Fire Exclusion is Causing an Increase in Hybrids Between Shortleaf and Loblolly Pine

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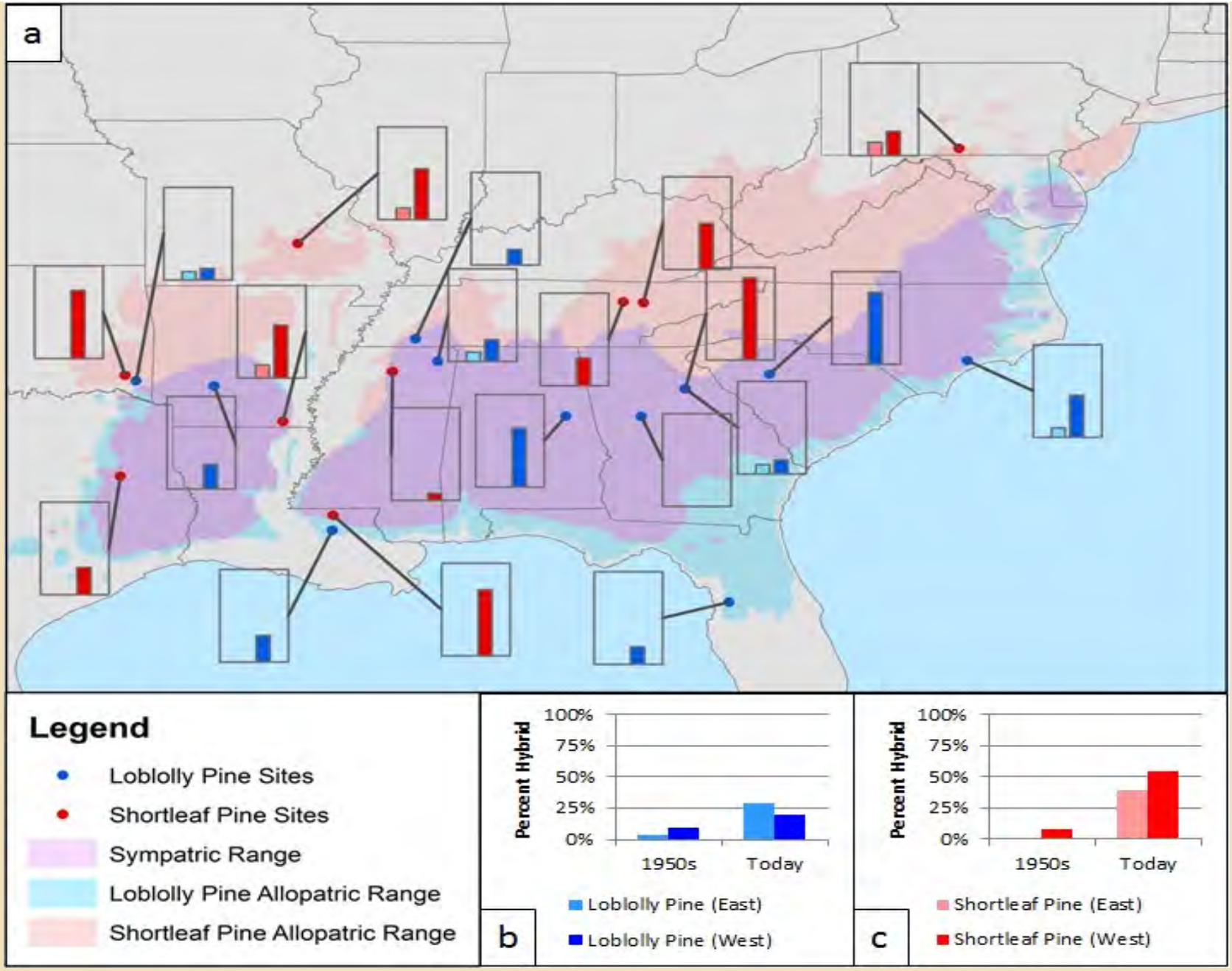
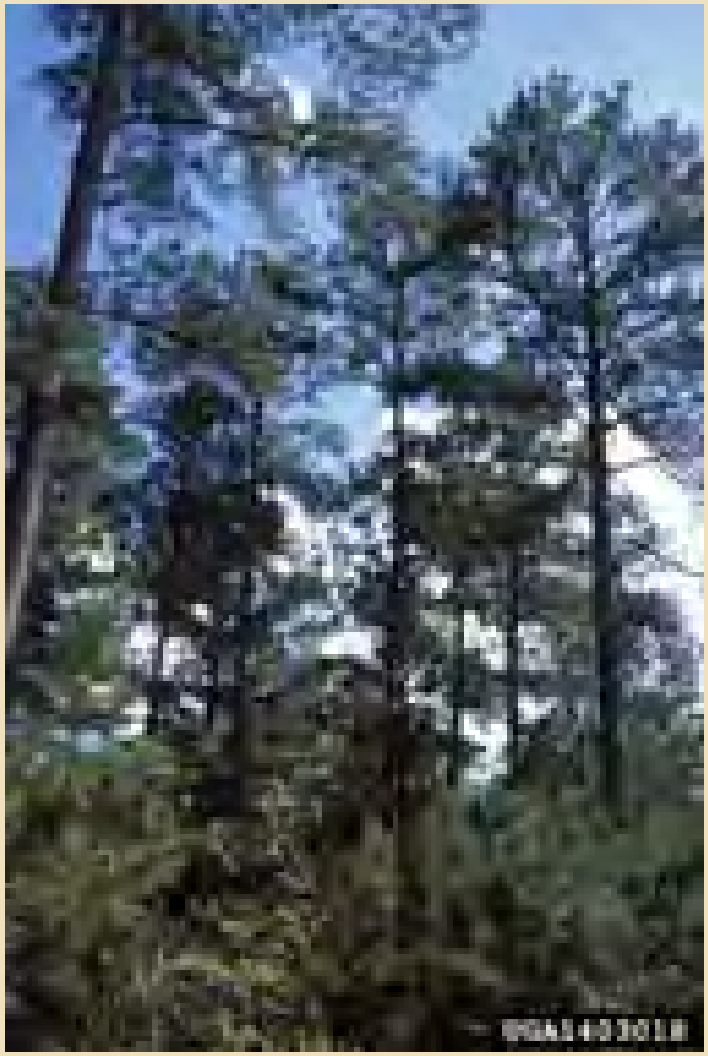
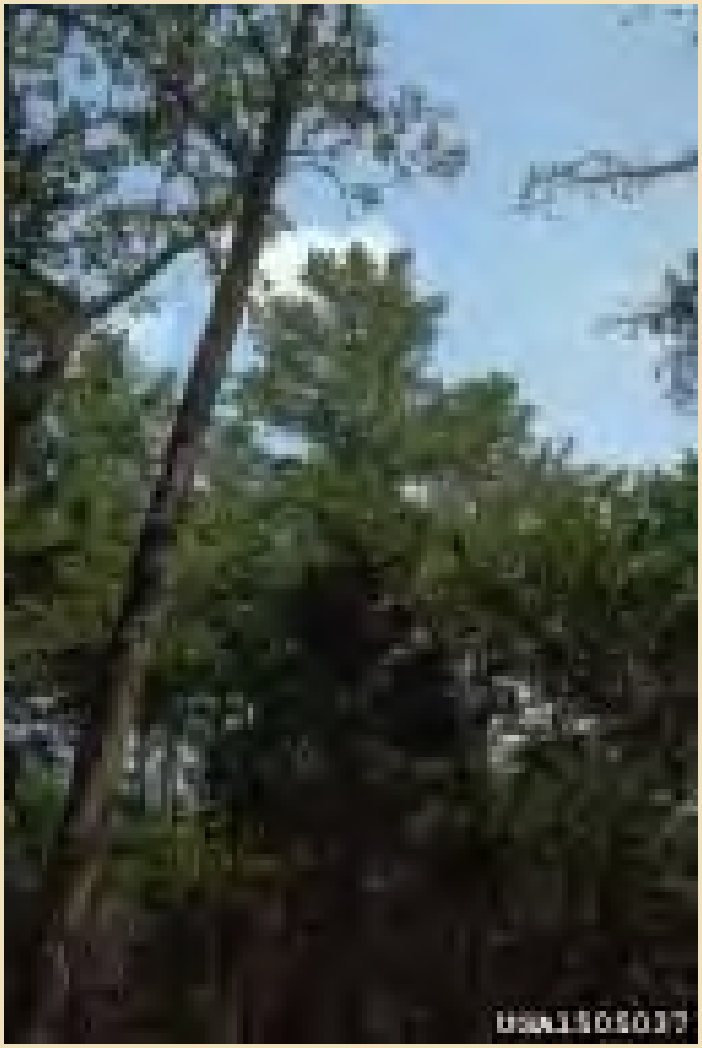
Background

Since 1950, hybridization between shortleaf pine and loblolly pine has increased from 3% to 46% in shortleaf pine and 2% to 27% in loblolly pine stands (Stewart et al. 2012)



Tauer et al. 2012





Risk of shortleaf pine extinction through introgression with loblolly pine

Why low previous hybridization?

- Shortleaf and loblolly reproductively isolated by time of pollen shed (loblolly before shortleaf)
- Shortleaf and loblolly isolated due to environmental preferences (loblolly = mesic, shortleaf = xeric)
- Fire worked as a post reproduction selection pressure to reduce survival of hybrids and strengthen habitat preferences

What's different now?

- Increased cross fertilization
  - Climate change and increased variability in weather leading to overlap in pollen shed
  - Wide scale planting of loblolly pine and nonlocal seed sources
  - Habitat fragmentation
- Removal of post-hybridization selection pressures against hybrids
  - Fire exclusion

Why do we care?

- If loblolly, hybrids, and shortleaf all perform the same ecological function, does it matter?
- If hybrids grow faster than shortleaf isn't that a good thing?
- Stuff happens

Why do we care?

- Resilience!

Shortleaf is more fire tolerant

Loblolly pine

Shortleaf pine

Shortleaf is more snow and ice tolerant

Loblolly pine

Shortleaf pine

Shortleaf is more drought tolerant

Loblolly pine

Shortleaf pine

Why do we care?

- Resilience - Shortleaf more drought, fire, cold, and ice tolerant
- Sudden increase in hybridization indicates a perturbation
- Once we cross the hybridization threshold, there may be no going back even if conditions change to favor pure shortleaf
- Intrinsic value of biodiversity
- I (we) like shortleaf pine

Objectives

- To determine if there are morphological or physiological advantages that have allowed shortleaf pine x loblolly pine hybrids to increase over the last 60 years
- To determine the role of fire exclusion

Associated Manuscripts

Stewart, J.S., Tauer, C.G., and Nelson, C.D. *2012*. Bidirectional introgression between loblolly pine (*Pinus taeda* L.) and shortleaf pine (*P. echinata* Mill.) has increased since the 1950s. Tree Genet. Genomes 8:725-735

Tauer, C.G., Stewart, J.F., Will, R., Lilly, C., Guldin, J., and Nelson, C.D. 2012. Hybridization leads to loss of genetic stability in shortleaf pine: Unexpected consequences of pine management and fire suppression. Journal of Forestry. 110:216-224

Lilly, C.G., Will, R.E., and Tauer, C.G. 2012. Physiological and morphological attributes of shortleaf x loblolly pine F1 hybrid seedlings: is there an advantage to being a hybrid? Canadian Journal of Forest Research 42:238-246.

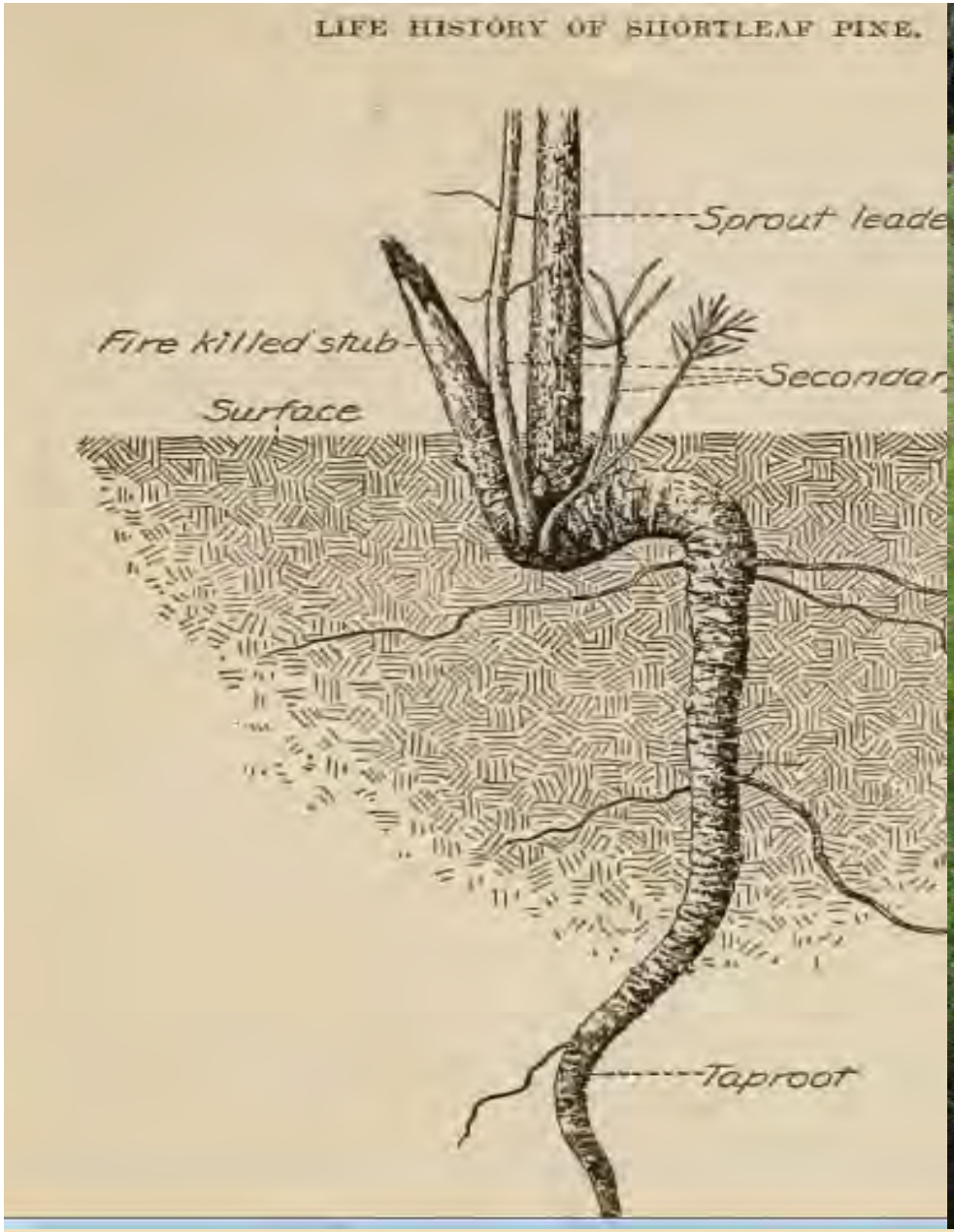
Will, R.E., C.J. Lilly, J. Stewart, S. Huff and C.G. Tauer. 2013 Recovery from topkill of shortleaf pine X loblolly pine hybrids compared to their parent populations. Trees: Structure and Function. DOI 10.1007/s00468-013-0866-

Stewart, J.F., R.E. Will, K.M Roberston, C.D. Nelson. 2015. Frequent fire protects shortleaf pine from introgression by loblolly pine. Conservation Genetics

Bradley, J., R.E. Will, et al. In Preparation. Sprouting response of shortleaf x loblolly pine seedlings to fire.

Background

- What we already know about hybrids:
  - Can grow as fast as loblolly
  - Have intermediate needle characteristics
  - Are resistant to fusiform rust like shortleaf
  - Have better cold resistance than loblolly
  - Have better form than loblolly
- What we don't know about hybrids:
  - Resprouting potential following topkill
  - Fire adaptations – basal crook



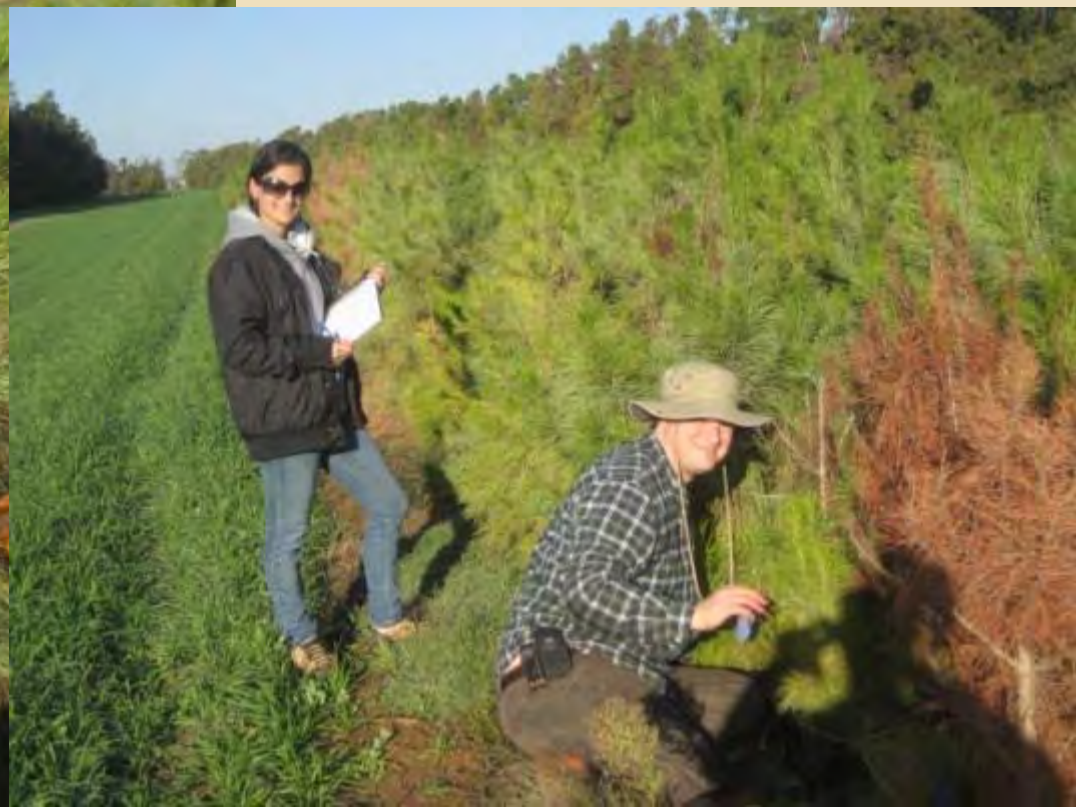
Picture from Mattoon 1915


12
13
14
15

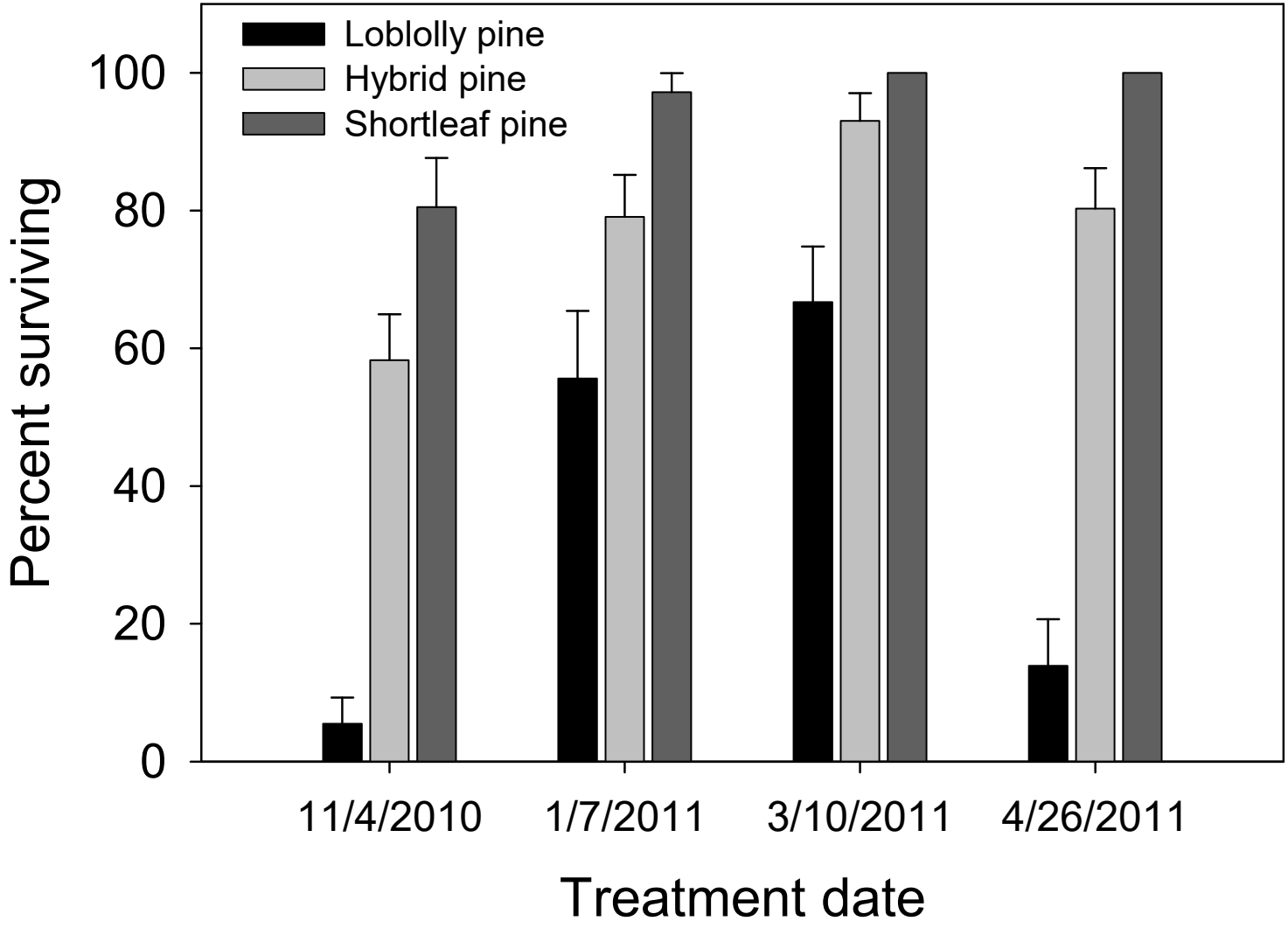
How do hybrids respond to topkill?

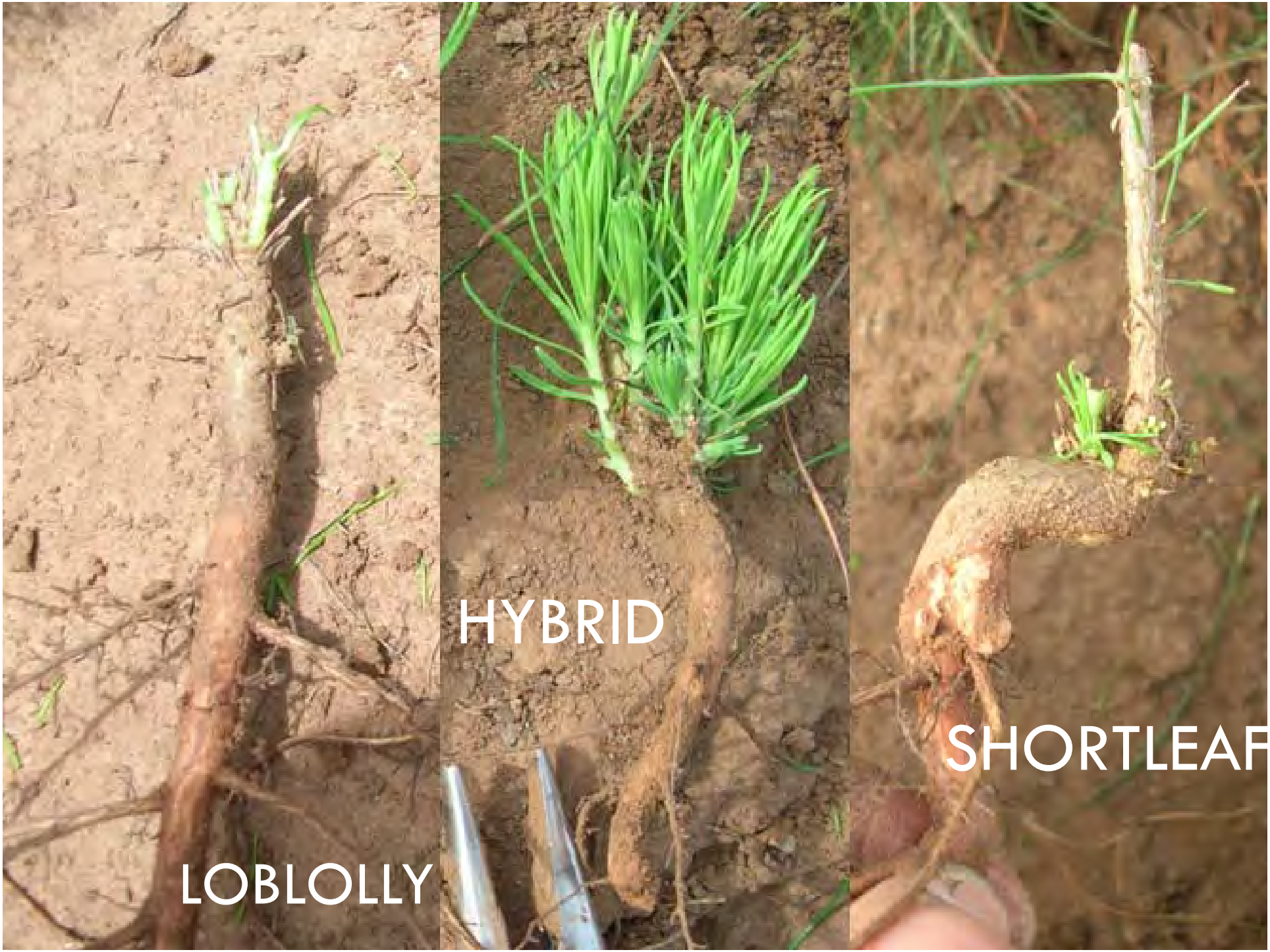
- Nursery study using loblolly pine, shortleaf pine, and F1 hybrids
- Topclipping

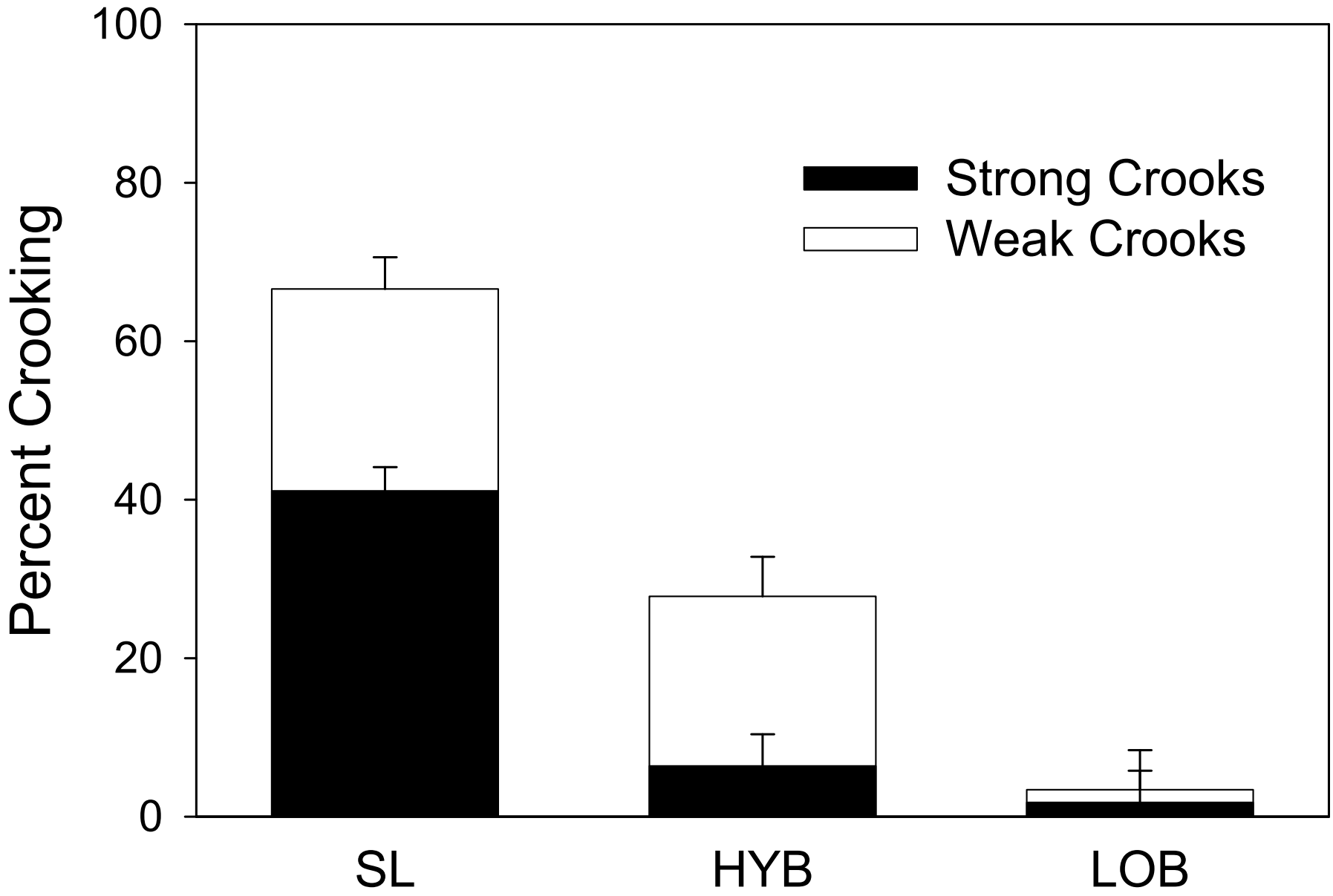
Seedling size end of year 3



Seedling survival after topkill after 2 and into 3rd growing season




LOBLOLLY
HYBRID
SHORTLEAF


Percent Crooking
100
80
60
40
20
0
Strong Crooks
Weak Crooks
SL
HYB
LOB

Height to first sprout

- shortleaf pine = 3.5 ± 0.6 mm SE
- hybrids = 7.7 ± 0.6 mm SE
- loblolly pine = 21.3 ± 1.5 mm SE

Is the crook important?

How does prescribed fire affect resprouting of hybrids?

- Seeds of loblolly, shortleaf, and hybrid planted in Idabel, OK
- Burned in spring after 1st growing season and in August of the 2nd growing season
- Resprouting measured

Spring burn seedlings alive in May

Species	Total	May Surviving	Percent
Loblolly	35	0	0 %
Hybrid	33	1	3 %
Shortleaf	28	16	44 %

Summer burn seedlings alive in October

Species	Total	October Surviving	Percent
Loblolly	26	0	0 %
Hybrid	26	1	4 %
Shortleaf	16	10	63 %

How does previous prescribed fire affect seedling populations?

- Tall Timbers Research Station and Land Conservancy near Tallahassee, Florida
- Mixed canopy of shortleaf and loblolly pine
- Compared seedling and adult population
  - Not burned for 30+ years
  - Burned every 2 years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Google earth

Fire eliminated loblolly and greatly reduced hybrids

- Seedlings from nonburned areas
  - Loblolly = 45%
  - Hybrids = 30%
  - Shortleaf = 25%
- Seedlings from burned areas
  - Loblolly = 0.0%
  - Hybrids = 15%
  - Shortleaf = 85%

-Of hybrids in burned areas, 10% of the 15% total were SLBC2

-None of the hybrids from the burned areas were LLBC

Conclusions

- Hybrid pines have several competitive advantages over their parent species:
  - Growth rate; Hybrids = Loblolly > Shortleaf
  - Sprouting after damage; Shortleaf > Hybrids > Loblolly

- Hybrids lack a strong basal crook that can serve as an adaptation to resprout following surface fire
- **Prescribed Fire kills hybrids**
- **A regular burning regime shifts population to pure shortleaf**

Shortleaf pine is a ~~fire-adapted~~ fire-dependent species

Shortleaf pine sprouts vigorously, and thus reproduces itself if killed back during the period of early life. This period fortunately is the time of greatest susceptibility to injury both by fire and various mechanical agencies. Its range over the drier uplands is coincident with a region of frequent forest fires, yet it is saved by notably abundant reproduction practically everywhere.

Quotes from Mattoon 1915

Stands of direct seedling origin are on the whole of insignificant area, because there are few localities protected against fire by natural barriers or by man. In one locality of optimum shortleaf development in Pike County, Ark., the only stands of direct seedling origin found were located in low, moist situations where burnings have been infrequent.

Management implications

- Mechanical damage alone is not enough to eliminate hybrids (or loblolly pine) during the first couple of growing seasons
- Prescribed fire will reduce or eliminate hybrids due to lack of strong basal crook
- Seedling age and season of treatment matter
- **Emphasize restoration efforts where fire can be used in management, i.e., without including fire, it probably doesn't matter**

Implications for artificial regeneration

- Remove hybrids from orchards
- The crook is important - Sow at wider spacing in nursery to allow crook to develop or, plant deeper to protect dormant buds

Some shortleaf pine (*Pinus echinata* Mill.) seed orchard clones are hybrids with loblolly pine[1]

John F. Stewart, Barbara S. Crane, Rodney E. Will, C. Dana Nelson

From 8 to 10% of U.S. Forest Service orchard clones from 0 to 10% of state agency orchard clones had hybrid character in the range of F1 or first backcrosses to shortleaf pine.

Hybrid frequencies in seedlings available for purchase were about the same as the parent population

Matty Mattoon provided forestry information to extension specialists across the South.

We need a modern day Matty Mattoon!

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