Status of Longleaf & Shortleaf Pine Seed Orchards

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Southern Nursery Cooperative Meeting July 2017

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Talking Points

- **Background**
  - Longleaf & Shortleaf Pine Initiatives
  - Southwide Seed Orchard & Seed Resources surveys
- **Status of the genetic resources**
  - Seed orchards, seed inventory, progeny tests, seed production areas
- **Suspected increased hybridization between species**
  - genetic DNA tests & seedling morphology studies
- **Current & future strategies**
- **Partnership options**

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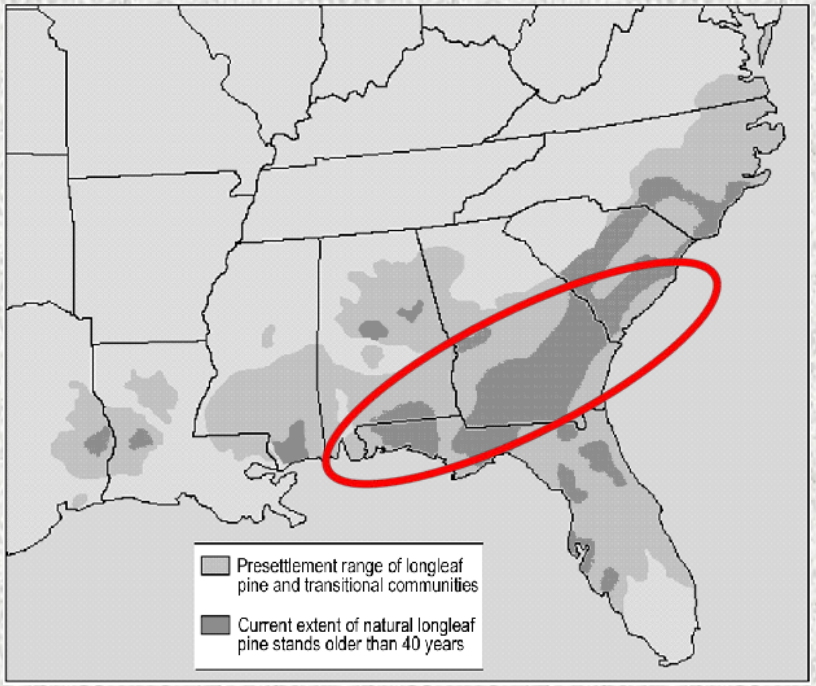
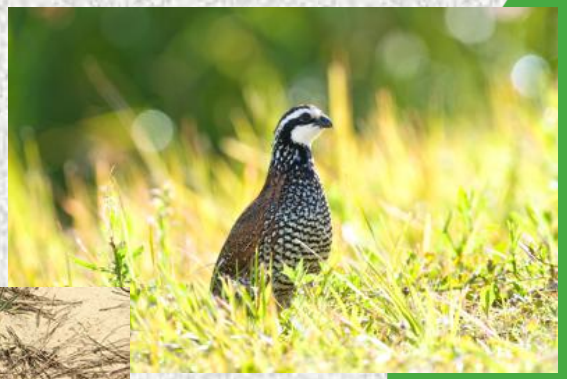
Longleaf pine story





Less than 3% of the native range remaining

AMERICA'S LONGLEAF
a Restoration Initiative

THE LONGLEAF ALLIANCE

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Aggressive restoration goals set by the Longleaf Restoration Plan = 5 million acres in 15 years !

WHAT ABOUT SEED TO SUPPORT THIS?

1 lb. longleaf seed = approximately 5000 seed = plant 10 acres, @ 500 TPA

So how much seed do we need to plant 5 million acres? > 500,000 lbs.

Cyclic cone crop every 5 years, need to accumulate 100,000 lbs. each cycle

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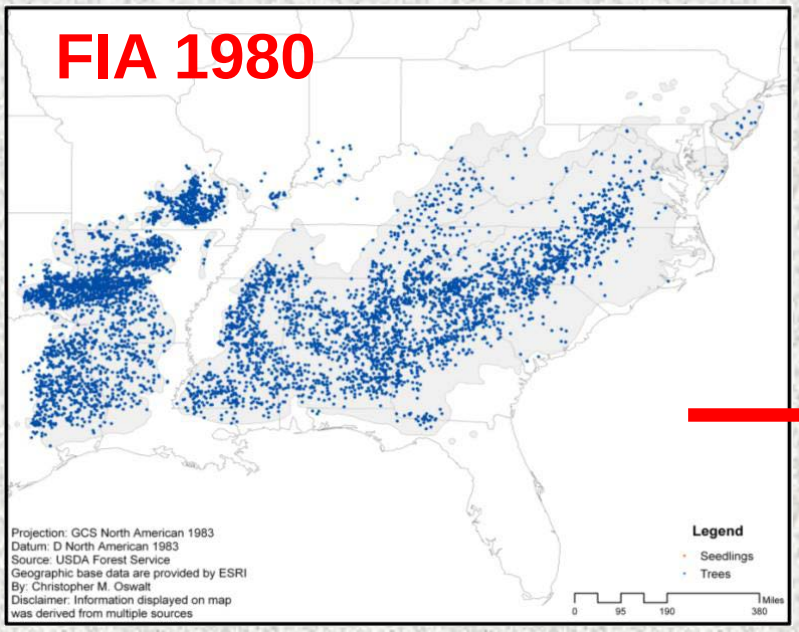
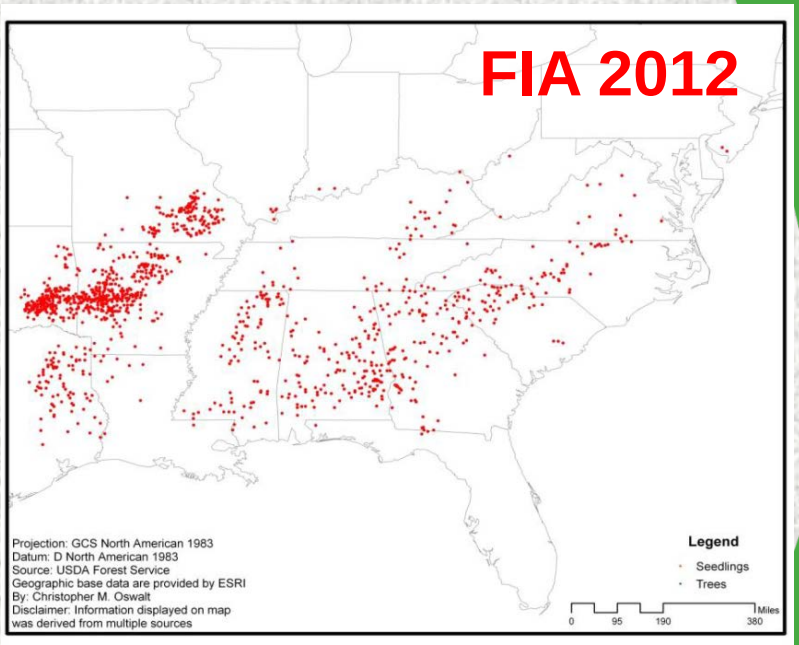
Shortleaf pine story

- Imperiled ecosystem, 50% lost over the past 40 years
- Cyclic cone crop 5-7 years
- http://www.shortleafpine.net, lots of partners
- Increasing artificial & natural regeneration efforts
- Draft Restoration Plan out for review
- WHAT ABOUT SEED?





Questions:

- Does the south have enough seed to support longleaf & shortleaf pine restoration efforts?
- Who has genetic resources?
- What kind of genetic resources exist?
- How much and in what state are these genetic resources?

Seed

Seed orchards

Statement	Answer
Seed Orchard Resources	ACRES
First Generation	
Second Generation	
Advanced Generation	
Seed Production Areas	

Seed orchards
1st, 2nd generation

Current Orchard Management	YES	NO
Original orchards retained, not managed, no seed collected		
Orchards retained, not managed, some seed collected		
Orchards retained, limited management, seed collected		
Orchards retained, actively managed, seed collected		
Orchards retained, actively managed, seed collected, additional genetics work underway or planned		
Orchards removed		
New orchards recently established on _____ acres		
Never had shortleaf orchards		

Orchard management
yes/no/maybe

Seed Inventory	POUNDS / 1st or 2nd GEN SEED?
Approximate annual seed collection (averaged for last five years)	
Approximate pounds of seed in storage	
Seed Age	

Seed inventory

Program Intentions Next Five Years	YES	NO
Maintain status quo		
Increase management intensity and seed collection activity		
Discontinue shortleaf efforts, remove orchards		
Mothball orchards for the time being		
Kiln Facility (Write in YES or NO and LOCATION)		

Program intentions
Yes/no/maybe

Geographic sources for shortleaf in your program: _____

_____

Geographic area where seed/seedlings are adapted for out-planting: _____

_____

Additional Comments:

Geographic sources
Missing seed zones?

Longleaf survey circulated 2009, 2015
Shortleaf survey circulated 2013

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What is the capacity of the resources?

- Seed processing & storage (Crane & Barbour, SFTIC 2009)
- Kiln facilities, e.g. process 600-700 bushels/week
- Personnel to process cones & seed
- Retention of skill set & experience
- Longleaf cones MUST be processed and seed extracted in 7-10 days (Barnett et.al.)

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Talking Points

- Background & Initiatives
  - south wide resources survey
- State of longleaf & shortleaf genetic resources
  - Seed orchards, seed inventory, progeny tests, seed production areas
- Suspected hybridization
  - genetic tests & seedling morphology studies
- Current & future strategies
- Partnership options

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Longleaf Survey Results

- **SEED ORCHARDS**
  - **State agencies** **225 acres**
    - **GA, LA, MS, NC, SC**
  - **Industries seed orchards*** **47 acres**
  - **Industry seed production areas*** **125 acres**
    - ***some not actively managed**
- **SEED – amounts and age varies, most have 2-5 years worth of seed in inventory**
- **KILN Capacity – 8 kilns in southeast able to handle longleaf**

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Forest Service Longleaf pine

503 acres	1st Generation
37 acres	2nd Generation
2.5 acres	3rd Generation
272 acres	seed production areas

*** We manage ~ 70% of the resources and 35 progeny tests**

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Montane (mountain) longleaf pine

- less than 10 acres of seed orchards exist
- genetic studies with Berry College & Southern Research Station & NFGEL
    - Coastal vs piedmont vs montane – is there a genetic difference?

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Shortleaf Survey Results

- **SEED ORCHARDS**
  - **State agencies** **70 acres**
    - **ARK, GA, KY, LA, NC, OK, TN**
  - **Industries seed orchards** **0 acres**
  - **Industry seed production areas** **0 acres**

- **SEED – amounts and age varies, most have 2-10 years worth of seed in inventory**

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Forest Service Shortleaf seed orchards

500 acres	1st Generation
27 acres	2nd Generation
0 acres	3rd Generation
0 acres	seed production areas

*** We manage ~ 90% of the resources and 155 progeny tests**

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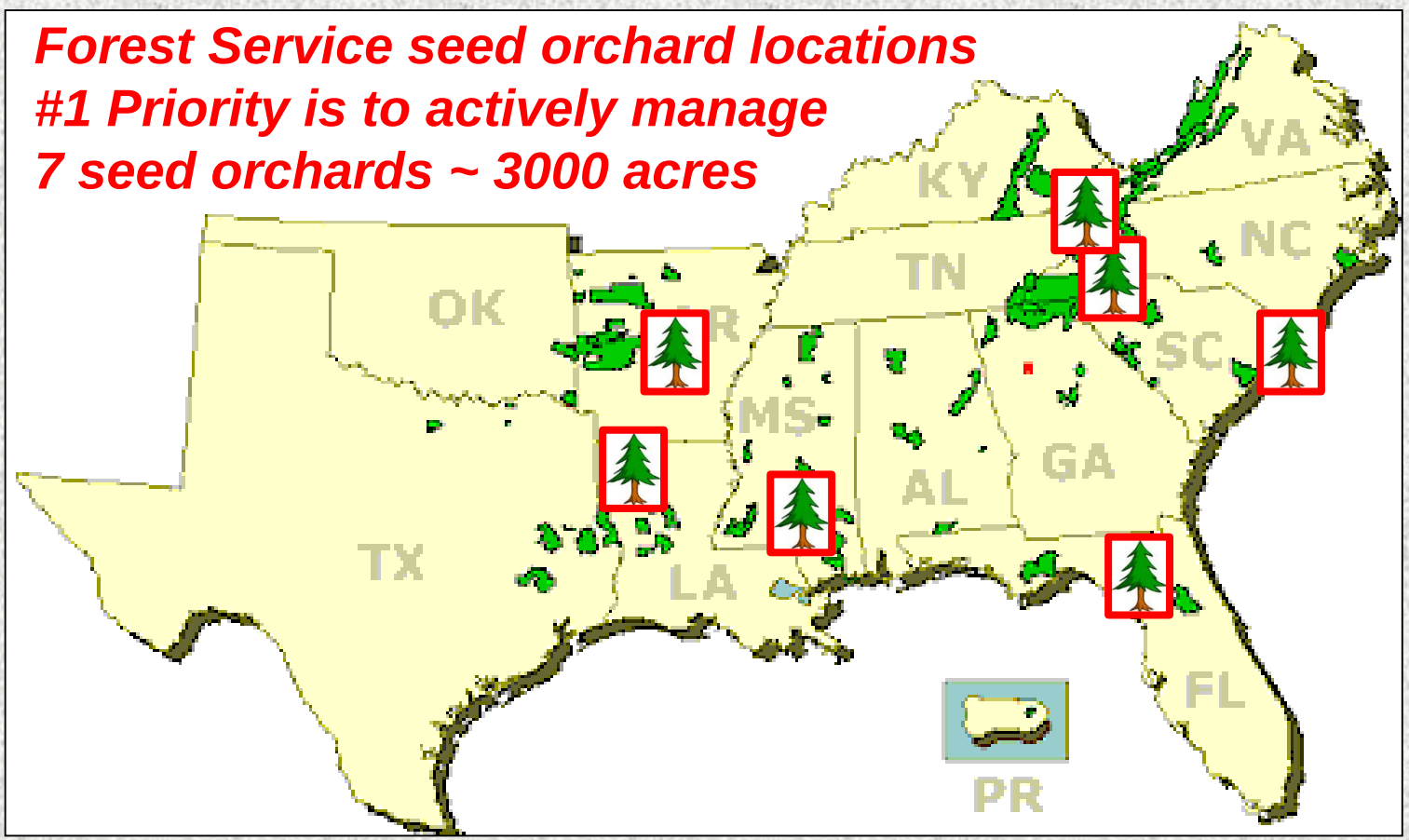

Seed orchard locations & species: loblolly, longleaf (coastal & mountain), sand, slash, shortleaf, table mountain pine, Virginia, white pines, hardwood *species:* oaks, American chestnut, black cherry, butternut

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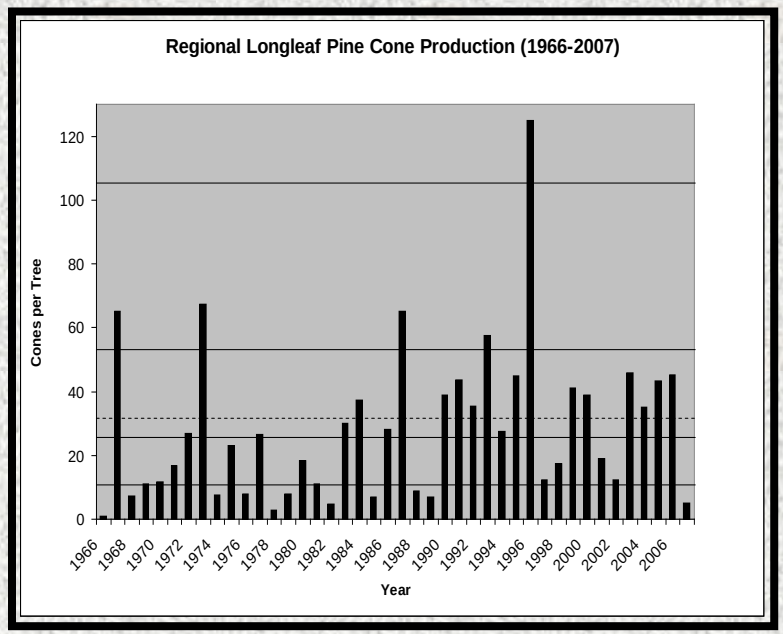
Observations:

- Seed storage longevity issues
  - Longleaf 5-10 yrs.
  - Shortleaf 10-15 yrs.
- Geographic seed zones are missing
- Demand for seed is increasing



Longleaf cone crop production reports over the past 40+ years in the general forests, Boyer, Brockway et.al.

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Shortleaf x loblolly hybridization

- **Naturally occurring at a rate of < 5%**
- **Tauer, Wiil. Stewart (OK) theorized increases up to 40%, especially in seed orchards**

Longleaf x loblolly hybridization

- **Naturally occurring < 5%, e.g. *Sondereggers***
- **Suspected increases > 50%, based on unusual seedling morphology seen in nursery crops in 2015 from 2014 seed collected**

Is there really increased hybridization going on between species?
Do we need to be concerned about the seed orchards & seed?

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Genetic tools have the ability to help answer these questions

National Genetics Lab "NFGEL"
Located at the Institute of Forest Genetics
Placerville, CA (PSW RS & NFS)
Celebrated 90th year anniversary

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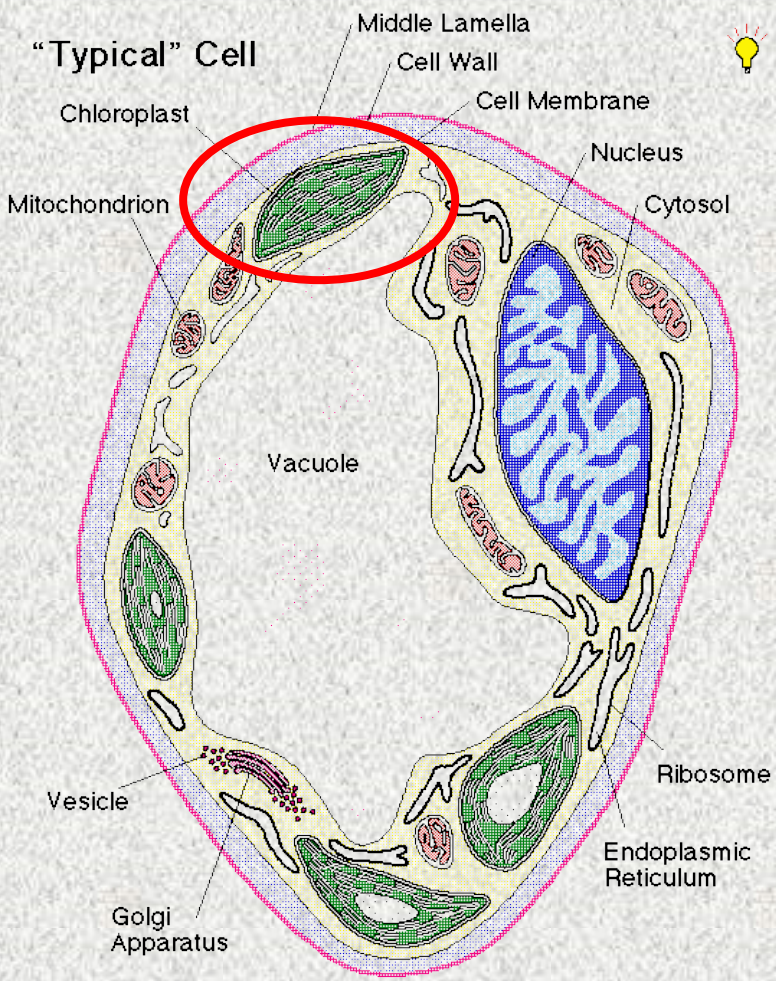

Using chloroplast DNA
Paternal inheritance
e.g. pollen parent

- DNA fingerprinting seed orchard trees & seed bank for species purity (NFGEL)
- Seedling morphology studies on-going (Barnett, Sung (SRS), Paul Jackson)

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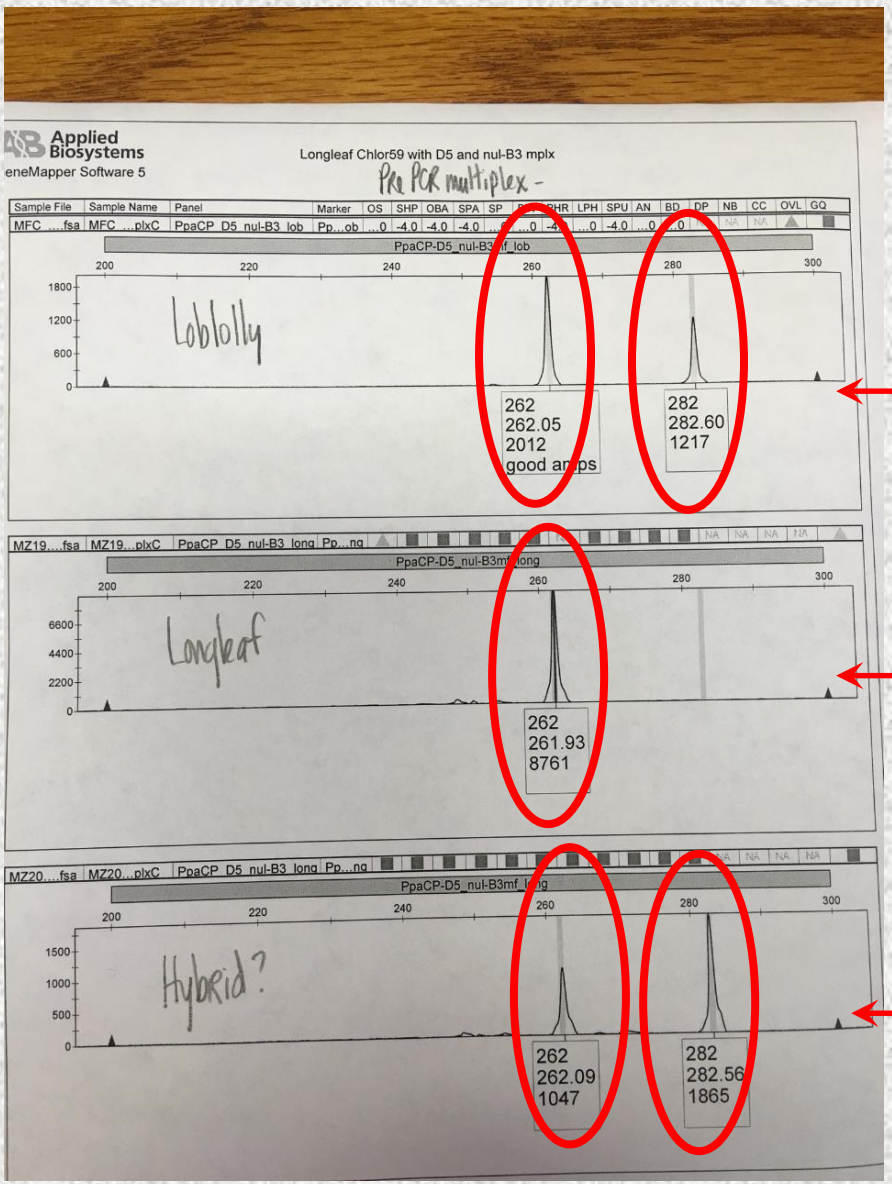
Simple Sequence Repeats (SSR) DNA markers used, developed by SRS Southern Institute of Forest Genetics (Josserand & Echt)



SSR DNA fingerprint pure loblolly, 2 peaks

SSR DNA fingerprint longleaf, 1 peak

SSR DNA hybrid fingerprint, 2 “peaks”

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SEED TESTED:

- Forest Service 2014 seed bank (quarantined)
- Tested 7 lots of longleaf (MS, LA, FL, AL, TX)
- Tested 2 lots of shortleaf (ARK, MS)
- 100 embryo's from each seed lot
  - stratify, dissect, separate from megagametophyte
  - another 100 embryo's in process
- Used 3 SSR DNA markers, unique to the chloroplast (pollen parent)
- Results:
  - Longleaf: 2 seedlots had 1 seed / 100 showed hybrid DNA fingerprint
  - Shortleaf: 1 seedlot had 2 seed / 100 that showed hybrid DNA fingerprint
- NO WORRIES! so we will not be testing anymore seed from other years or seed zones.

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DNA Fingerprinting seed orchard trees for species purity:

- Longleaf and shortleaf from all FS seed orchards
  - ARK, FL, KY, LA, MS, MO, NC, TN, TX, VA sources
- 1761 ramets (~ 2 per clone)
- 869 clones total across sources
- Why? > did a hybrid slip in during the super tree hunt in the 1960's?
- Will be fingerprinting orchard trees for clonal identity as well
- suspected *Sonderegger* seedlings from various studies & nurseries are being fingerprinted

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RESULTS - DNA Fingerprinting seed orchard trees for species purity:

- Longleaf
  - Tested 517 ramets, 250 clones
  - Found NO hybrid fingerprint
- Shortleaf
  - Tested 1144 ramets, 619 clones
  - Found 12 of 350 ARK clones to have the hybrid fingerprint
  - Found 5 of 66 LA clones to have the hybrid fingerprint
  - All other sources NO hybrid fingerprint
- Next step – cull those clones with hybrid fingerprint out of the orchards

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There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.

(Donald Rumsfeld)

izquotes.com

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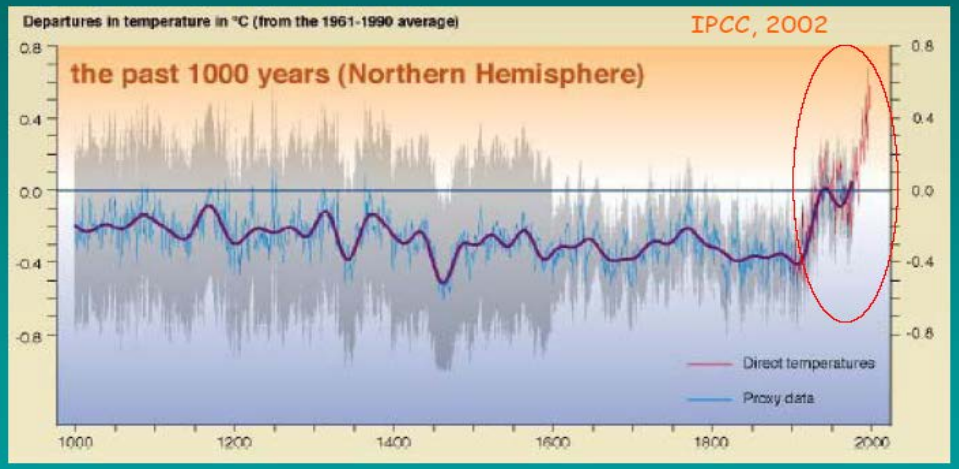
Climate change

Temperature Change over the Past 1000 Years



CRITICAL QUESTION:

- ***What is the most appropriate genetic material to plant that will grow a healthy, diverse and sustainable forest?***

- **Forests need to be resilient**
  - **Climate change variability's are occurring faster than some tree species ability to respond.**
  - **Are longleaf and shortleaf resilient species? generalists or specialists?**

- ***Planting in the right areas – for now and for the future***

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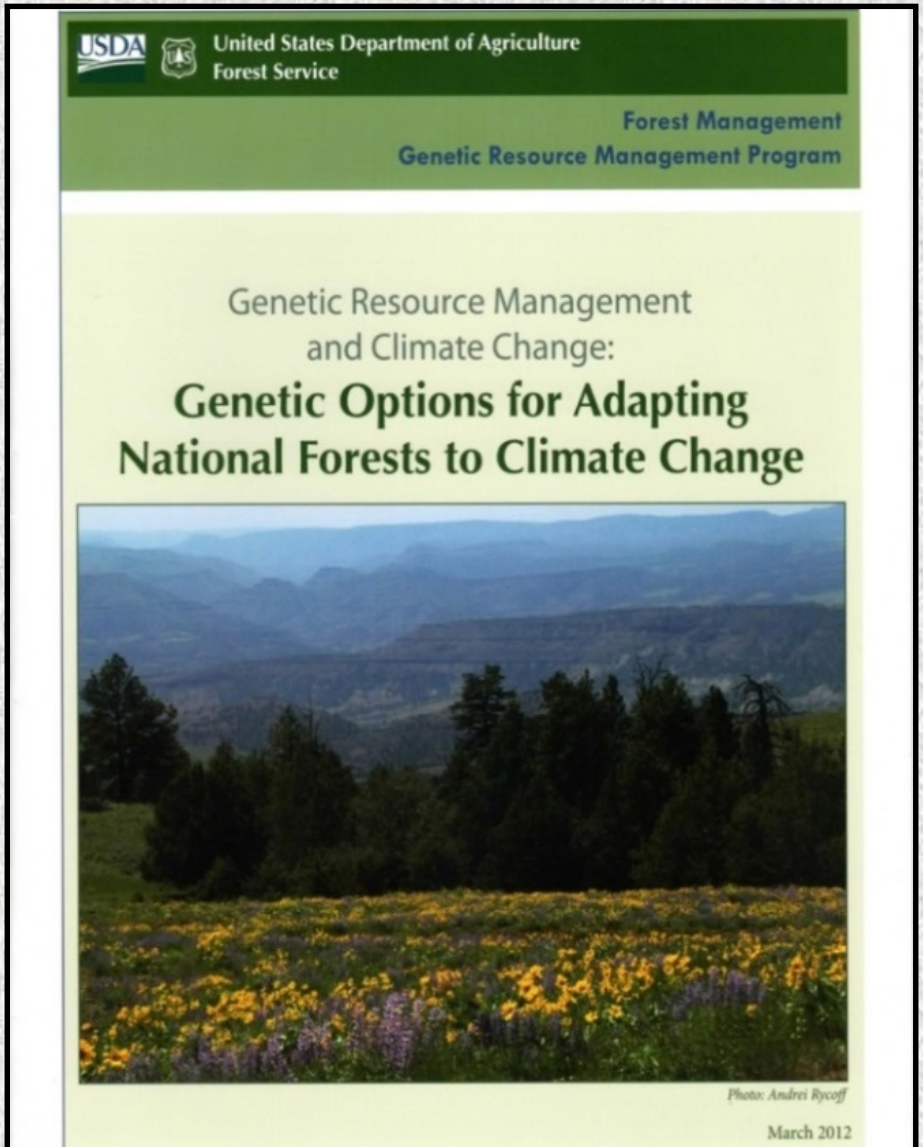
FS National Guidelines for National Forests

Goals, Principles and Recommendations for Enhancing Forest Resiliency



Erickson et. al. 2012

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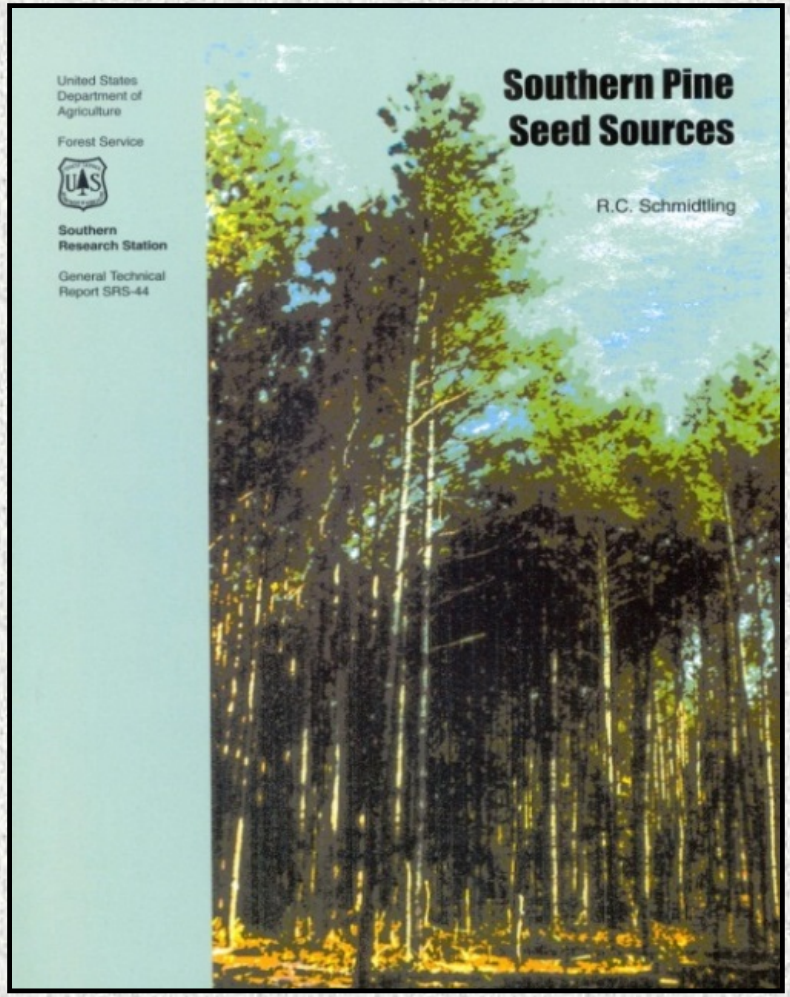

Time for an update?

Developed using genetic information & past climatic conditions to designate seed sources & seed zones.

- ***HOWEVER** will it be pertinent for future seedling deployment? Under the threat of climate change?*

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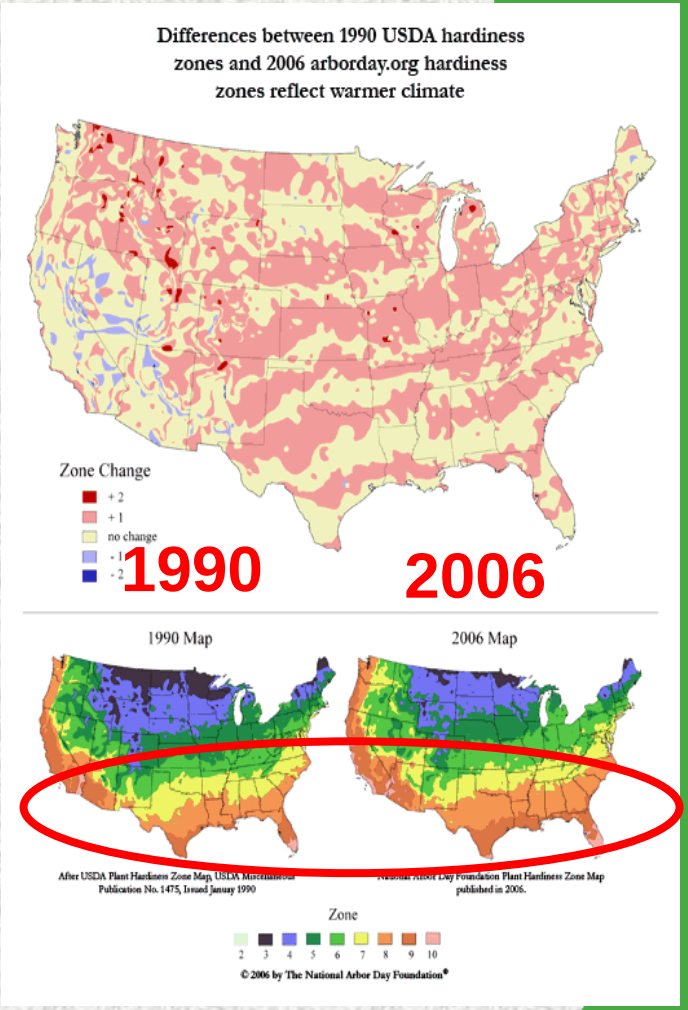
Guidance for future seed deployment:

Eastern Seed Zone Project – R8 & R9

- Developing new seed zones
- Updating current seed zones
- Mixing seed in south/north adjacent seed zones
- Webinars 2017 on-going
- May 2018 workshop
- Trees and small understory plants
- Botanical gardens & other partners

Eastern Seed Zone Forum
http://eszf.sref.info
Webinars, workshop 2018



Options & guidance to consider for future species ranges and planting zones:

- **EFETAC** *Eastern Forest Environmental Threat Assessment Center*
  - Developing new tree range maps (FORECasts)
  - Used for seedling deployment
- Mix adjacent south:north seed sources in the new planting zones
- Increased phenology data collection
- Seed forecasting & seed planning for more species
- Understanding tree physiology & seed biology
- Genecology studies
- Assisted migration studies
- Longleaf and Shortleaf – taking risks in small areas

"Determining Suitable Locations for Seed Transfer under Climate Change, Potter & Hargrove, 2014

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http://www.forestthreats.org/research/projects/project-summaries/assessing-forest-tree-risk

Challenges to restoration Of Longleaf & Shortleaf pines:

- Intermittent cone crops
- Aging, lost or mothballed seed orchards
- Seed biology issues (collect, process, storage)
- Lack of infrastructure (drying kilns, nurseries)
- Lost art of tree shaking, grafting, and other skills
- Artificial regeneration - container vs bareroot seedlings – root morphology
- Natural regen & re-introduction of fire – duff layers
- Lack of resources (funding, people)

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FS NFS, S/P and RD, state agencies, universities, nurseries, industries, private companies, NGOs, Longleaf and Shortleaf Initiative groups & partners

NCGRP
Preserving our Future
National Center for Genetic Resources Preservation

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More longleaf & shortleaf partners to increase genetic resources would be great!

Shortleaf MOA, FS NFS & NC Forest Service, Establishing shortleaf 2nd gen orchards. Thanks to Robin Taylor, David Stiles, Clyde Leggins, Ken Roeder and others

SUMMARY

- Need more seed orchard resources
- Increase general forest cone collections
- NO WORRIES on hybridization for now
- Increase partners to increase & exchange resources
- Encourage BOTH artificial and natural regeneration
- Consider updated seed & planting zones

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Acknowledgements

Forest Service NFGEL, Dr. Valerie Hipkins and staff

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Sedley Josserand, Craig Echt, Dana Nelson

Chuck Tauer (retired) Oklahoma State – who first began working on shortleaf suspect hybrids, and John Stewart & Rod Will

Jim Barnett (retired SRS) and Paul Jackson and team – seedling morphology work, in cooperation with SRS Dr. Susana Sung

All those who responded to the surveys, thanks!

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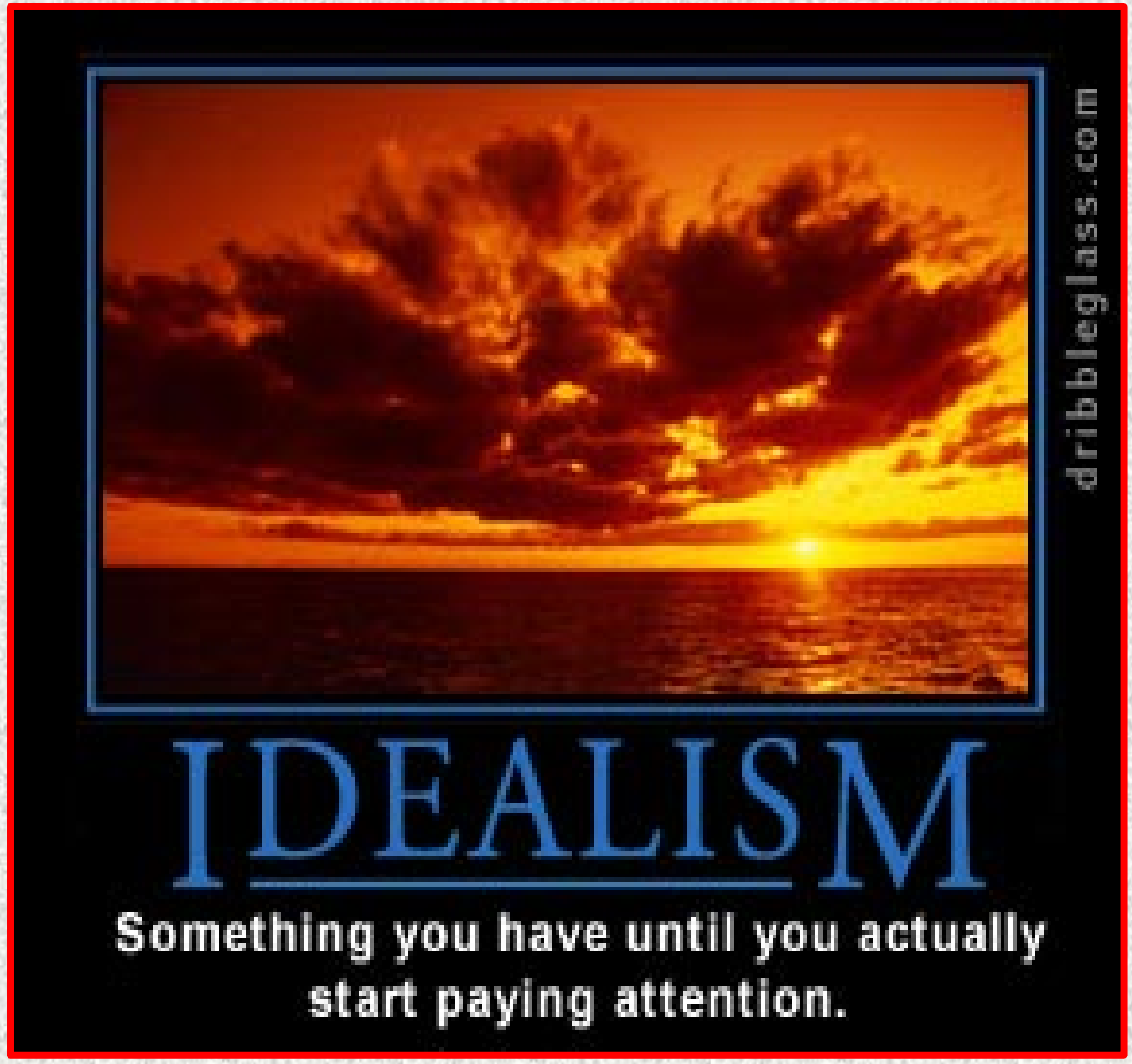

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