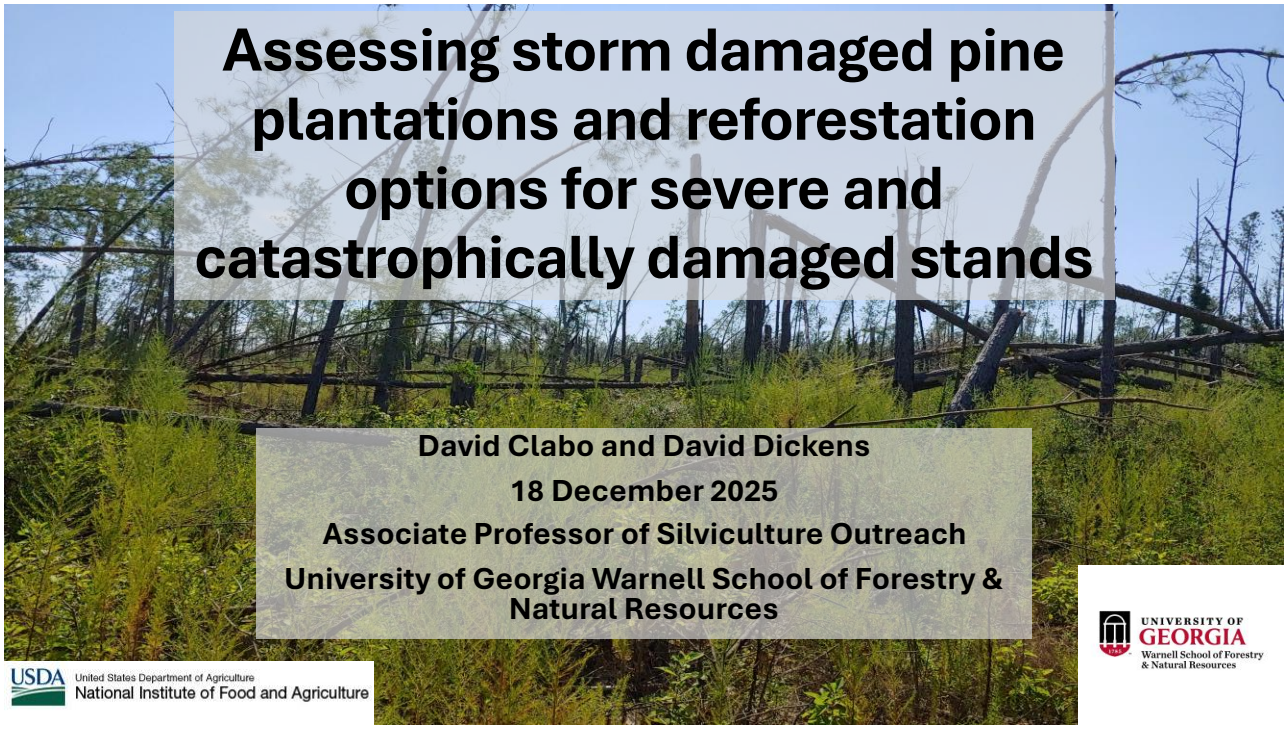

Assessing storm damaged pine plantations and reforestation options for severe and catastrophically damaged stands

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UNIVERSITY OF GEORGIA Warnell School of Forestry & Natural Resources

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Assessing Storm Damaged Stands

Having a reputable, local forestry consultant becomes very valuable after a major storm event – as they tend to know your forest stands, their age and condition and can visit these stands, assess the damage and give the landowner recommendations – they can contact local loggers and see who can get to the tracts first

- Other assistance: state foresters, Area Forestry Agents, Extension Foresters (these will usually not have the logger contacts that the forestry consultants will have)

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Assessing Storm Damaged Stands

Priority--Get most valuable wood salvaged ASAP

Categories of damage (can be based on # of leave trees left or % damage)

Catastrophic or Severe = An average of 75% damage (range of 50 to 100% damage); not enough quality trees standing and in good condition to thin back to = salvage clearcut

Moderate = an average of 35% damage (range of 11 up to 50% damage) = often enough trees/acre to thin back to (salvage thin the broken and otherwise damaged trees)

Light < = 10% damage = usually no salvage cut needed

Minimal damage = no thinning needed

3

Assessing Storm Damaged Stands

Light Damage

- Typically, only branches are broken from trees, with minor damage to tree stems across the stand
- No salvage operation will be necessary and the stand may recover with no additional immediate treatments
- Clean-up optional

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Assessing Storm Damaged Stands

Moderate Damage

- Up to half the trees in the stand may be snapped, noticeably uprooted, or have severe lean greater than 45 degrees from vertical.
- Are there enough trees per acre in visibly good condition, with less than 30 degree lean to carry on to rotation age?
- Sanitation thinning
- Could be done in conjunction with salvage operations for catastrophically damaged stands
- 125 to 200+ trees/acre in good condition to thin back to – visit these stands every 3-4 weeks for several months and look for yellowing crowns (possible beetle activity)

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Thinning may occur 1-2 years post wind event in moderate damage stands

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Stand clean-up for pine straw raking objective

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Assessing Storm Damaged Stands

Severe/ catastrophic damage

- Fifty to 100% of the stems are broken, numerous tops broken, limbs stripped, and trees bent more than 45 degrees from vertical.
- Catastrophic damage stands often do not have enough standing trees for seed tree natural regeneration, severe damage stands may have enough
- Salvage harvest should be considered; may earn 10% or less of pre-storm pulpwood stumpage price due to market saturation
- Check for federally declared emergency reforestation funds availability in your county

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Assessing Storm Damaged Stands

Salvage window guidelines

Product	Harvest window*	Comments
Pine and hardwood veneers	4 - 6 weeks	Blue Stain prohibits use if left longer
Pine dimension lumber	3- 4 months	Should be kiln dried to prevent emergence of secondary pests
Pine posts	4 - 6 weeks	Blue Stain will affect wood toughness and preservative treatment
Pine and hardwood pulp, fiberboard, particleboard and OSB	6 - 8 months with a few cases up to 1 year	As wood begins to decay, pulping process will be affected. Storm damaged wood should be mixed with sound wood

Damaging Insect and Diseases

Year 1 post-storm: bark beetles, ambrosia beetles, sawyers, blue stain fungus, soft rot fungi

Year 2 post-storm: decay fungi

The harvest window can vary due to several factors including but not limited to: time of year of the storm event, temperatures, rainfall, humidity and winds after the storm event. Once the bark starts to fall off the trees, the window to salvage and get some value is considered past.

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Assessing Storm Damaged Stands

General Rules of Thumb for Assessment

- Unthinned, well stocked young pine stands less than five to eight years old and hardwood stands less than 15 years old, with heights less than 15 - 20 feet generally have the least damage.
  - Damage most concentrated near the stand edges
- Recently thinned (within the last two years) pine stands tend to have the most damage, with leaning and uprooted trees and greater stem breakage (usually at the eight -20 feet stem height range).
- Pines with heights greater than 15-20 feet and lean greater than 30 to 45 degrees (from vertical) do not typically straighten and recover.

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Assessing Storm Damaged Stands

General Rules of Thumb for Assessment

- Older, larger pines (diameters ≥ 12-14 inches and ≥ 60-80 feet tall) that are leaning < 30-45 degrees will usually not return to a straight position but tend to live for years as long as the root system is intact with little to no evidence of mounding, uprooting, or exposed roots.
- Partially uprooted pines that have most of their root system intact in the ground can survive for some time, but may not be a viable part of the stand.
  - Uprooted pines with exposed roots and leaning more than 60 degrees or crowns laying on the ground tend to present brown needles in spring of the following year
-

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Management Strategies

Limit wind damage

- Managing at low stem densities during early stand development could potentially increase taper lessening impacts from extreme wind events.
- More varied crown structure (stands with mixtures of short and tall trees as well as varying crown sizes) throughout a stand or collection of stands in a forest can also decrease wind speeds thus reducing individual tree and overall stand damage during storms.
  - Uneven-age management, mixed species stands, or small acreage even-age stands of varying age interspersed across a landscape

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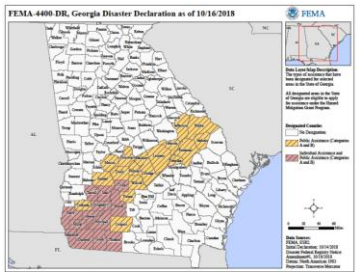
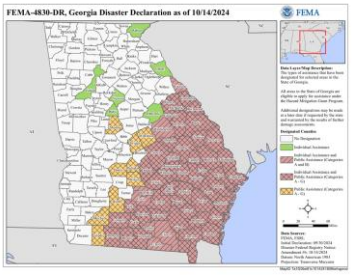
Conditions vary, landowner objectives and resources differ – a range in approaches:

- Heavy debris, poor access
  - Innovations in heavy equipment
  - Aerial vegetation management using herbicides, later prescribed burning
  - TIME, decay, planting over years (4-5 yrs)
- Salvaged timber, good access
  - Similar to typical site prep, but more need for mechanical → case by case Rx



Hurricane Michael GA disaster declaration counties



Hurricane Helene GA disaster declaration counties

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Important factors when considering reforestation: (1) Stand conditions, (2) landowner objectives, (3) site prep options & costs (need to regain access to get site plantable & control competing vegetation) –often both mechanical and chemical treatments needed. (4) Is natural regeneration an option?

>80% of trees broken

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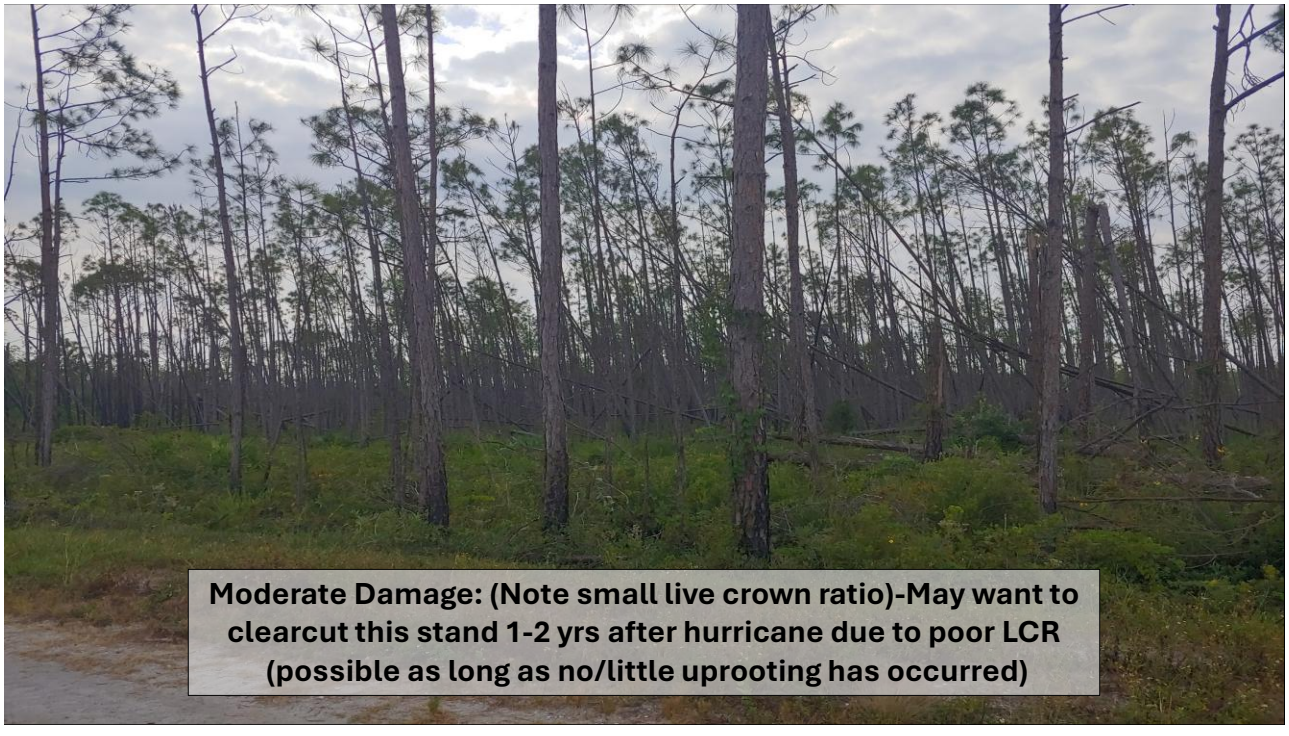

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Site Preparation Options

Chemical

- Access will necessitate most applications be done aerially
  - Stands neglected for long periods will need greater amounts of spray solution per acre → 10-15+ gpa helicopter
  - Drones—2 to 3 gpa; unsure of effectiveness at low GPAs
- In stands with less damage, skidders may be used for vegetation potentially to ≈30 ft tall
  - May be best option for multiple vegetation strata - greater amounts of water per acre (20-30 GPA)

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Site Preparation Options

Common Tank Mixes

- Imazapyr + ester/choline triclopyr formulations—hardwoods and waxy leaf species—questionable volunteer pine control
- Imazapyr and glyphosate-July through October—Volunteer pine control can be excellent with summer (July-early Aug) applications with 2 oz/ac saflufenacil
- Imazapyr + glyphosate + sulfometuron methyl—residual HWC into first growing season if applied after Aug 15th
- Imazapyr and glufosinate (56 to 82 oz/ac) for hardwood and volunteer pine control – no antagonism observed and window to apply is July – Nov (before hardwood leaf color change)

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Site Preparation Options

Mechanical Site Prep

- Much more expensive after hurricanes due to debris levels
- Debris management on high debris sites with (>75-100+ tons/ac) D8's + anchor chaining to level debris
- Lesser debris site may involve v-blade shearing and root raking
  - Modified equipment to protect dozer tracks and radiators may be needed
- Smaller piles better for smoke management than windrows if burning is done
- Poorly drained soils will usually require bedding (or use old beds?)

Modified D8 dozer

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Post first v-blade shear pass

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Innovations in mechanical site prep and debris removal

Saw-head clearing young to small merchantable sized pines on Tyndall AF Base near Mexico Beach, FL

- Fuel wood harvest

- **Strip clearing**
  - **Bulldozed paths** every 12-14 ft for planting rows or for bedding
  - D8's with heavy duty, reinforced V-blade
- **Mulching**
- Altha, FL

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Site had hundreds to thousand of nonmerchantable (usually bent) small stems per acre—'sawheaded' with modified feller buncher, followed by rootrake and windrow

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Maddox Tract, FL Post-Hurricane Michael (Oct 2018) – Timber Objective

64 oz/A Chopper Gen II plus 32 oz/A MSO @ 14.25 gal/A – can add glufosinate (56 oz/ac Cheetah) to control pines

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Site conditions required mechanical SP after herbicide then plant next year

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Maddox Tract, FL February 2024

Hawthorne and American beautyberry were only woody species present after 4 growing seasons

- Standing timber 'sawheaded', then rootraked and windrowed (13 to 15 ft wide) during late 2019
  - Early 2025—rootrake averages $180/ac
- CRIFF G soils—Foxworth and Lakeland
- Loblolly hand planted at 7x12 ft spacing during Feb 2020
- Trees average 2.0" DBH; 11.3' tall Feb 29, 2024
- Survival = 80.3%
- Basal area per acre = 13.5 to 15.4 ft^2/ac

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Ranch Tract, Florida, April 2019

- Initial aerial chemical site prep—some nearby similar sites did aerial site prep after mechanical site prep
- 2019 Modified D8 dozers shear path down former thinned row corridors
- Next two D8 dozers drag 340 ft anchor chain (60 lb links) (100 ft wide sections)—120 acres per day possible
- Finally, more paths are D8 dozer sheared to allow Savannah bedding plow access
- No price per acre given but dozer operators paid $425 to $475/hr-2019
  - KG/shearing averages $248/ac as of early 2025
- Most expensive site preparation sequence observed following hurricane Michael

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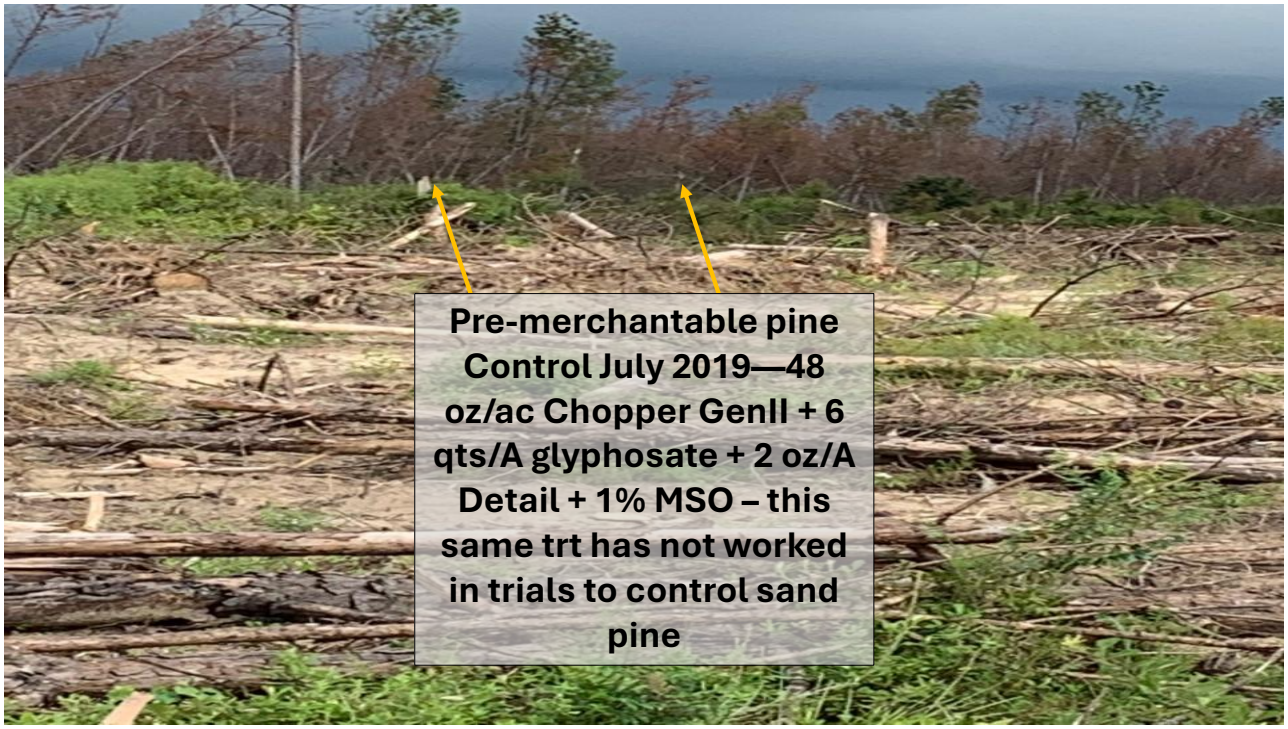

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Ranch Tract, Florida February 2024

Yaupon and gallberry coverage was less than 20% in all plots. Stems less than 2-3 ft tall

- Arborgen MCP loblolly seedlings hand planted at 5 x 15.5 ft spacing during Feb 2020
- CRIFF B soil—Leefield
- Feb 27, 2024 average DBH = 2.7” and total height = 14.1’
- Survival = 91.2%
- Basal Area = 25.7 to 49.1 ft^2/ac

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Altha, FL Mulched Site, February 2024

- Forestry mulched during 2020
  - Early 2025—averages ≈ $215/ac
- Imazapyr + glyphosate site prep
- V-blade planted with OP loblolly Feb 2021 at 6 x 12 ft spacing
- CRIFF E soils
- As of Feb 2024 average DBH = 1.5” and height = 9.2’
- Survival = 74.5%
- Basal Area = 7.2 to 10.6 ft^2/ac

No woody competition on 4 plots other than eastern Baccharis after 3 growing seasons

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Tyndall Air Force Base Reforestation

- Ecological forest management objective
  - Preserve herbaceous vegetation, plant longleaf pine
- Site ‘sawhead felled’, chipped and planted with containerized longleaf
- No chemical site prep
- Hand planted Jan 2020 at 6 x 9.5 ft spacing
- CRIFF D soil—Leon and Mandarin
- Feb 28, 2024—80.4% survival
- 83% of stems still in grass stage—no trees out of grass stage taller than 32 inches

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Natural Regeneration Option

- Damaged pine stands, seed fall at time of disturbance (hurricane season)
- Seeding from residual pines
  - Loblolly (best results likely) 6-10 trees per acre (annual production, <300 ft dispersal distance downwind)
  - Slash 15-25 trees per acre (<150 ft dispersal distance)
  - Longleaf 30+ trees per acre (Annual seed crops vary widely across range often 4 to 10+ years—usually <66 ft dispersal distance)
- Vegetation Control—Aerial broadcast 4 lb ae imazapyr, September
  - Loblolly 16-18 oz/ac, Slash & Longleaf 12 oz/ac—after Aug 15th
  - $90 per acre treatment
  - Prescribe fire after herbicide debris loads lesson may thin pre-merchantable stems

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Pine natural regeneration

Stocking will be variable (300-3000+/ac), longer rotation, later thinning,
Genetics from site (not from seedlings brought into site), no chemical site prep, much lower cost

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Site preparation sequences for unsalvaged stands

- Aerial herbicide (July-October)
- Rx burn 2 months post herb treatment
- Strip V-blade plant (rows 12-14+ ft wide – spacings 6x12, 5.5x13 or 5x14 ft) after burn
- Or hand plant (difficult walking)
- Burned stands will be mostly smaller tracts

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Site preparation sequences for unsalvaged stands

- Aerial herbicide (July-October)
- Strip V-blade with larger bull-dozer (D8 or D9) to create planting rows – with 10-12 ft wide V-blade
- Hand plant – V-blade strips with 2 rows per strip w/ each of the 2 rows close to the debris windrow
- Smaller tract – burn windrows
- Larger tracts – may not be able to burn windrows but have to be very concerned with heavy fuel loads on site for some time

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V-blade on dozer to clear planting rows

Highway transport constraints w/ wide V-blade ???

A wide (12-14 ft) V-blade (up & back pass) gives 2 row option

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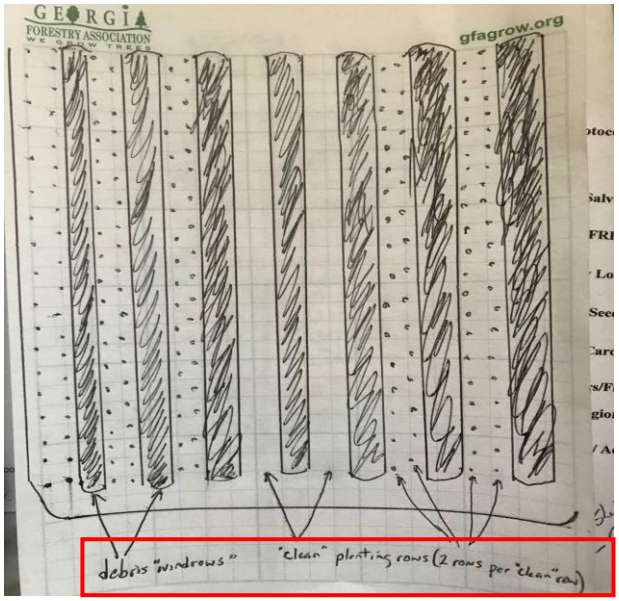
V-blade or Mulcher 12-14 ft planting "rows" diagram



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Other site preparation options with lower costs for unsalvaged stands

- **For sites with <u>poorly drained soils that need bedding</u>**
- Can old beds be used or not?
- Aerial herbicide (July-October)
- If old beds <u>can</u> be used – Rx burn 2+ months after herbicide treatment OR strip clear over beds with modified feller-buncher – hand plant on the beds
- If old beds <u>cannot</u> be used – heavy mechanical work will be needed to move debris for bedding plow—shear paths
- Smaller tract – burn windrows or piles (possible smoke issues near sensitive areas)
- Larger tracts – may not be able to burn windrows or piles but must be very concerned with heavy fuel loads on site for some time

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Other site preparation options with lower costs for unsalvaged stands

This stand may be held for a salvage operation after initial clean-up/access operations are completed

- Salvage (delayed) this stand and do usual site prep
- Aerial herbicide (July-Oct)
- Rx burn smaller tracts (or any tract that can be burned) 2+ months after herb trt
- V-blade plant or hand plant site (most cases)

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Reforestation after major wind disturbances summary

- **Natural regeneration** of pine on smaller tracts may be the best option assuming seed or seedlings in place or enough seed trees present to adequately stock tract
- For some stands the best option may be natural regeneration—check regularly for **invasive plant establishment**-disturbance perpetuates especially without active management
- For **pine artificial regeneration** – case by case prescription based on debris level, landowner near- and long-term objectives, $/ac each landowner can afford
  - In federally declared disaster regions—Emergency reforestation programs can assist with higher site preparation costs
- Target the winter season you want to plant and try to schedule site prep (chem + mech, chem only, mech only then aerial release), order seedlings and have planting crew committed in the 9 months before that target date
- In major hurricane paths, the "window" to get most/all the stands reforested that were catastrophically damaged will take 4-5 yrs due to the work needed vs seedling and contractor supply/availability

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Factors involved in lean pine recovery

- Rainfall amount and duration **prior to** the hurricane impacting the pine stand
- Precipitation and temporary increases in soil moisture during hurricanes on better drained soils may help support trees by increasing root system weight and increase tree stability during wind drag and oscillation. This can be especially important for larger individual trees.

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Factors involved in lean pine recovery

- Southern pines growing on somewhat poorly, poorly and very poorly drained soils tend to have a higher incidence of tree damage during wind events due to less root development and mass contributed to more anaerobic soil conditions. Similar situation for soils with hardpan horizons.
- Wind speed and duration (time) in the stand (possible for two wind directions with locations in the eye – front end and back end of hurricane)

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Factors involved in lean pine recovery

- Tree height class → taller trees are exposed to more wind than shorter trees and are generally more apt to break or lean
- How recently the stand was thinned → pine stands thinned in the last 2 yrs are more apt to have greater damage than stands thinned >2 yrs prior to the hurricane
- Younger, unthinned stands tend to have much less damage than taller, older thinned stands (evident after Hugo in Sept 1989, Mathew in 2016, Irma in 2017 and Michael in Oct 2018)
- Individual crown size → crowns act as sails on a sailboat →large crown trees, at least in young stands (5-15 yrs old) capture more wind and are more apt to lean than smaller (and often shorter) crown pines
- When wind speeds are 135 to 155+ mph sustained (Sept 1989 Hugo and Oct 2018 Michael, respectively); pine species does not matter, loblolly, longleaf and slash pine will all have similar amounts of damage (evident in Hugo and Michael)

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Leaning pines over 40 ft tall—Recovery Prospects

- 40-100+ ft tall pines with minimal lean: very few (<10%) will straighten up, most (75-90%) will **not** straighten up after 1–2 yrs but will continue to live as long as no uprooting has occurred

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Lean pines over 40 ft tall—Recovery Prospects

- L photo: 1 month after Hurricane Matthew >85 ft tall loblolly with varying degrees of lean
- R photo: 2 YA Hurricane Matthew 85+ ft tall lob, all but 1 straightened up (a rare case)
- Note last tree in L photo – **if stem bend/sweep per 16 ft is > 3" then it is a pulpwood log/tree**

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Leaning pines over 40 ft tall—Recovery Prospects

- L photo: 1 month after hurricane Matthew >70 ft tall loblolly with varying degrees of lean –some straightened up after 1-2 yrs, some did not (Bulloch Co, GA)
- R photo: 2 YA hurricane Matthew (R photo) 70+ ft tall slash – most still with lean

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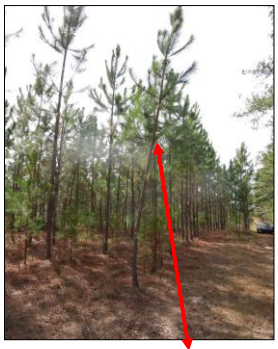
Leaning pines 20-40 ft tall

Leaning < 30 degrees from vertical = most will straighten up
30-45 degree lean = some will straighten up
45-60 degree lean = some/most will NOT straighten up
> 60 degree lean = most will NOT straighten up
(shorter trees = greater chance of straightening)



30-40 ft longleaf (left photo) did not straighten after 1 or 2 yrs. With 20 ft tall slash pine leaning <30 degrees some did straighten up after 2 yr (right photo) → **Give these young stands 1-2 growing seasons (much is known after 1st yr)**

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Pines 20-40 ft tall

An EF1 tornado that went through eastern Liberty Co, GA and catastrophically damaged the foreground hardwood stand but did no damage to the loblolly pine stand (25-30 ft tall) behind the hardwood stand (circled in red)

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Leaning pines 5-20 ft tall

leaning < 30 degrees from vertical = most/all will straighten up
30-45 degree lean = most/all will straighten up
45-60 degree lean = some will straighten up
> 60 degree lean = most will NOT straighten up
(shorter trees = greater chance of straightening up)

Longleaf (left photo) did straighten after 1 growing season (right photo)
Give these young stands 1+ growing **season**

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Leaning pines <5 ft tall → rules of thumb

Leaning < 30-45 degrees from vertical = most/all will straighten up
45-60 degree lean = most/all will straighten up
60-80 degree lean = most will straighten up
shorter trees = greater chance of straightening

L Photo 1 yr old loblolly leaning >45- 60 deg that straightened back up after 1 yr.
R photo 1-yr old loblolly with hole at base from hurricane Matthew tree straightened up after 1 yr.
Give these young stands **1+ growing season**

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Leaning pines <5 ft tall → rules of thumb

leaning < 30-45 degrees from vertical = most/all will straighten up
45-60 degree lean = most/all will straighten up
60-80 degree lean = most (>60-75%) will straighten up
shorter trees = greater chance of straightening up

Left photo: 1-yr old loblolly w/ 45 deg lean from vertical post Matthew (Nov 2016 photo) that straightened back up after 2 yrs Right photo: 2 yrs post Matthew in Effingham Co, GA

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Uprooted large pines

Tops tended to stay green until spring (March-April) of following year
5-6 month salvage window for high value uprooted (no stem breakage) wood

Late Oct 2016 after Matthew Bulloch Co GA

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Uprooted large pines

Uprooted loblolly pines post Hurricane Michael –NE Laurens Co, GA

Photo taken April 2019 after 10 Oct 2018 hurricane Michael > 85% of trees died but only 1 acre area
→ 4 to 5-month window to salvage these trees before decay, but 60 ac stand overall had minimal damage
→ stand was clearcut during summer 2022 when pine chip-n-saw and sawtimber prices were strong

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Uprooted longleaf with > 60-degree lean

Post hurricane Michael, unthinned longleaf planted on a poorly drained Pelham soil with greater than 60 degree lean and uprooted – these trees died 4 months after Michael

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Lean pine summary

- Experience with Hugo (1989), Matthew (2016), Irma (2017), and Michael (2018) has shown that 90+% of lean pines (loblolly, longleaf or slash pine) will live for 2+ years **if root system is not mounded with exposed/broken roots** (most or all will live for a longer period of time)
- This gives forest landowners the chance to thin or clearcut these low to moderate damage stands 1-2+ yrs later when pine stumpage prices may improve, or continue to manage these stands as they are
- Some pines will straighten up after one-year but this result is a function of root damage evidence, tree height, and degree lean (follow guidelines)
- Pines with crowns leaning onto adjacent pines crown will sometimes (33-50% of the time) die (possible reduced sunlight to that tree)

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