Conservation of High-Elevation Red Spruce (*Picea rubens*) and Fraser Fir (*Abies fraseri*) in the Southern Appalachians

Andrew Whittier, Robert Jetton, Gary Hodge - Camcore, NCSU
Barbara Crane – USDA Forest Service
November 15, 2017

camcore
Global partners for the future of our forests

NC STATE UNIVERSITY College of Natural Resources

Department of Forestry & Environmental Resources

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

camcore
Global partners for the future of our forests
NC STATE

WHAT IS CAMCORE

- Forestry research cooperative program formed in 1980
- Originally focused on the pines of Central America and Mexico
- Collaboration of private industry and NC State University
- Department of Forestry & Environmental Resources, College of Natural Resources, NCSU

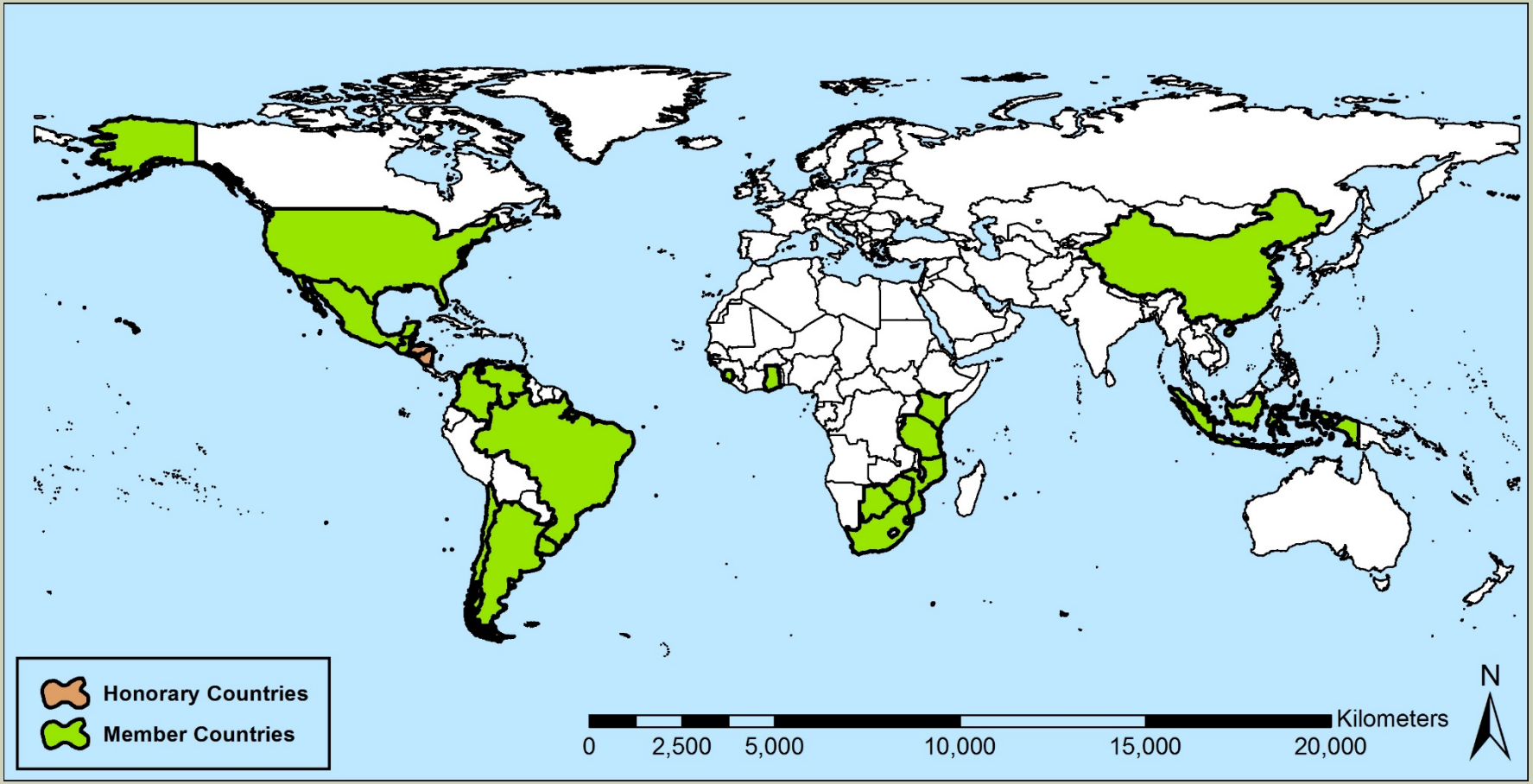
camcore
Global partners for the future of our forests
NC STATE

WHAT IS CAMCORE

- Specialize in applied conservation and breeding of forest genetic resources
- Utilize an *Ex situ,* or off site, approach
- Work with more than 40 tropical & subtropical species, both hard and softwoods: *Pinus*, *Gmelina*, *Eucalyptus*, *Tectona, etc.*
- Work with ten domestic temperate species

camcore
Global partners for the future of our forests
NC STATE

MEMBERSHIP



40 Industrial & Governmental organizations in 20 countries (29 full, 4 associate, 7 honorary)

camcore
Global partners for the future of our forests
NC STATE

CAMCORE OBJECTIVES

- Gene Conservation
  - Collect genetic material from threatened and endangered species and provenances
- Breeding and Tree Improvement
  - Species and provenance testing, pure species and hybrid breeding
- Species Characterization
  - Reproductive biology, nursery requirements, silviculture, wood properties, disease resistance, etc.
- Research and Development
  - Developing technology to make breeding more efficient

camcore
Global partners for the future of our forests
NC STATE

GENE CONSERVATION

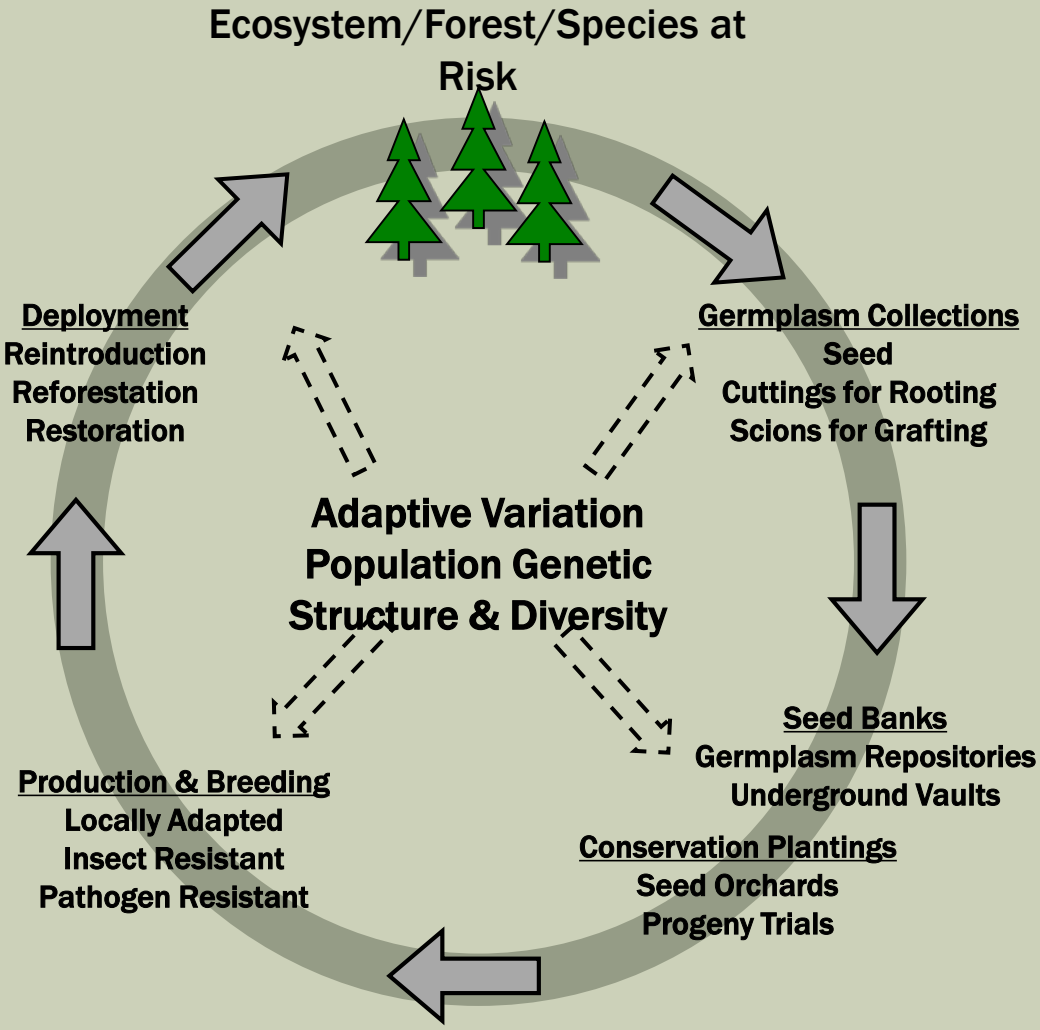
- Policy & management actions taken to assure the continued availability and existence of genetic variation (FAO 2001)
- Essential component of sustainable forestry
- Genetic diversity is the core of the adaptive value of ecosystems, forests, and species
- *In Situ*: protection of threatened ecosystems, forests, or species within their native habitat
- *Ex Situ*: off site protection of species and populations in seed banks, conservation plantings, progeny trials, arboreta, etc.

ADAPTIVE (*Ex situ*) GENE CONSERVATION

- **Priorities:**

1) Adaptive variation
2) Genetic diversity

- **Goal:** Maintain viable populations in the event the species of concern is functionally eliminated so that representative genetic material is available for future restoration activities.



camcore
Global partners for the future of our forests
NC STATE

Pinus patula REINTRODUCTION IN MEXICO

camcore
Global partners for the future of our forests
NC STATE

CAMCORE EFFORT

- The Camcore/USDA Forest Service program aims to maintain in perpetuity viable *ex situ* genetic material for use in breeding and restoration activities
- We are an insurance policy against a worst case scenario



camcore
Global partners for the future of our forests
NC STATE

SEED COLLECTION STRATEGY

- Based on previous molecular diversity studies (Dvorak et al. 1999. *Forest Genetics* 6:21-28)
- 10-20 trees per population to capture most alleles occurring at 5% or greater assuming low to moderate genetic diversity
- 6-10 populations across species range to capture broad environmental adaptability

camcore
Global partners for the future of our forests
NC STATE

SEED STORAGE

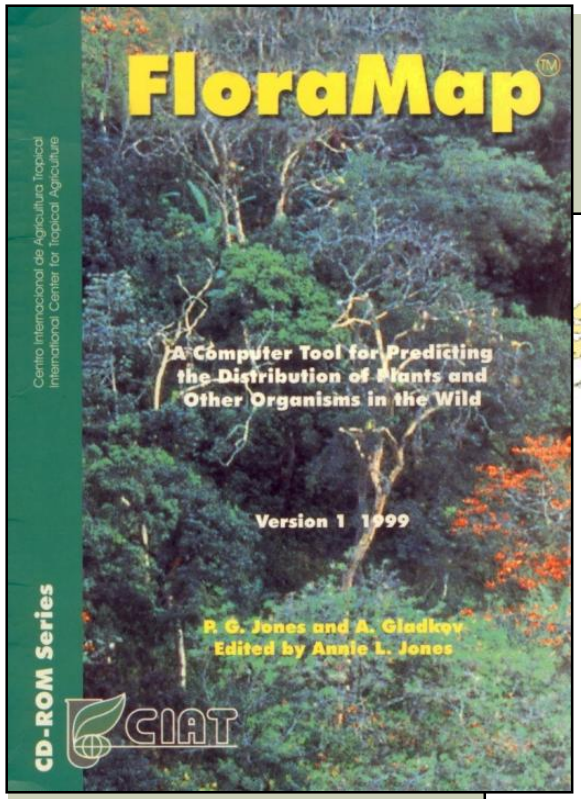
Carolina Hemlock Seed

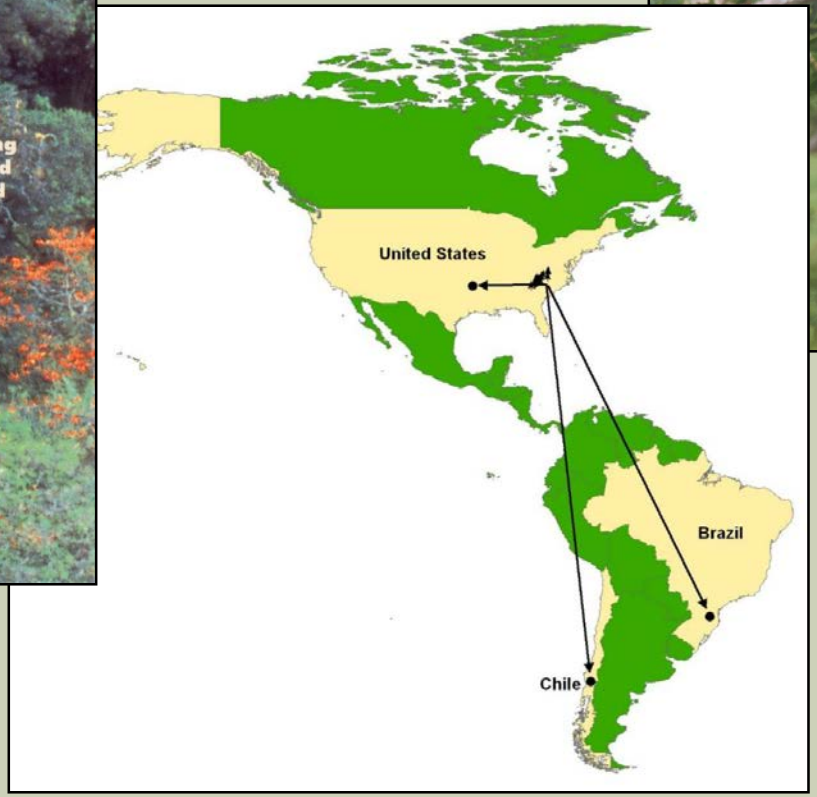
USA National Seed Bank in Fort Collins, CO
Credit: Tom Parkin

- Seedbank
- Little concern for adaptive variation
- Static, dead end for some species

camcore
Global partners for the future of our forests
NC STATE

Ex situ CAROLINA HEMLOCK PLANTINGS





camcore
Global partners for the future of our forests
NC STATE

DOMESTIC CONIFER CONSERVATION PROJECTS

Carolina Hemlock

Eastern Hemlock

Table Mountain Pine

Atlantic White Cedar

Fraser Fir

Red Spruce

camcore
Global partners for the future of our forests
NC STATE

DOMESTIC CONSERVATION RARE ASH SPECIES

Carolina Ash

Blue Ash

Pumpkin Ash

Texas Ash

camcore
Global partners for the future of our forests
NC STATE

DOMESTIC CONSERVATION

Objective

Conservation of native tree species threatened by invasive insects and pathogens, wildfires or fire suppression, habitat degradation, air pollution, climate change, and other disturbances.

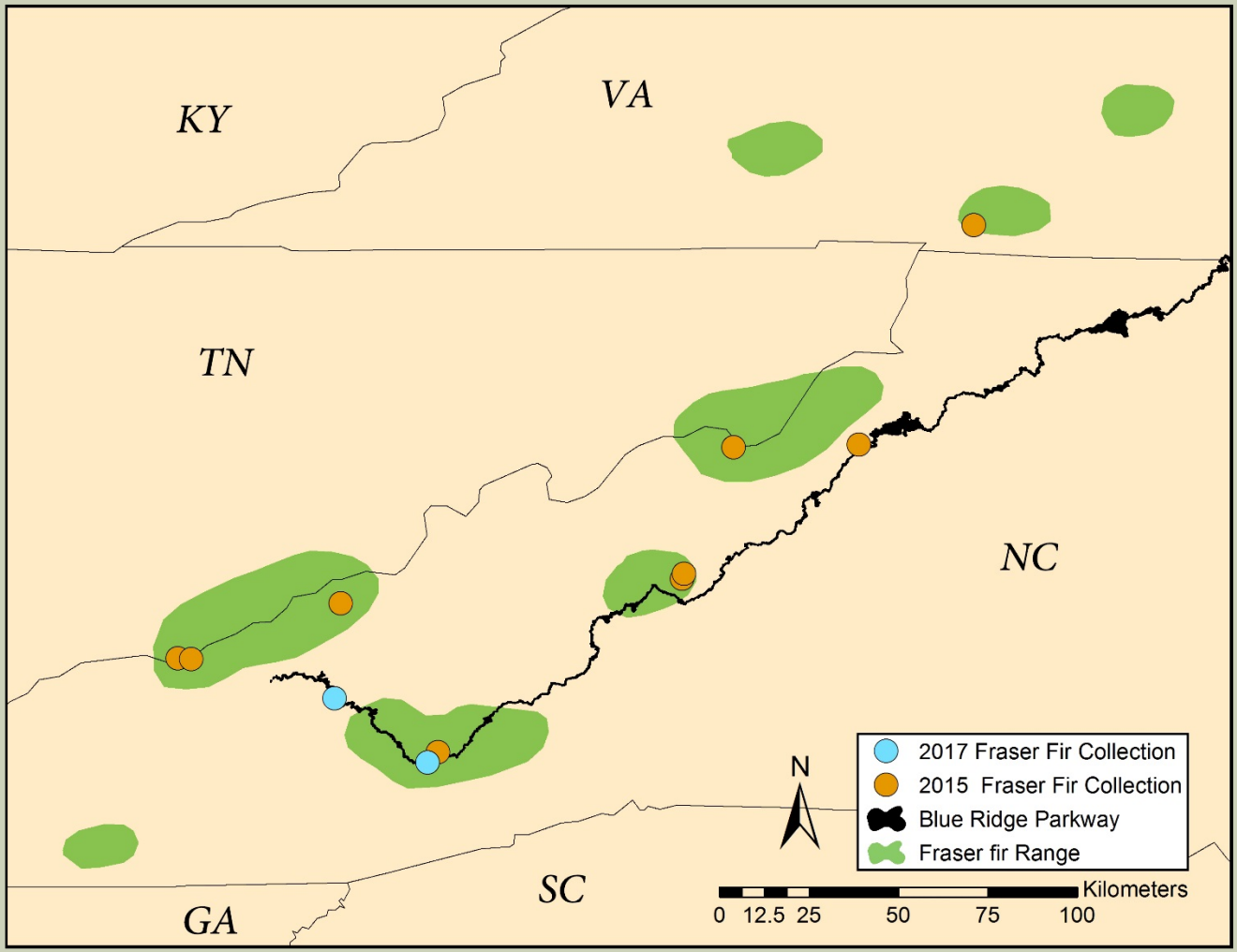
camcore
Global partners for the future of our forests
NC STATE

FRASER FIR

- *Abies fraseri*
- Endemic to high elevations in the southern Appalachians
- Primary Threat is the Invasive Insect Balsam Woolly Adelgid (*Adelges piceae*)
- Concerns climate change may reduce suitable high elevation habitats
- Highly valued in Christmas tree and ornamental industries
- Ecologically important
- Camcore/USFS conservation project began in 2014

camcore
Global partners for the future of our forests
NC STATE

FRASER FIR SEED COLLECTIONS



camcore
Global partners for the future of our forests
NC STATE

FRASER FIR SEED COLLECTIONS

Site	State	Elevation (m)	Year	Number of Trees
NCSU CTG Bulk	NC	1141	2012	1 Bulk
NCSU CTG Bulk	NC	1141	2014	29
Grandfather Mountain	NC	1686	2015	13
Mt Mitchell	NC	1998	2015	20
Double Spring GSMNP	TN	1808	2015	11
Clingman GSMNP	NC	1986	2015	10
Roan Mountain	NC	1865	2015	17
Mt. Rogers	VA	1676	2015	10
Mt. Sterling	NC	1746	2015	2
Black Balsam	NC	1782	2015	6
Hooper Bald	NC	1653	2015	10
Black Mt Crest	NC	2012	2016	1
Waterrock Knob	NC	1667	2017	4
Mt Hardy	NC	1640	2017	3

13 Sites, 137 Trees

camcore
Global partners for the future of our forests
NC STATE

FRASER FIR PROJECT FUTURE

- Companion population genetic structure and diversity study
- Seed currently in refrigerated and cryostorage with both NCSU and the USFS
- Future collections will focus on Smokies, Virginia, and areas around Roan Mt
- Locate suitable restoration and orchard sites
- Establish seed orchards

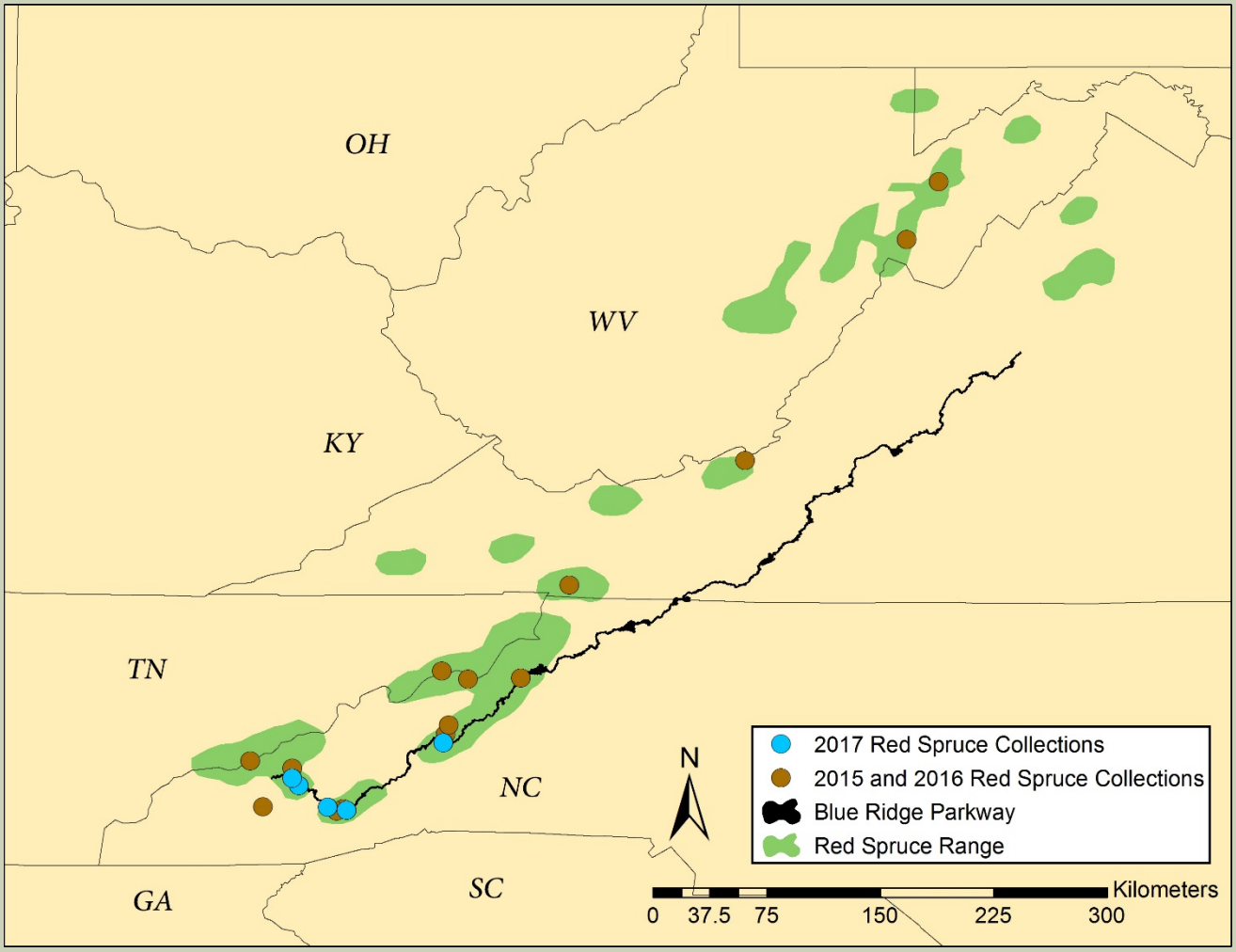
camcore
Global partners for the future of our forests
NC STATE

RED SPRUCE

- *Picea rubens*
- Extensive logging followed by wildfires in the late 1800s and 1900 destroyed many populations
- Concerns climate change may reduce suitable southern high elevation habitats
- Highly valued wood
- Ecologically important
- Camcore/USFS conservation project began in 2014

camcore
Global partners for the future of our forests
NC STATE

RED SPRUCE SEED COLLECTIONS



camcore
Global partners for the future of our forests
NC STATE

RED SPRUCE SEED COLLECTIONS

Site	State	Elevation	Year	Number of Trees
Mt Rogers	NC	1533	2015	10
Spruce Knob	WV	1462	2015	10
Dolly Sods	WV	1201	2015	10
Salt Pond	VA	1051	2015	2
Newfound Gap	NC	1527	2015	3
Balsam Camp	NC	1603	2015	5
Mt Mitchell	NC	1737	2015	7
Grandfather Mt	NC	1500	2015	13
Roan Mt	NC	1735	2015	10
Black Balsam	NC	1685	2015	7
NC 215	NC	1477	2015	3
Unaka Mt	NC	1478	2015	3
Black Mt	NC	1852	2016	3
Alarka	NC	1250	2016	7
Waterrock Knob	NC	1591	2017	8
Plott Balsam	NC	1509	2017	1
BRP North	NC	1446	2017	10
Richland Balsam	NC	1695	2017	10
Mt Pisgah	NC	1475	2017	5

19 Sites
127 trees

camcore
Global partners for the future of our forests
NC STATE

RED SPRUCE PROJECT FUTURE

- Companion population genetic structure and diversity study will be conducted
- Future collections will focus on Virginia and West Virginia
- Locate suitable restoration and orchard sites
- Establish seed orchards

camcore
Global partners for the future of our forests
NC STATE

MOUNTAIN RESEARCH STATION WAYNESVILLE, NC

- Seedlings ready for outplanting spring 2019

- Table Mountain pine – 1839
- Eastern hemlock – 1650
- Carolina hemlock – 578
- Red spruce – 462
- Fraser fir – 2375

camcore
Global partners for the future of our forests
NC STATE

ACKNOWLEDGMENTS

- USDA Forest Service
- Barbara Crane, USFS
- Dept. of Forestry & Env. Res. (NCSU)
- College of Natural Res. (NCSU)
- Grandfather Mountain State Park
- National Park Service
- Josh Kelly and Mountain True
- NC Extension Service
- Private Landowners
- Camcore staff
- Shawn Swartz and Warren Wilson College
- Numerous State Parks & Forests
- Federal & State Pest Management Cooperators
- Mountain Research Station, Waynesville, NC
- North Carolina Department of Agriculture