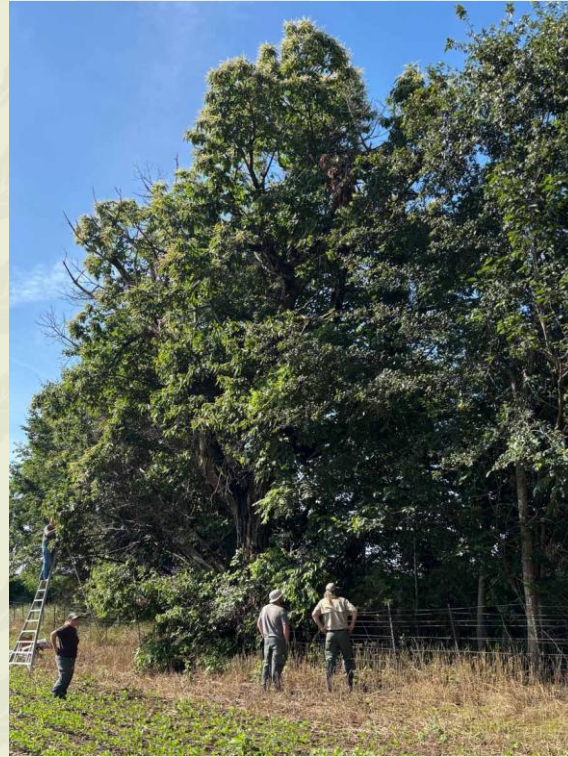
~7000 seeds per year



Meet the parents



Tree ID: VA-LSFB1-R9C2
Location: Virginia, Lesesne
American Ancestry: 100%
Blight Resistance:
Year Planted: 1990
Height: 76 feet (23.3 m) in 2023
Diameter: 44.1 inches (112 cm) in 2023



Nickname: Adair Tree
Tree ID: KY-ADAI1-A
Location: Kentucky, Adair County
American Ancestry: 100%
Year Planted: wild tree, age unknown
Height: 70 feet (21 m) estimated
Diameter: 50 inches (127 cm) estimated



Tree ID: D4-14-39
Location: Virginia, Meadowview
American Ancestry: 50%
Blight Resistance: >100
Year Planted: 2006
Height: 49 feet (15 m) in 2021
Diameter: 12.2 inches (31 cm) in 2021



The RGS cycle

Step 2. Predict & screen resilience

5000 – 6000 genotyped seedlings/yr



Seed orchards (N~800/yr)
Purpose: Select 10-20% with the highest predicted resistance. Produce large quantities of open-pollinated seed with improved blight resistance



Progeny tests (N~3800/yr)
Purpose: evaluate growth and resistance across sites, retrain genomic prediction models, select parent for next generation



SSAs (N~1500/yr)
Purpose: obtain early estimates of family average resistance, select most resistant families for planting in seed orchards



PRR trials (N~1000/yr)
Purpose: Evaluate PRR resistance in greenhouse trials. Improve prediction models.



Selection for improved blight resistance & majority American chestnut ancestry



Main stem
alive?



Cankers >
15 cm?



Cankers
sunken?



% canopy
dead



Exposed wood?



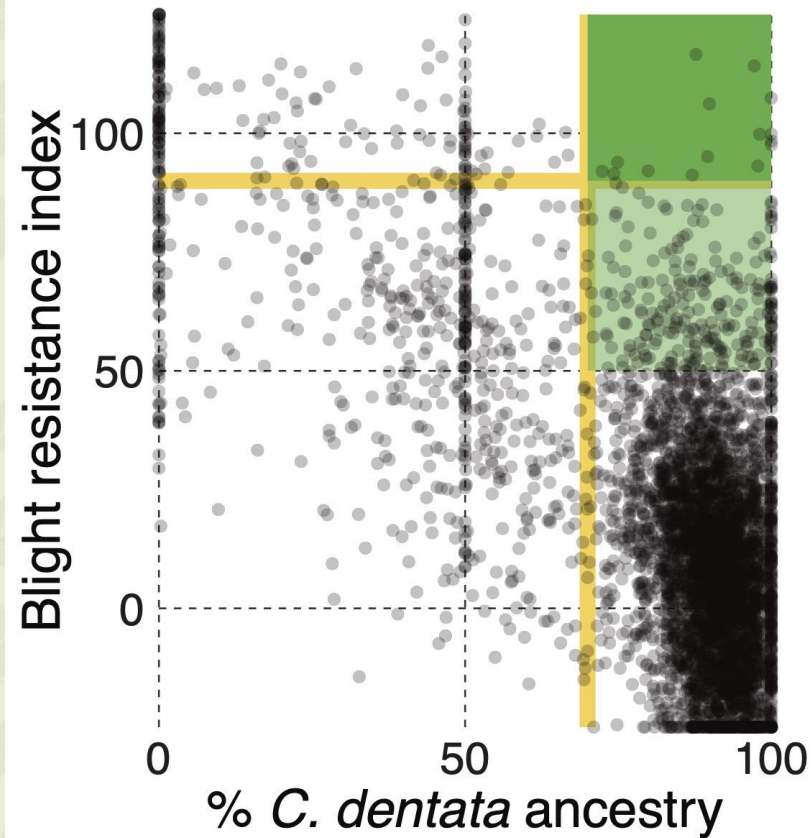
Sporulation?



Stump sprouts?

Blight resistance traits

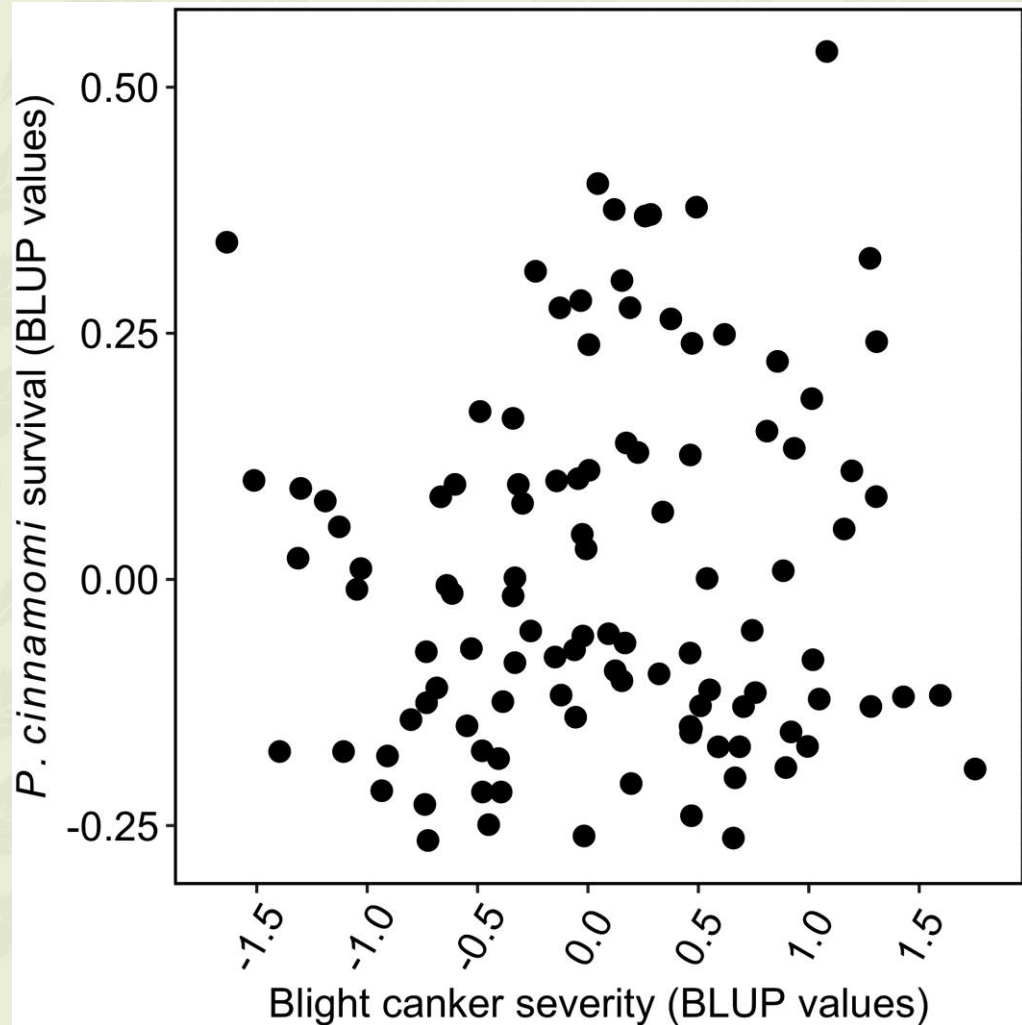
C Disease Resistance



Trees with
blight
resistance >
50 and
American
chestnut
ancestry 70%
- 100%



.... And Phytophthora root rot (PRR) resistance



Genetic correlation between survival after inoculation with *P. cinnamomi* and chestnut blight canker severity (best linear unbiased predictions [BLUP] values) among chestnut seedlings from 103 Graves BC₃F₃ families.





Breeding: Recurrent Genomic Selection

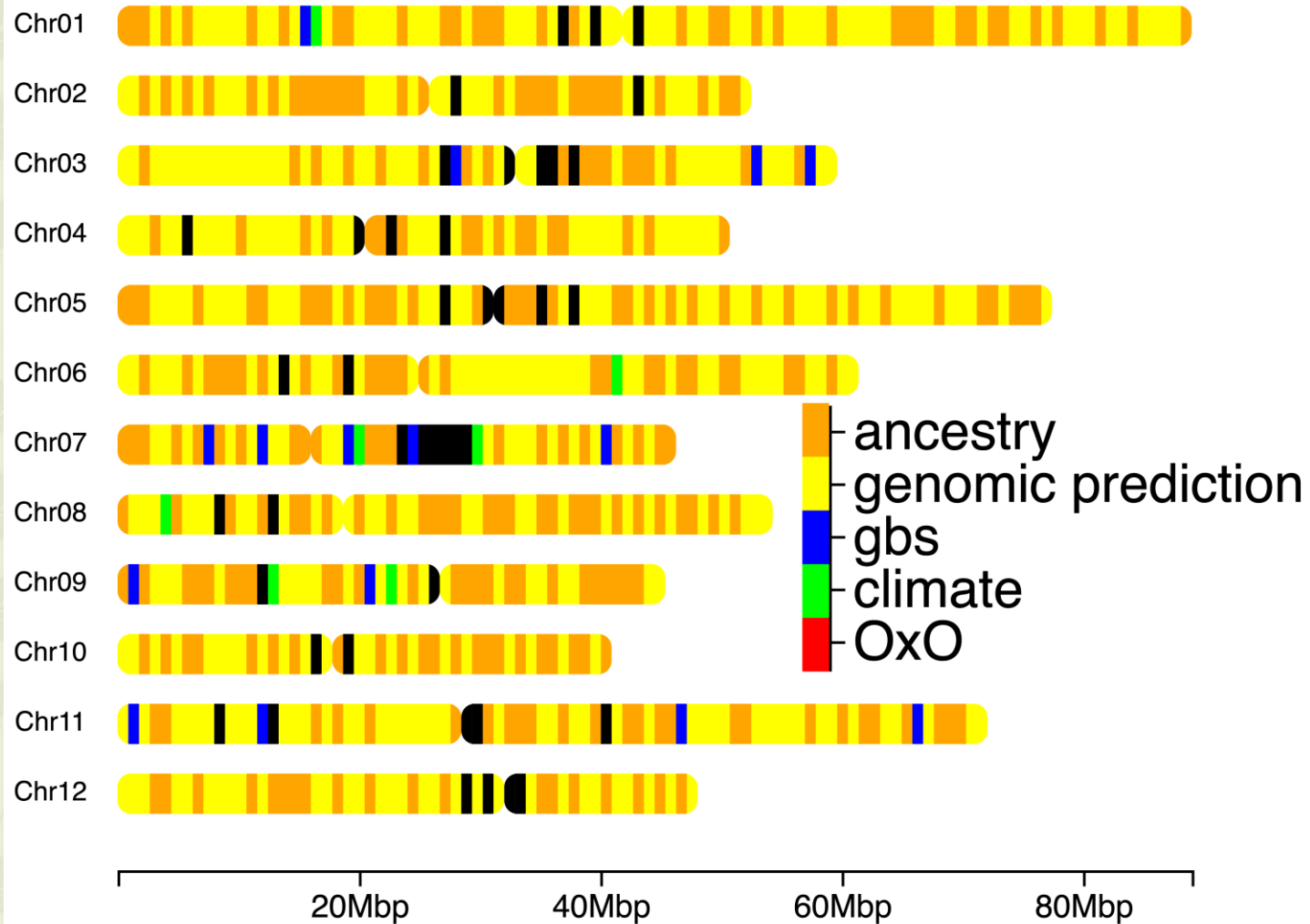
3. Select the best candidates



4. Plant next generation seed orchards



Development of an affordable platform for genomic prediction of disease resistance & ancestry



\$18 Per Tree

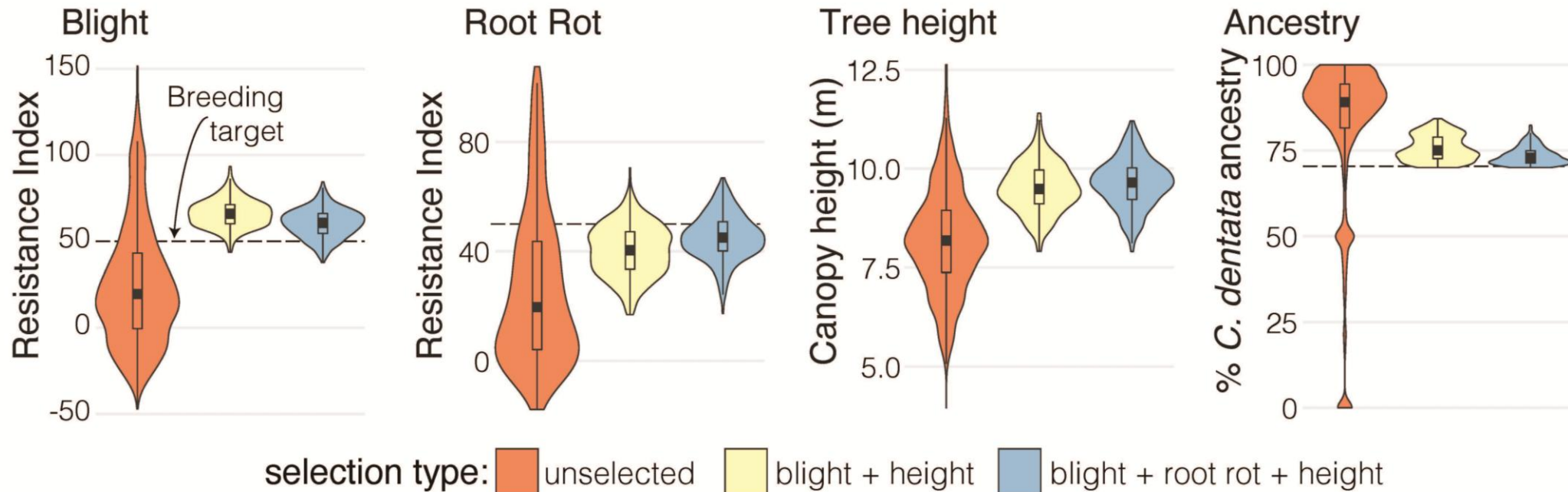
6500 markers of two types

- High minor allele frequency (MAF > 0.2)
- Ancestry informative



10y goal: Double resistance + increase competitiveness

B Predicted gains in the first RGS cycle



Predicted increases in population average blight, root rot, and tree height from one generation of controlled crosses followed by genomic selection of 20% of the highest performing progeny



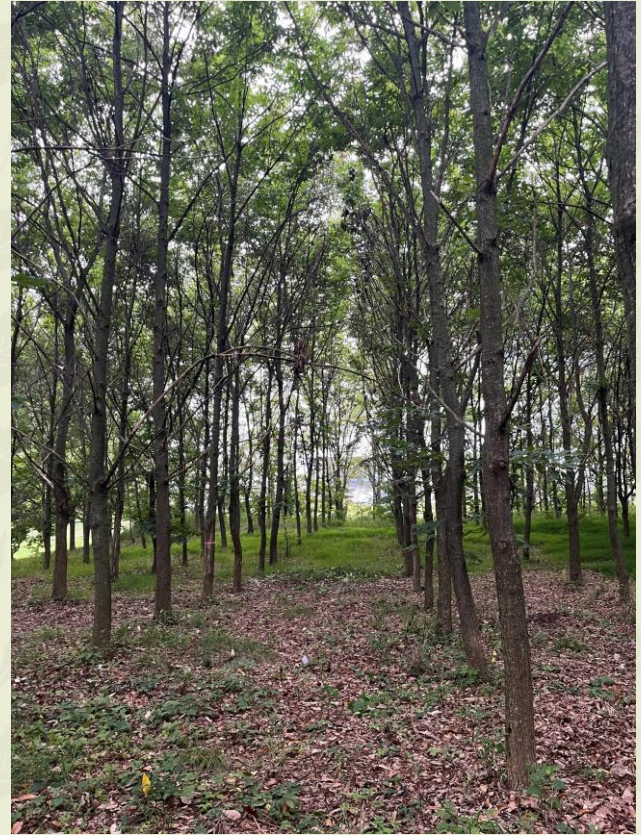
Blight Resistance Index Examples



Blight resistance Index: 0
Tree ID: Not Assigned
Location: Woolrich, PA
American Ancestry: 100% (assumed)
Year Planted: Before 1930
Height: 12 feet in 2019
Diameter: 2 inches



Blight Resistance Index: 69
Tree ID: D1-3-59
Location: Meadowview, VA
American Ancestry: 87.4%
Year Planted: 2008
Height: 41 feet in 2021
Diameter : 7.2 inches



Blight Resistance: 100
Tree ID: Walizer Tall Chinese
Location: Hublersburg, PA
American Ancestry: 0%
Year Planted ~ 2004 (Coppiced)
Height: 40 feet in 2024
Diameter: 9 inches



RGS: What does success look like?

Blight resistance



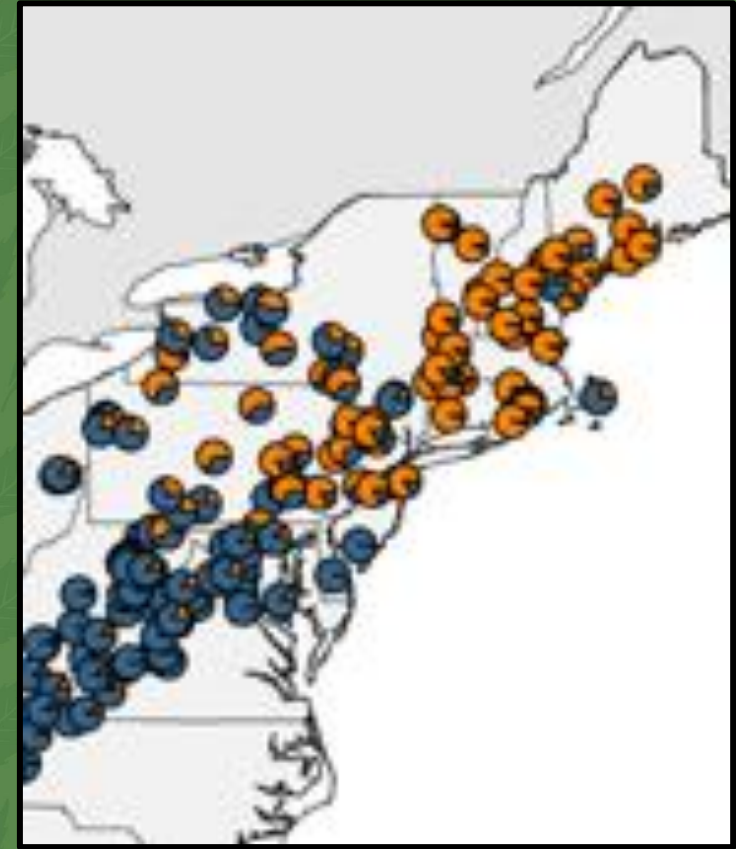
Phytophthora root rot resistance

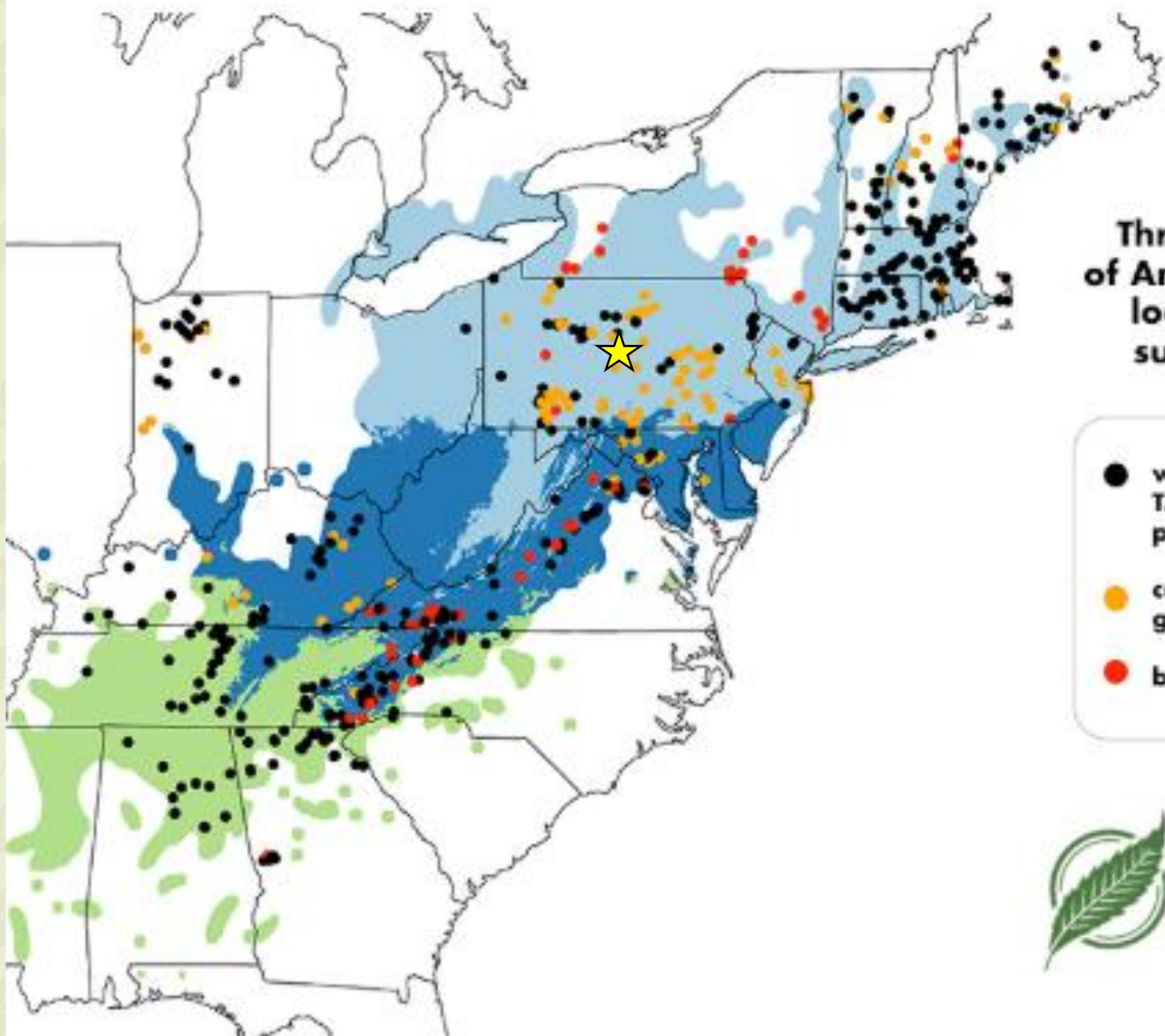


Forest competitiveness



Diversity and climate resilience



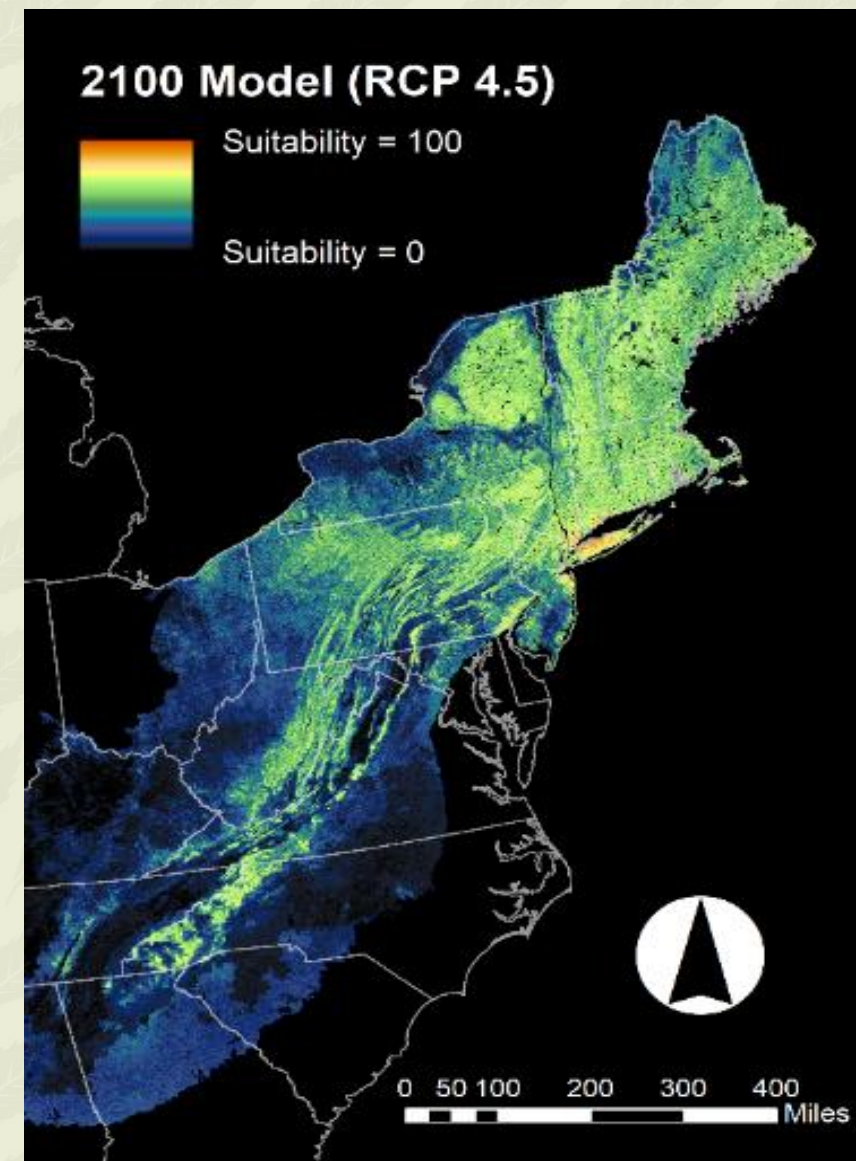
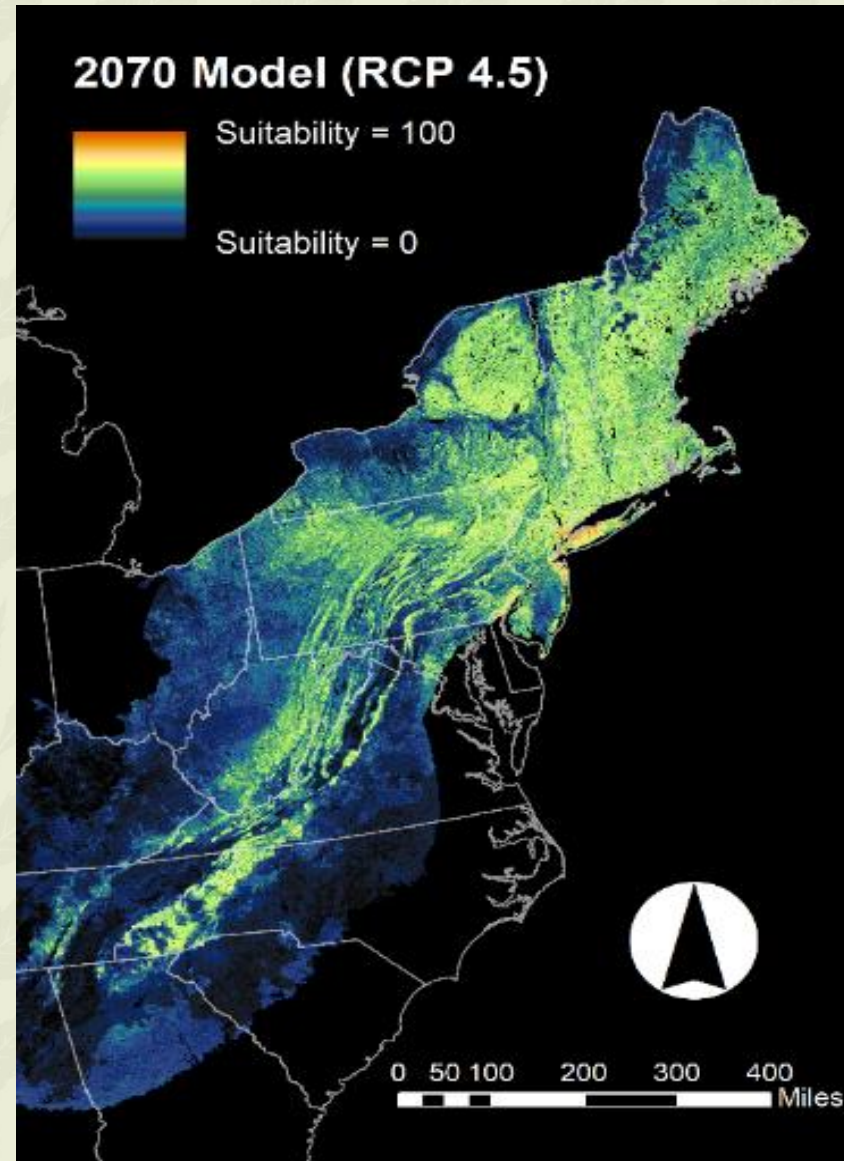
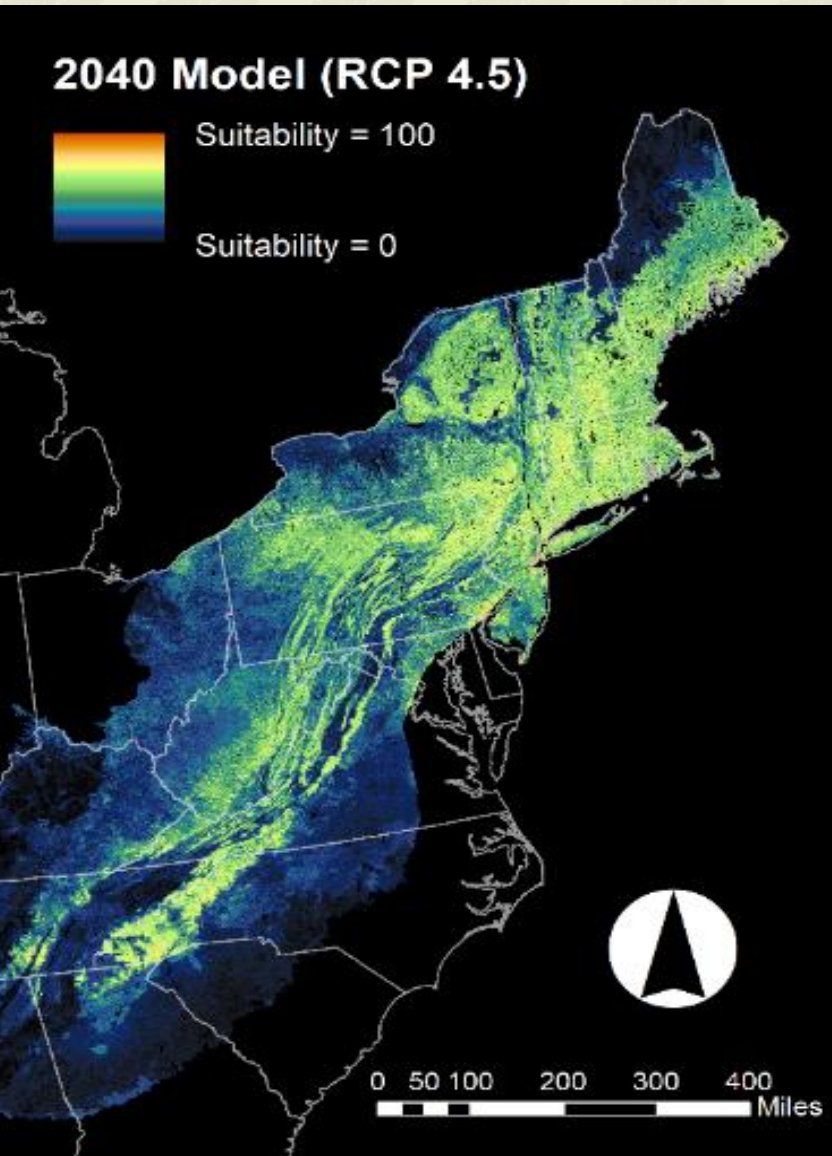


**Three seed zones
of American chestnut
locally adapted
subpopulations**

- wild trees used in
TACF's backcross
program
- conserved in
germplasm orchards
- both

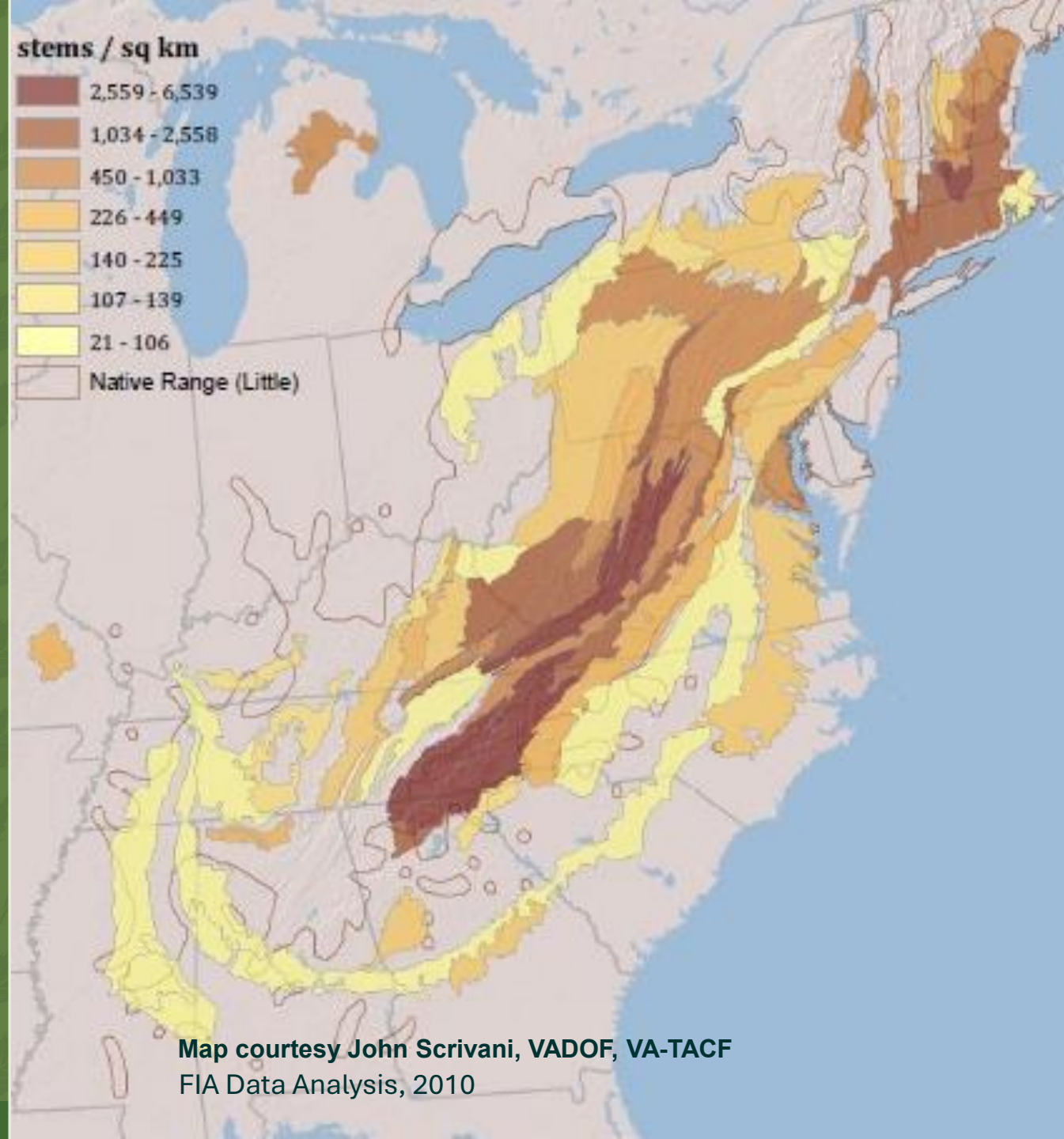


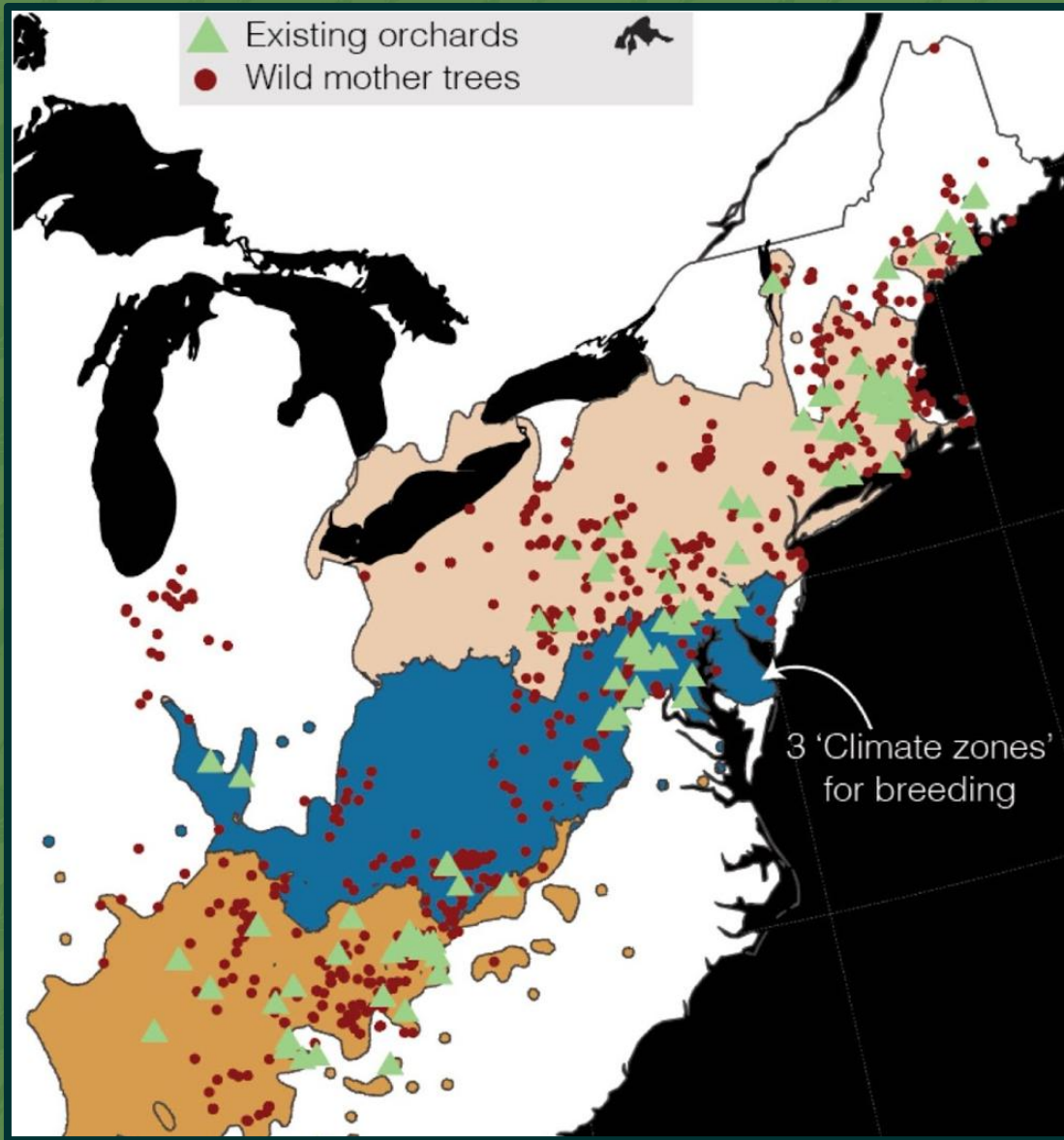
Anticipating a changing climate



Current American chestnut populations

- Not threatened, endangered, or extinct but **Functionally Extinct**
- 430M stems: 84% < 1" dbh (*Dalgleish et al 2014*)





Regionalized Diversity

Adaptive diversity target:
Conserve enough *C. dentata*
individuals each seed zone to
match adaptive allele frequencies
at $R^2 = 0.99$

Collaborate across chapters for
crosses to conserve > 95% of the
adaptive diversity from *C. dentata*

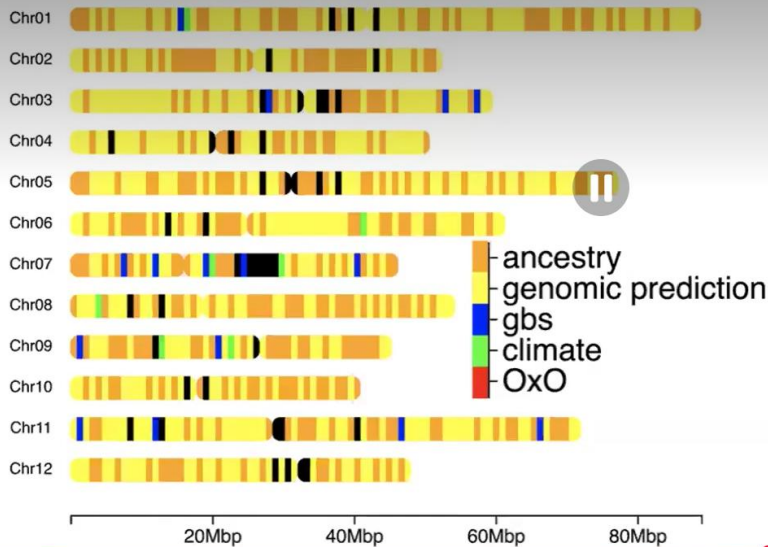
Analyses by Alex Sandercock

Check Out Jared's Presentation: Chestnut Chat #52

Chestnut Chat 52: September 20, 2024 -Assisting Evolution: The History of American Chestnut Breeding and New Innovations

Chestnut Chat: The History of American Chestnut Breeding and New Innovations
The American Chestnut Foundation

Development of a cost effective platform for genomic prediction of disease resistance & ancestry



Chr01
Chr02
Chr03
Chr04
Chr05
Chr06
Chr07
Chr08
Chr09
Chr10
Chr11
Chr12

ancestry
genomic prediction
gbs
climate
OxO

20Mbp 40Mbp 60Mbp 80Mbp

DArT | diversity arrays technology

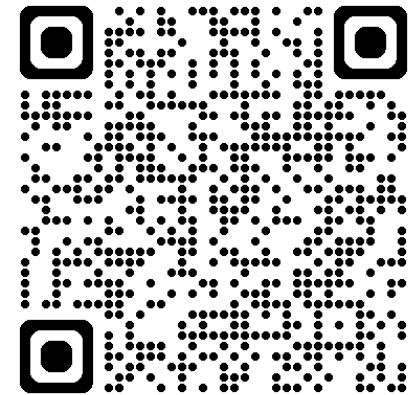
Jared Westbrook

54:59 / 1:29:49

More videos YouTube

www.tacf.org/chestnut-chat/

Scroll to Chat #52



Part 2

How can New York Get Involved in These Efforts?



**Eric Oliver, Green Forests Works, Points to American chestnut
planted in mine reclamation site near Philipsburg, PA - 2024**



NY has room
to grow...
Literally.



Find and Report Wild American Chestnuts



Wild Tree Identification









Diversity

Germplasm Conservation Orchards (GCO)

- 10 unique wild sources
- 10 trees/source
- Planted from seed or grafted seedlings

Plant Wild American Chestnuts

- Participate in “ex situ” conservation with Germplasm Conservation orchards
- Plant 2+ wild-type AC
- Encourage your municipality, local land trust, or school to plant wild-type AC



Become a Member

Join the more than 5,000 chestnut enthusiasts we're proud to call supporters of American chestnut restoration!

Membership supports:

- TACF's multi-generational effort to restore the American chestnut tree
- Meadowview Research Farms
- University partners + forestry students
- TACF's external grants program
- Local chapters and volunteer efforts
- Free American chestnut education and science updates





Big American
Chestnut Tree
Still Alive in
Indiana (the state)

Roselawn, Indiana – 2024
Diameter: 3' 6.5"
Height: 6'
Dominant Crown
<100 Years Old (estimated)









Wild Tree Identification



Wild Tree Identification

- All chestnut species can cross-breed (hybridize)
- Over 80% of leaves sent to TACF for ID usually end up as either Chinese or Chinese/American hybrids
- PlantNet can be a useful tree ID app, photos can be uploaded to their website or app (Android, IOS)
- TACF provides free chestnut tree ID to the public
 - Visit <https://tacf.org/identification/> for instructions



Wild Tree Identification

- A good place to start is to compare the leaf against the Chinese Chestnut
- Three other trees that may also be mistaken are chestnut oak, beech, and horse chestnut

American chestnut
Castanea dentata



Chinese chestnut
Castanea mollissima



Chestnut oak
Quercus montana



American Beech
Fagus grandifolia



Chestnut oak
Quercus montana



Nine species of chestnuts and chinquapins

American chestnut
Castanea dentata

Allegheny chinquapin
Castanea pumila

European chestnut
Castanea sativa

Chinese chestnut
Castanea mollissima

Japanese chestnut
Castanea crenata

Ozark chinquapin
Castanea ozarkensis

Alabama chinquapin
Castanea alabamensis

Henry chinquapin
Castanea henryi

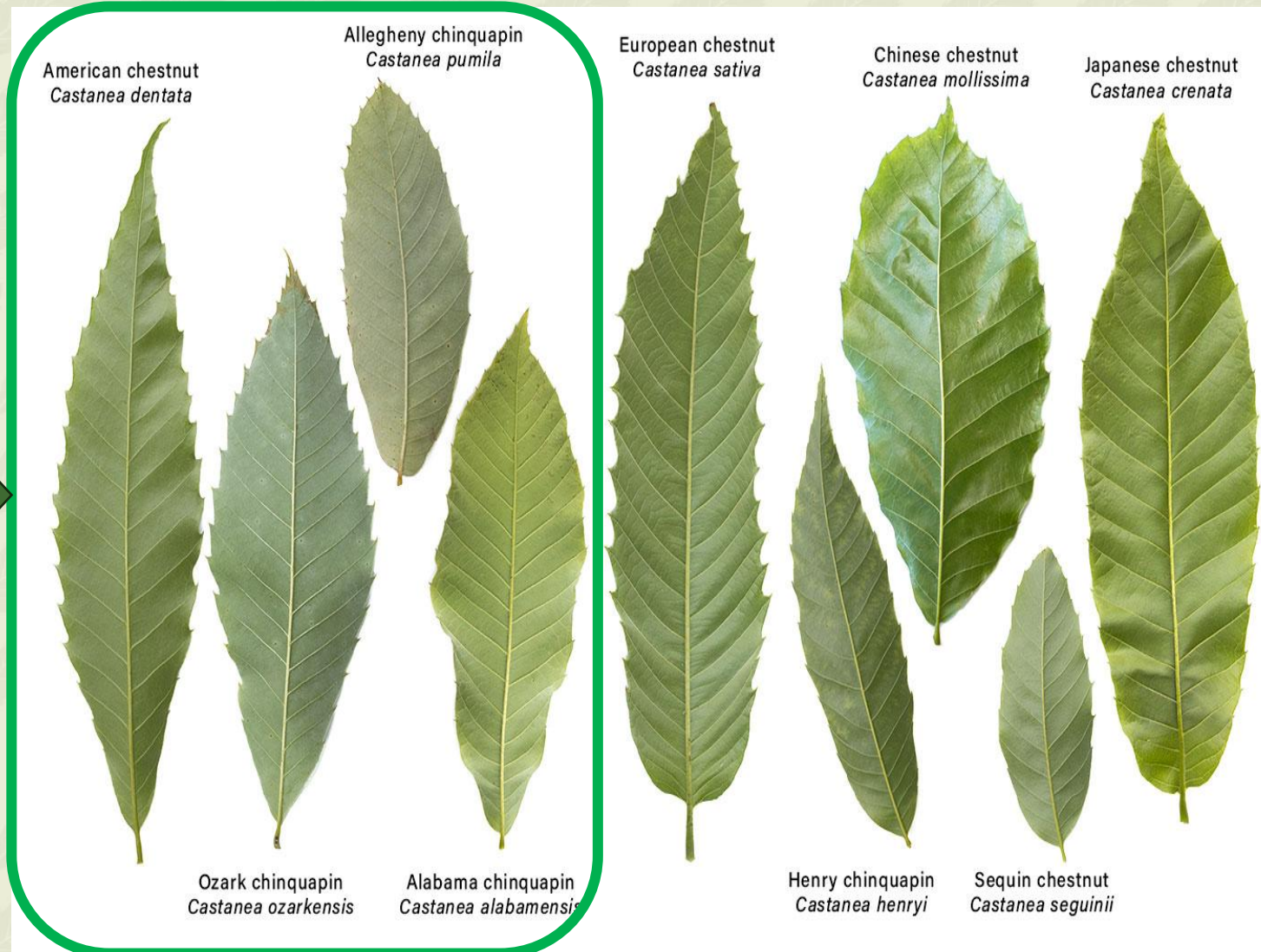
Sequin chestnut
Castanea seguinii

Due to importing of other species, Chinese chestnut is the most common

Native
to NA



Nine species of chestnuts and chinquapins



American Leaf

- Leaf is long in relation to its width
- Large, prominent teeth on edge; bristle at the end of each tooth curves inward like a breaking wave
- Base of leaf blade tapers sharply
- Leaf is very thin and papery
- Lighter green underside on leaves exposed to the sun

Chinese Leaf

- Leaf is oval-shaped
- Teeth are smaller
- Base of leaf blade is rounded
- Leaf is thick and waxy-feeling
- Underside of sun leaves look whitish because of many hairs



Bur Anatomy



Example of Chestnut Burs

From Top, Clockwise: Allegheny chinkapin, European chestnut, Japanese chestnut, Chinese chestnut, and American chestnut burs

Note that the Chinese bur looks small, even though the nuts inside are large. This is because of their short, stubby spines.

Chestnut Bur Anatomy

Chestnut burs have two sutures and open into four valves (sections). There are up to three nuts per bur



Chinkapin Bur Anatomy

Chinkapin burs have one suture and open into two valves (sections). There is only a single nut per bur



American Chestnut Burs (left):

- A dense mass of long, slender spines
- Spines are 2 to 3 cm long, 0.5 mm thick
- Up to 3 nuts per bur

Chinese Chestnut Burs (right):

- A sparse mass of short, thick spines
- Spines are 1 to 2 cm long, 1 mm thick
- Up to 3 nuts per bur



Stems & Buds



Photo of Stems

From Left: American, Chinese, European, and Japanese twigs

American twig: pointed bud at 45 degree angle from stem; smooth, reddish stem

Chinese twig: rounded, hairy buds, large stipules (leaf-like coverings over the buds), large lenticels (white “bumps” on stem)

European twig: thick stem, large buds

Japanese twig: pale, pinkish stem



Stems & Buds

American Buds & Lenticels

- Pointed buds that angle away from the stem
- Stems smooth and hairless
- Stem color reddish brown to dark green
- Small but numerous lenticels on stem



Chinese Buds and Lenticels

- Rounded buds that hug the stem
- Hairy stems and hairy leaf veins
- Stem color tan to pea-green
- Large lenticels (bumps) on stem



Stipules

American Stipules

- Slender
- Angle sharply out from stem
- Usually fall off in June



Chinese Stipules

- Broad
- Cover the buds
- Remain on the stem through September



Nuts



Top View of Chestnuts

Top: Chinkapin nuts: note the pointed end

Middle: American chestnuts: note the hairy surface

Bottom: Chinese chestnuts: note the rounded end



Side View of Chestnuts

From Left: American, Chinese, Japanese, and European chestnuts.

American Chestnuts:

- Nuts are relatively small, 1/2 to 1 inch in diameter
- Tips of American chestnuts are pointed
- Nuts are hairy over 1/3 to 2/3 of length from pointed end
- Vascular bundles in a sunburst pattern on hilum end
- 2 to 3 nuts in each bur

Chinese Chestnuts:

- Nuts are relatively large, 3/4 to 2 inches in diameter
- Tips of Chinese chestnuts are rounded
- Only the tips of the nuts are hairy
- Vascular bundles in a diffuse pattern on hilum end
- 2 to 3 nuts in each bur

