
WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

Reforestation After Fire-Salvage on Trust Lands: Societal, Ecological and Financial Influences and the Effects of Herbicides, Planting Season and Delays

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Presentation Outline

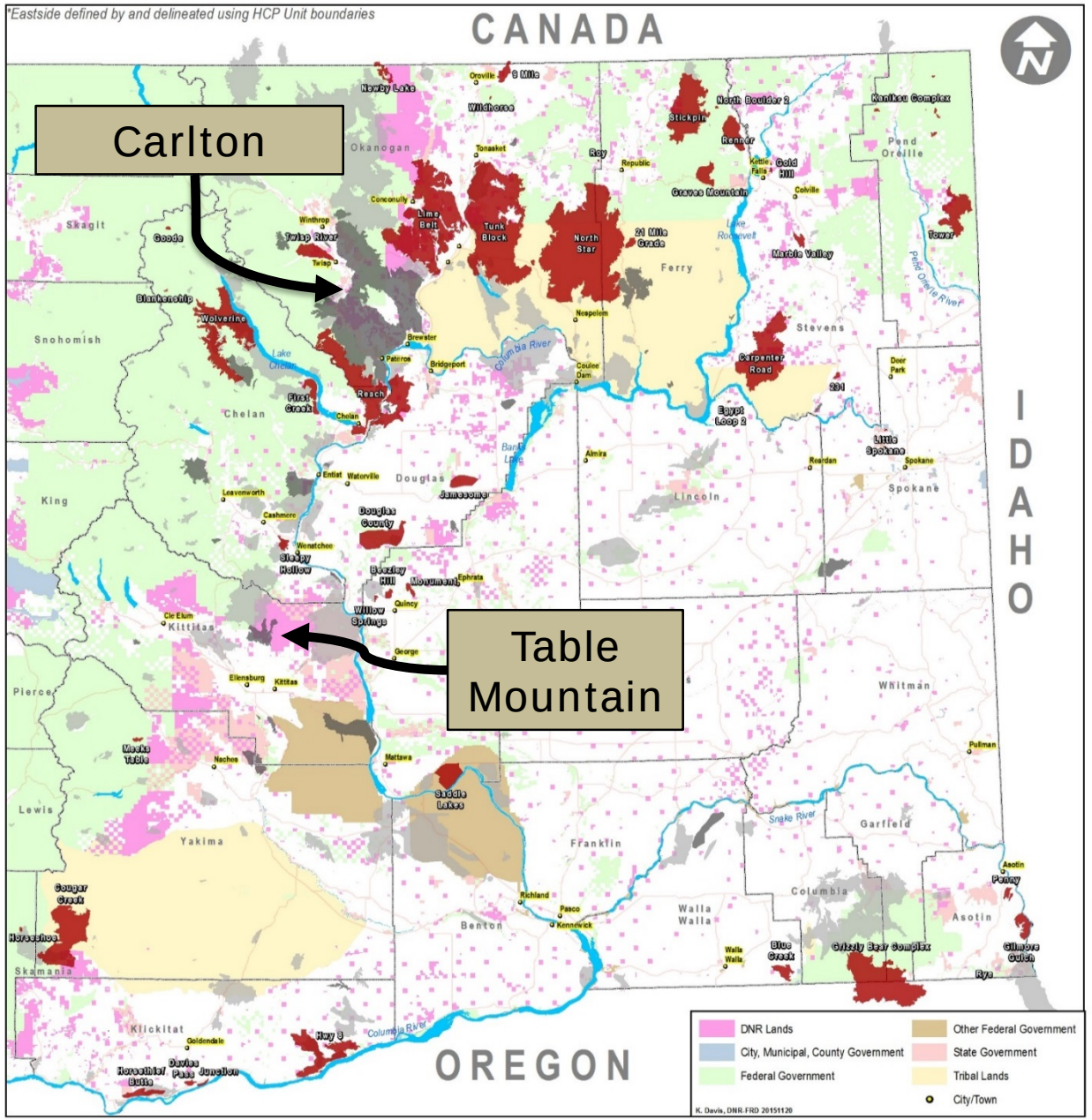
- Magnitude of recent fires and DNR response
- Salvage, Fuels Treatments and the Resilient Forest
- Financial considerations
- Reforestation Uncertainties and Research Results
  - Post-fire vegetative recovery
  - Season of planting and delayed planting
  - Herbicide effects
  - Natural regeneration

Washington Department of Natural Resources

- Trust land management – agency charged with making money
- Statewide timber revenue around $200,000,000 annually
- Westside Sustained harvest about 500 MMbf
  - One sixth of the western Washington annual harvest
  - $6 billion economic impact
- Manage about 747,000 acres in eastern Washington
  - Harvest around 60 MMbf annually

How Much Burned in 2014-15?

- 10% of DNR forest land
- 20% of NE Region
  - 5 year Fire Return Interval?
- Grasslands, shrublands, Dry ponderosa pine to moist grand fir and hemlock types
- Burnt acres amounts to over ten years of harvest



Washington Eastside Fire Statistics

Acres Burned - All Owners:
- 2003 - 2013 = 1,671,316 ac.
- 2014 = 434,229 ac.
- 2015 = 1,074,732 ac.

DNR State Land Totals
Land Base: 1,556,669 ac.
Forested Acres: 747,018 ac.

DNR Land Base Burned:
- 2014 = 65,336 ac.
- 2015 = 76,430 ac.

DNR Forested Acres Burned:
- 2014 = 25,060 ac.
- 2015 = 50,140 ac.

2003 - 2013 Fires
2014 Fires
2015 Fires

Magnitude of Recent Events Is Operationally Challenging

- Budgets
  - How do we pay for unanticipated planting that is 10 times annual averages?
- Personnel Burnout
  - Same people fought the fires need to set up and admin sales
- Salvage Harvest Site Selection
  - Prioritization process
- Reforestation issues
  - Seed often not available, and
  - Seedlings not available for another year

For DNR – Salvage is Required

RCW 79.15.210 Findings -- Damage to timber: "From time to time timber on state land is damaged by events such as fire, wind storms, and flooding. After such events the timber becomes very susceptible to loss of value and quality due to rot and disease. To obtain maximum value for the state, it is important to sell any damaged timber as fast as possible while providing ample protection for the physical environment and recognizing the sensitivity of removing timber from certain locations."

Also - RCW 79.15.220 Sale of damaged valuable materials.

Salvage Invokes a Reforestation Requirement

WAC 222-34-020 Required reforestation—East of Cascades Summit.

(1) Reforestation - where required.

(i) Clearcutting; or

(ii) Partial cutting where 50 percent or more of the timber volume is removed within any 5-year period, unless the department determines that the live trees remaining will reasonably utilize the timber growing capacity of the soils.

WAC 222-16-010 – Definitions

"Even-aged harvest methods" means the following harvest methods:

Clearcuts;

Seed tree harvests in which twenty or fewer trees per acre remain after harvest;

Shelterwood regeneration harvests in which twenty or fewer trees per acre remain after harvest;

Other Perspectives on Wildfire Response: Salvage, Fuels Treatments and the Resilient Forest

- In 2016, an anti-salvage logging letter to Congress was signed by 250 scientists
  - Equivalent Letters in many other years as well
  - But few, if any, of the signatories appear to be forest-land managers
- What they say:
  - Salvage is bad for forest recovery and an unsustainable practice
  - Even-aged management is bad
  - Roads are bad
  - Fuels treatments and prescribed fire are good – i.e., managing for resilience

What is Resilience and How Do We Get Resilient Forests?

- Managing fire-prone ecosystems for Resilient Forests enjoys a High Level of agreement among researchers, politicians, forest managers, environmental groups and others
  - Resilience becomes the Objective of management
- Resilience is the capacity of the system to return to a pre-disturbed condition and still maintain its essential structure and function (Halofsky et al 2014)
- Climate change adaptation strategy, primarily focused on dry forests
- Achieved through active management
  - Thinning
  - Prescribed fire

What's Missing from the Resilient Forest as Presented?

- Landowner objectives – DNR manages Trust lands to generate revenue
  - Resilience must consider the appropriate landscape conditions needed to accomplish objectives
- Definitions of sustainability related to Resilience
  - It appears resilience is the new sustainability
  - Is it solely ecological or does financial resilience matter?
- An understanding of the managed forest as a resilient forest
  - Management generates revenue needed to restore, rehab, maintain roads, reforest and so on
- Randomness of disturbance and rapid vegetative recovery rates
- Acceptance of the severity of summer wildfires in open forests and non-forest
  - Ex. Isolated large PP killed, stand replacement burns of shrublands and grasslands and even sparsely vegetated cliffs and rock outcrops

On Trust Lands, Resilience Should Be Tied To Financial Performance Objectives

- A Resilient Forest is not ecologically sustainable unless it is economically sustainable
  - A Resilient Forest or any other managed ecosystem is unsustainable if the financial inputs required to produce desired outputs exceed the revenue that can be generated
- Better Than Nature – Timber management provides the FINANCIAL resources to maintain not only a Resilient Forest – but any Forest that provides a desired benefit
  - Management can target non-resilient forests for removal
  - It maintains roads that provide access and fire breaks
  - It breaks up the continuity of fuels
  - It provides landscape diversity and resilience while avoiding the unsustainable investment of scarce financial resources in Low Value Thinning and Fuels Treatments that provide only a temporary respite from risk

The Reverse Lottery Logic of Fuels Treatments

- Lottery = very low investment with a very rare, very high payoff
  - $1 ticket for a 1 in 294,000,000 chance to win hundreds of millions of dollars
- Reverse lottery = high investment with a rare, low payoff
  - Spend Hundreds of dollars per acre to protect timber worth hundreds of dollars per acre, or some other non-revenue generating resource
  - Benefits of fuels treatments are temporary, lasting only a few years
  - Odds of burning your treated site is very low, i.e., a rare occurrence
  - Odds of treatment significantly changing fire behavior is very low, i.e., a low payoff
- Assumptions determine the financial viability of fuels treatments
- Potentially Misleading the public about our ability to influence wildfire

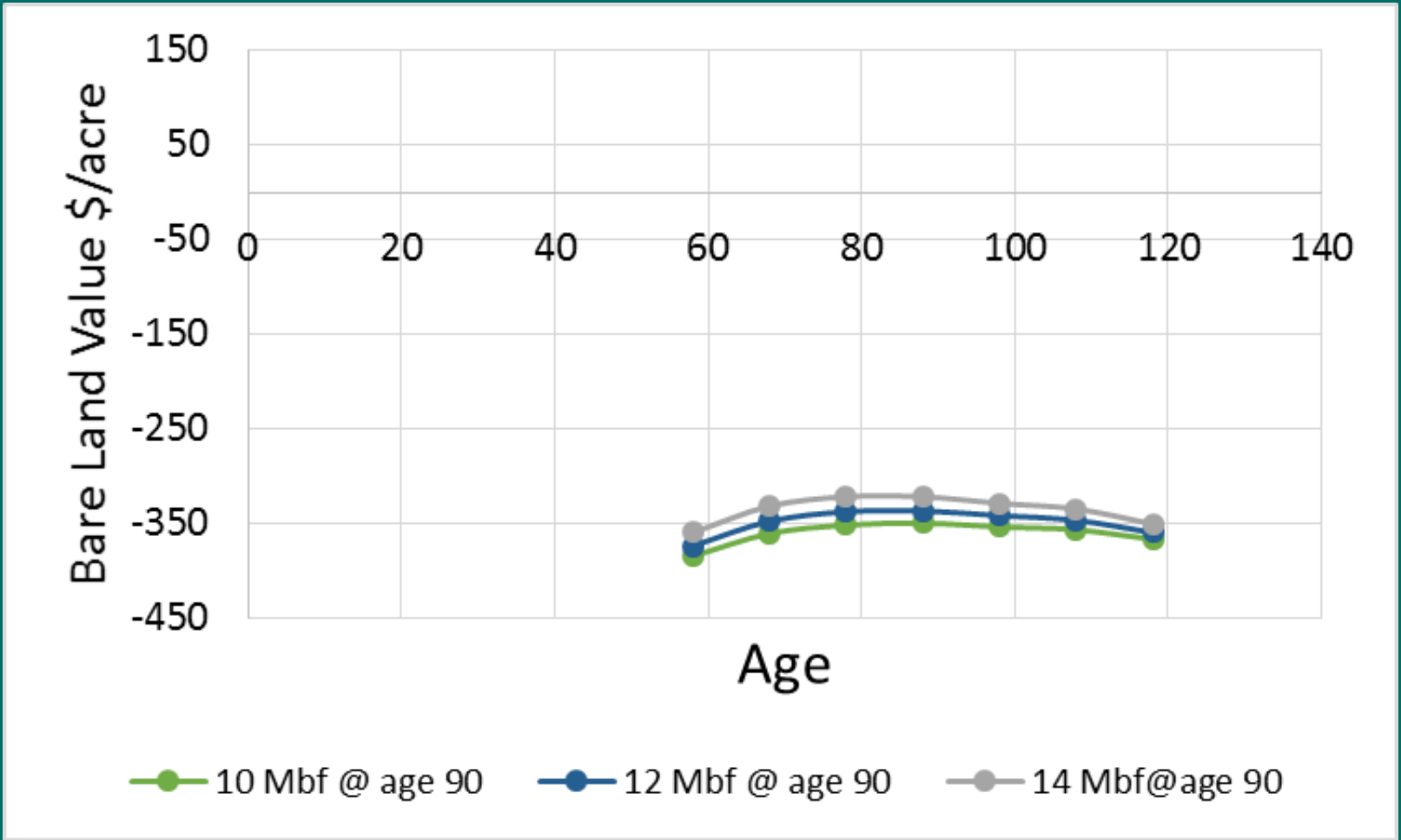
Does Wildfire Pose Problems for Post-Salvage Reforestation?

- Ecologically speaking – Not Really
  - Magnitude makes it an operational manpower and budgets issue
  - Caution against reliance on regeneration from likely maladapted legacies
- Fires seldom result in damage to the tree-growing capacity of a site
  - Nutrient volatilization? OK, but suppression may have increased inherent site productivity
  - Hydrophobicity – temporary and localized, freeze thaw breaks up, harvest does too
  - Erosion risks - real, but temporary
  - Soil-sterilization – very rare and localized
- Wildfire has benefits similar to prescribed burning to reforestation
  - Reduced competition, easier planting, nutrient flushes

Reforestation Investments on Low Productivity Sites: Financial and Societal Considerations

- Forest Practices Act requirements challenge traditional financial assumptions
  - Salvage harvest invokes reforestation requirement
  - Given legal requirements should costs be assigned to the current harvest or the future harvest?
- Obligations to Beneficiaries are clear, but what about Societal obligations?
  - Intergenerational equity and Future revenue streams to local economies
- Discount rate: Social versus financial
  - Social places higher value on intergenerational equity and 'public good' benefits
  - Financial based on opportunity cost, or alternative investment returns which DNR lacks
- Net Present Values become meaningless with very long planning horizons and typical financial discount rates
  - With a 4% discount rate the NPV of $1 billion in 400 years is about $150 today

Low Site Quality and Net Present Value by Age and Yield @4% Discount Rate



Assumptions:

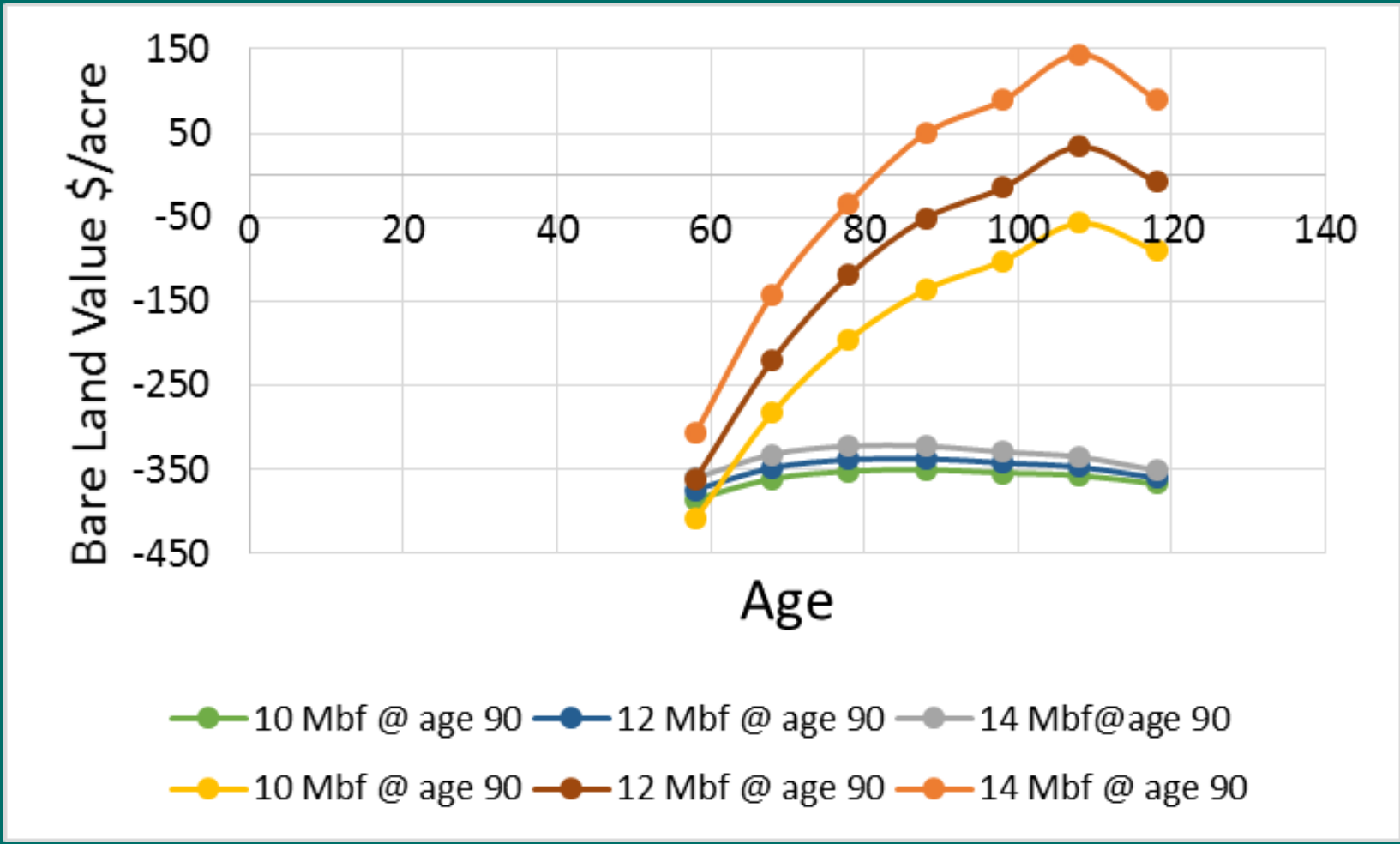
Site Prep = $80/ac

Plant = $220/ac

PCT at age 15 = $90/ac

Stumpage = $250/Mbf

Low Site Quality and Net Present Value by Age and Yield @2% Discount Rate



Assumptions:

Site Prep = $80/ac

Plant = $220/ac

PCT at age 15 = $90/ac

Stumpage = $250/Mbf

What About "Future Value" of Reforestation to Local Economies?

- Assume 12 Mbf/ac @ $250/Mbf = $3,000/ac
- Future local economic impact multiplier = 6
- Future Economic Impact to Local Communities = $18,000/acre

If all the economists in the world were laid end to end they still would not reach a conclusion.

George Bernard Shaw (maybe)

Operational Uncertainties and Post-Fire Salvage Reforestation

- Rates of Vegetative recovery
- Herbicide site prep
- Species
- Season of planting
- Delayed reforestation
- Rates of natural regeneration

Table Mountain and Carlton Complex Fires

Table Mountain

- Lightning ignition on September 8, 2012
- Total burned acres: 42,634 acres
  - 10,587 acres of State land
- Mostly stand replacement severity
- Habitat type series PP, DF and GF
- Elevations 3,900 to 4,500 ft.
- SI 45 to 60 at age 50

Carlton Complex

- Lightening ignition on July 14, 2014
- Burned over 250,000 acres
  - Destroyed approximately 300 houses
- 48,150 acres of Trust Lands
  - 17,109 acres forested
- Mostly stand replacement
- Most very low productivity
- PP types, some DF and WL

Vegetative Recovery Sampling at Table Mountain

- Seedling centered plots – 1 meter radius
- Every 5th seedling
  - Total 120 vegetation plots
- Recorded % cover and height by life form
  - Grass, forb, short shrub, tall shrub, HW and conifer
- Recorded germinants
- Measured established naturals

Table Mountain Vegetation Recovery

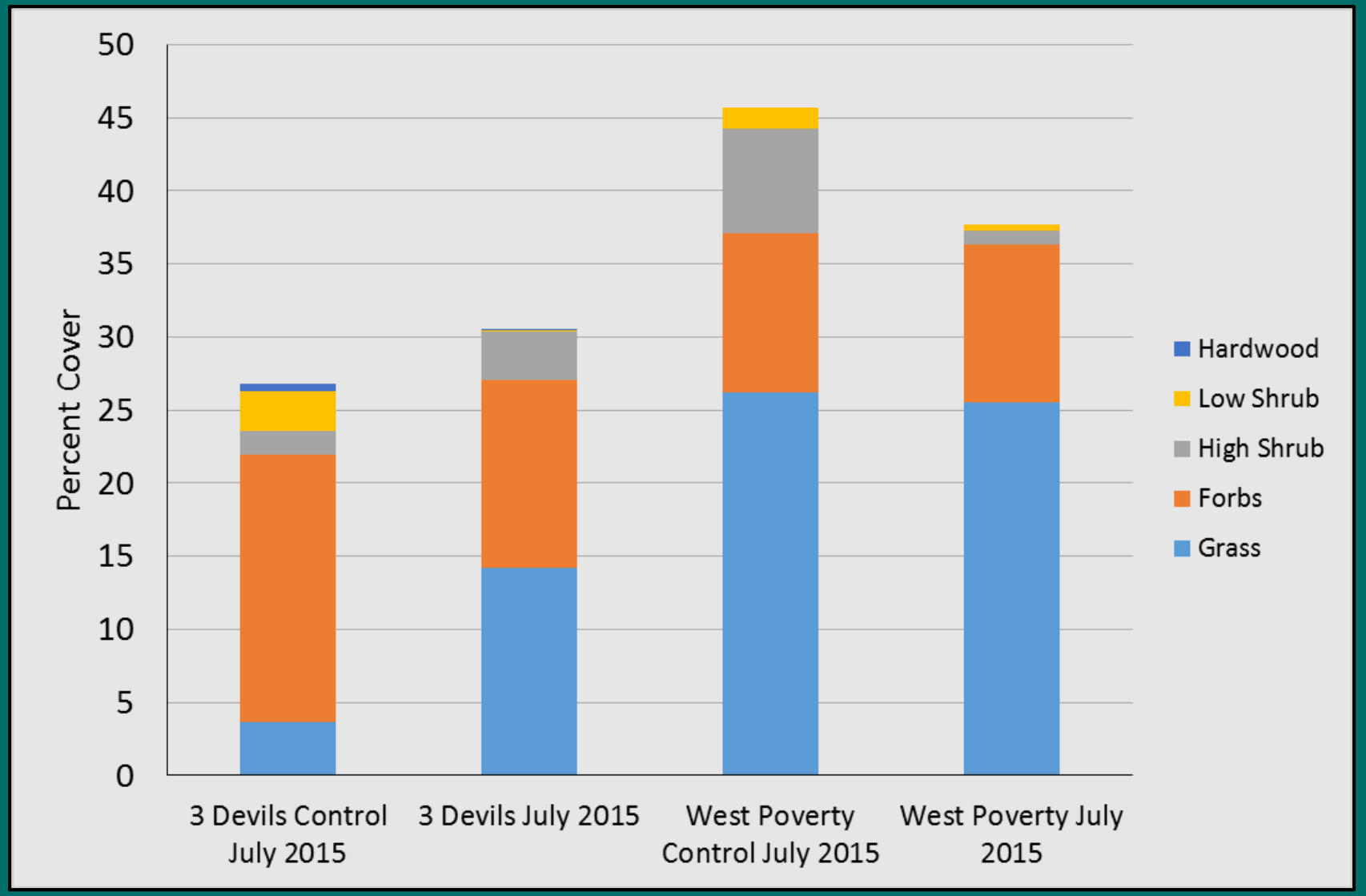
- Vegetation Assessed in Fall
- 1 m radius Tree centered plots
- 2013 = <1%
- 2014 = 27%
- 2015 = 29%
  - Grass = 18%
  - Forbs = 9%
  - Shrubs, HW = 2%

Vegetation Sampling at Carlton

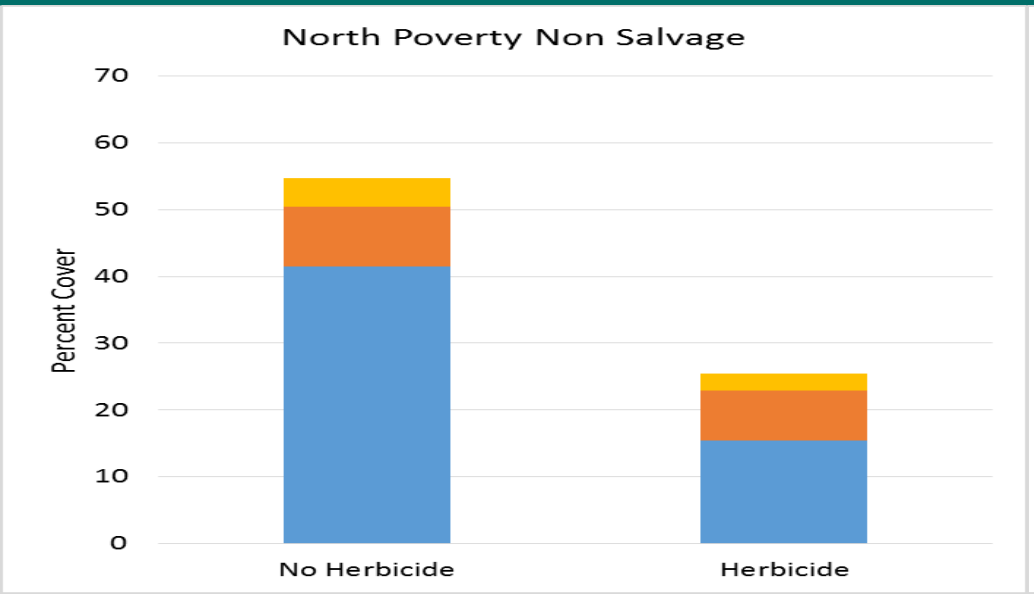
- 30 vegetation plots per stand
  - 1/300 acre circular fixed plot
- 225 plots centered on planted sample trees
  - 1 meter radius
- Vegetation % cover by life form
  - Grasses, forbs, short shrubs, tall shrubs, HW, conifer
- Recorded germinants
- Measure established naturals

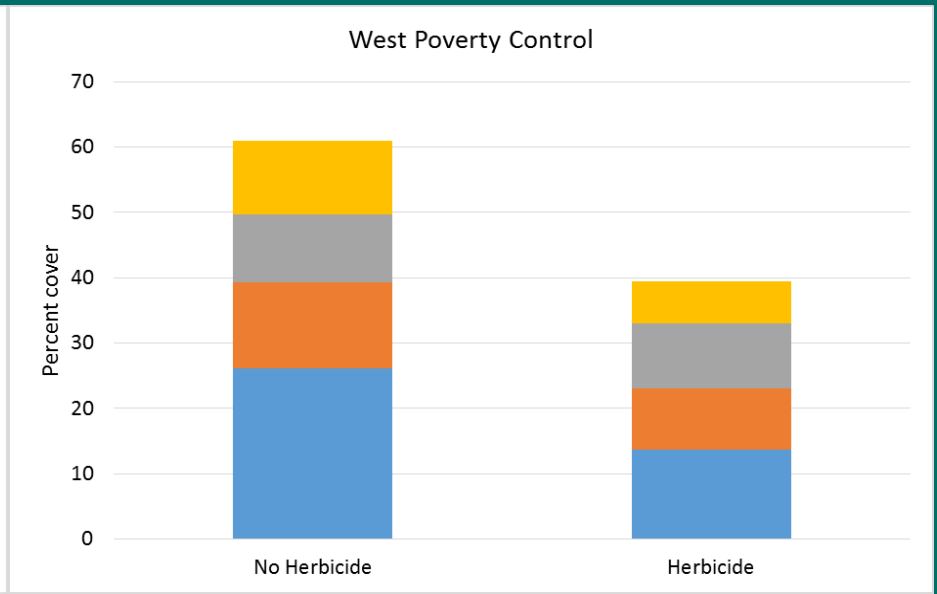
Carlton Vegetation Recovery

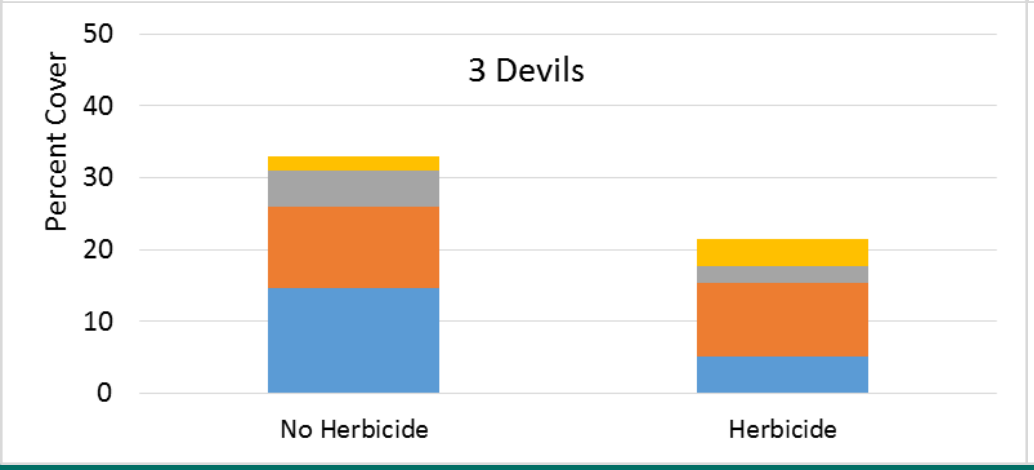
One-Year Post-Fire

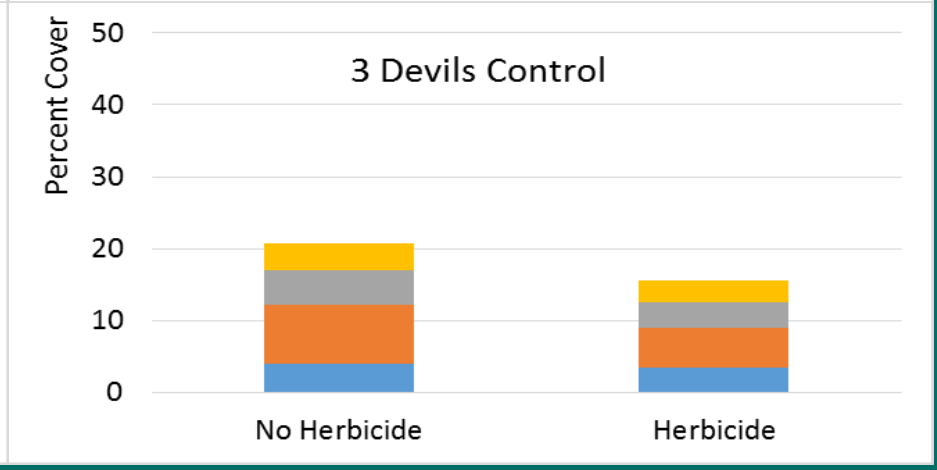


Herbicide Effects on 1st year Vegetation % Cover









Grasses

Forbs

Short Shrubs

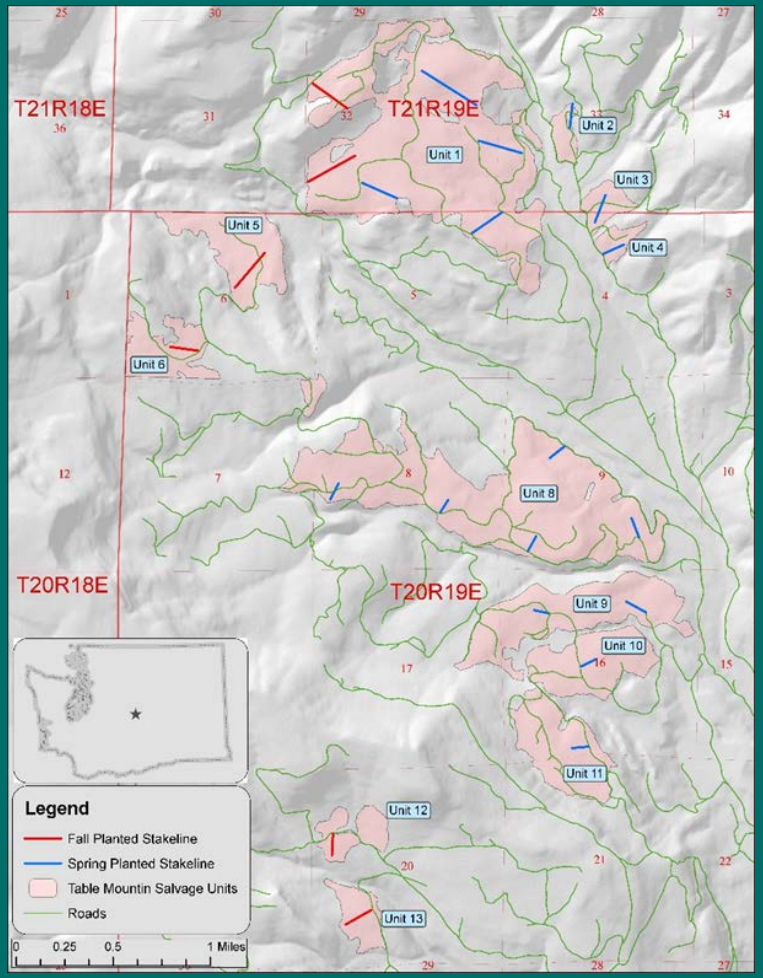
Tall Shrubs

Post-fire Vegetative Recovery

- Rapid, immediately post-fire
  - Typically no need for grass seeding
- Year one can be over 50% cover
- Can be controlled with soil active herbicides
- What does it mean to plantation survival and growth?

Table Mountain Seedling Sampling

- 12 stands were harvested in 2013/14
- Planting in fall of 2014, Spring 2014 and Spring 2015
- 22 stakelines of 20 seedlings each, originally
  - total of 440 seedlings
  - One to six lines per stand depending on variability
- 11 lines added in 2015 due to replanting
- Distance, direction and slope to seed source



Fall Planting Concerns

- Less common than spring planting
  - Previous DNR work suggests it works with larch (Barber 1999)
- Operationally more stressful than spring because of uncertainties related to weather
  - Concerns with soil moisture and temperature
  - Early snows and late precipitation
- Nursery issues –
  - maintaining vigor, Cold-hardiness, over-winter storage if outplanting site conditions aren't right

Delayed Planting

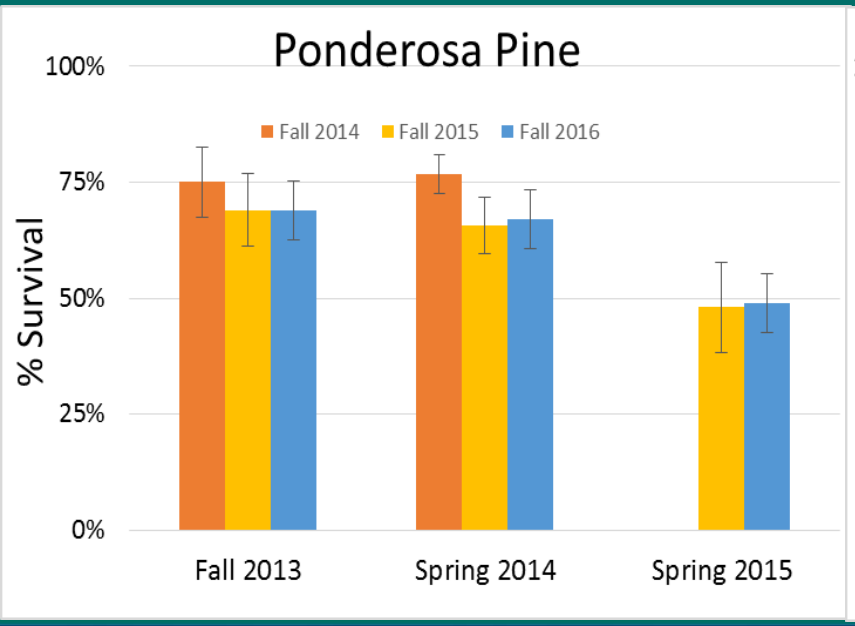
- Increased competition
  - Time allows establishment of competitors
  - Higher site prep costs
- Delayed future returns
- Increased time the site may be susceptible to erosion
- Public relations and expectations

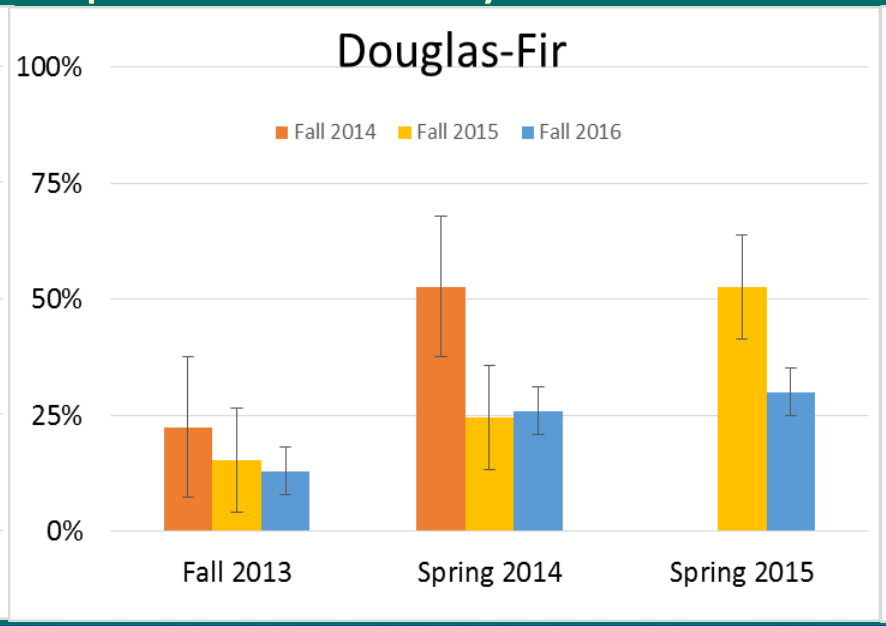
Table Mountain Tree Survival Results

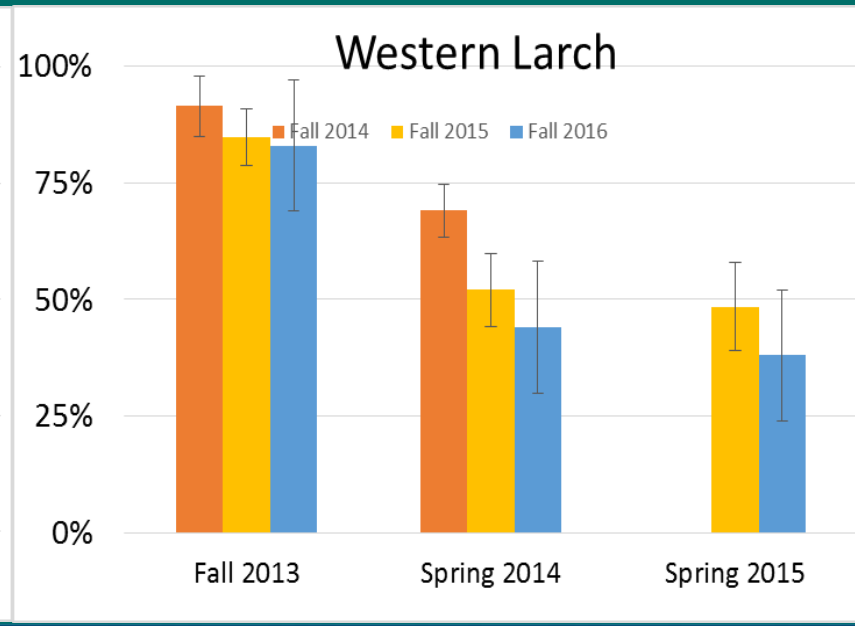
- Fall vs Spring
  - Equal for PP
  - Worse for DF
  - Better for WL
- Delayed Planting
  - Worse for PP and WL
  - Equal for DF

Species Differences
Importance of 1st year survival

- Conclusions:
  - FPA min's might not be met
  - Site prep may be needed
  - Replanting occurring
  - Naturals coming in

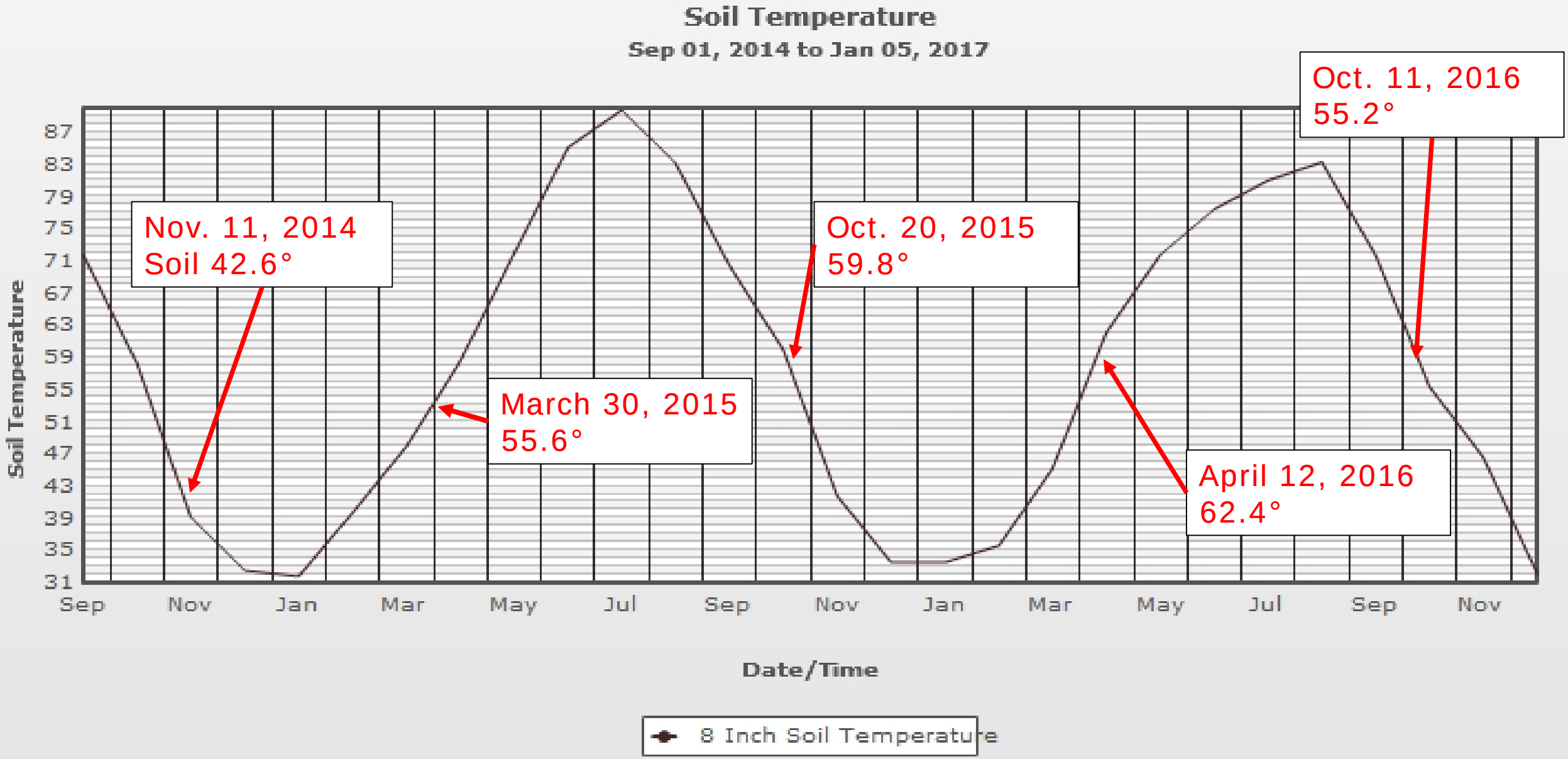




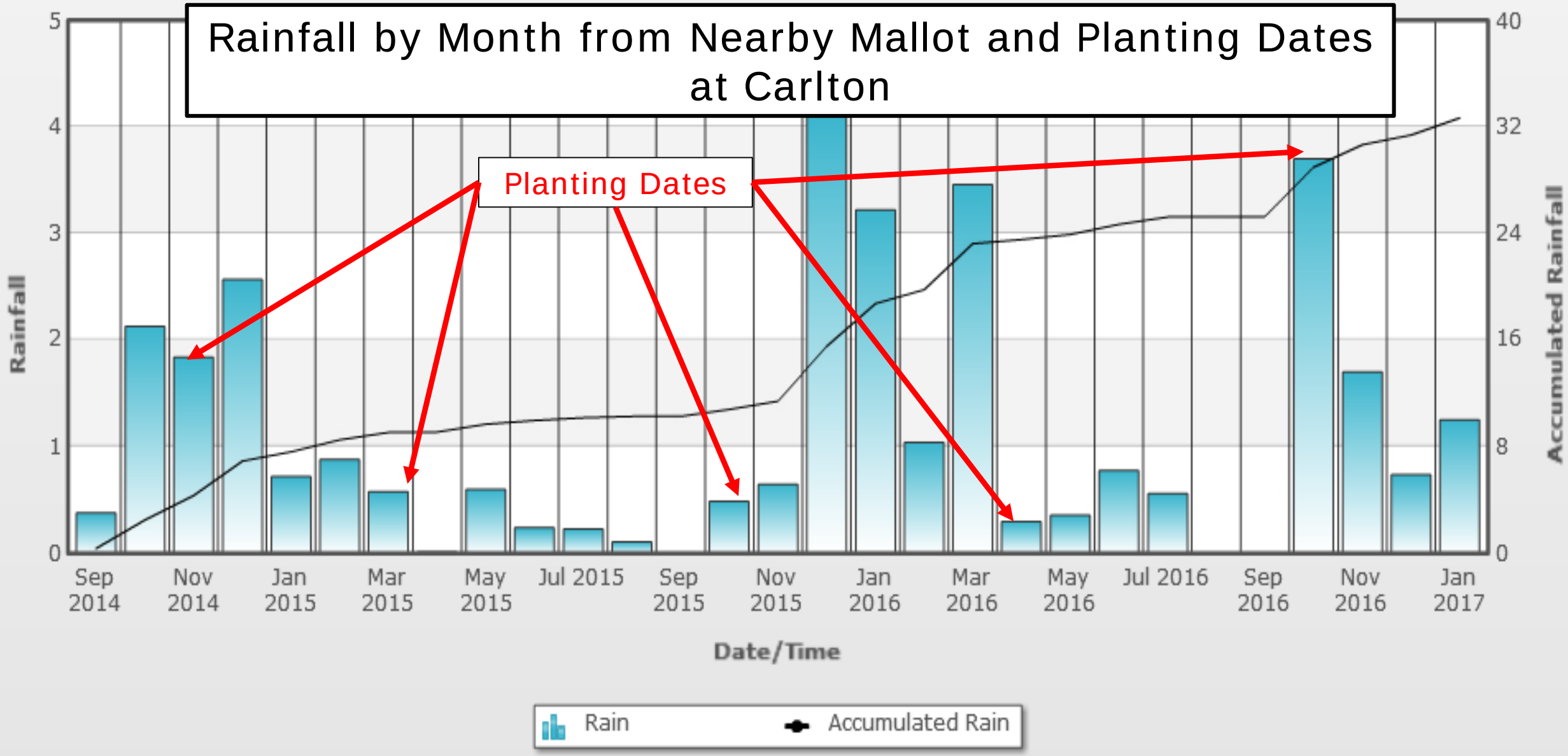


Reforestation Study at Carlton

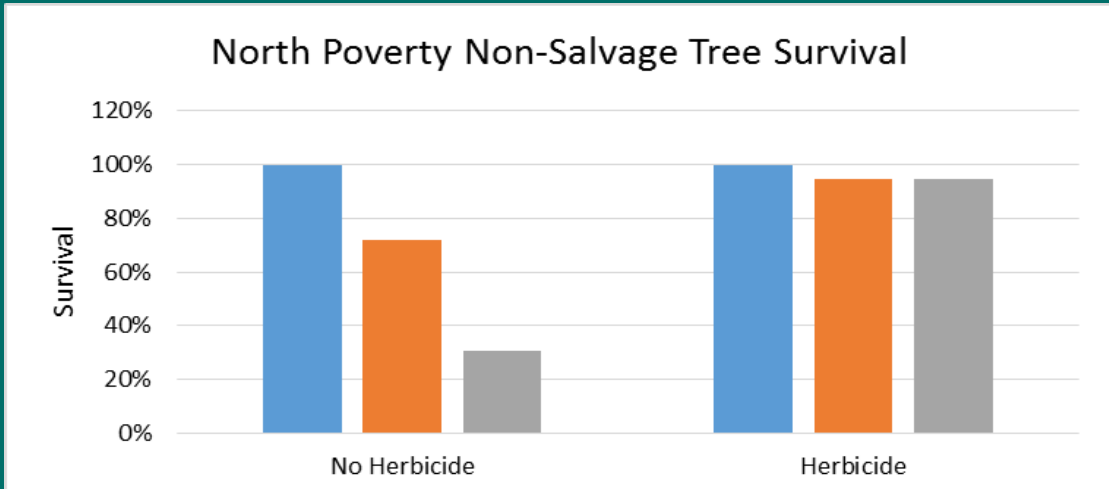
- 4 stands – plan was two harvested and two not
  - Ultimately only one was harvested
- All ponderosa pine
- Five planting seasons
  - Fall 2014, Spring and Fall 2015 and 2016
- Three blocks per stand
  - 25 seedlings per block, per planting date
  - Ultimately 1,500 seedlings
- Every other seedling received a spring Velpar treatment

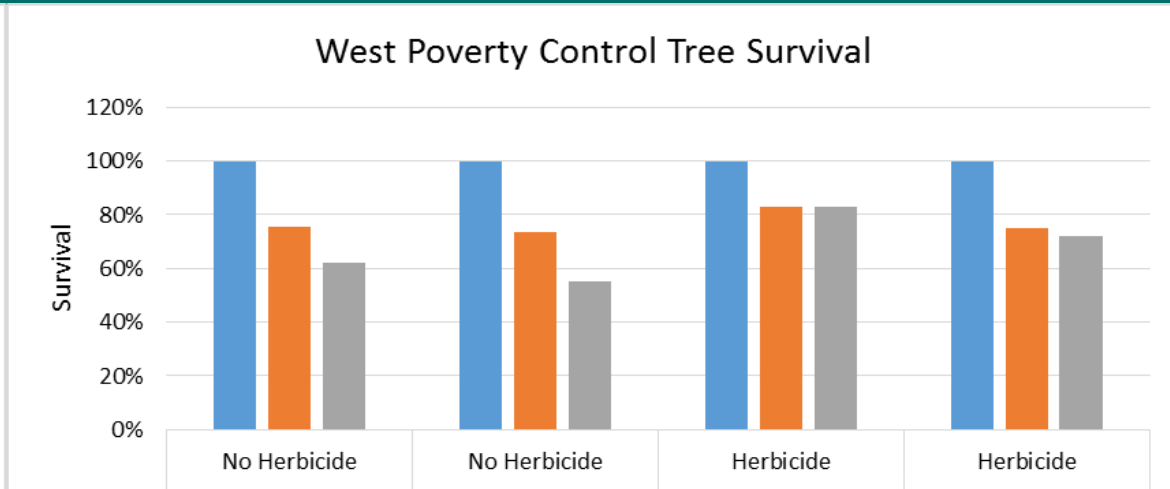

Soil Temperature
Sep 01, 2014 to Jan 05, 2017
Oct. 11, 2016
55.2°
Nov. 11, 2014
Soil 42.6°
Oct. 20, 2015
59.8°
March 30, 2015
55.6°
April 12, 2016
62.4°
Soil Temperature
87
83
79
75
71
67
63
59
55
51
47
43
39
35
31
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Date/Time
8 Inch Soil Temperature

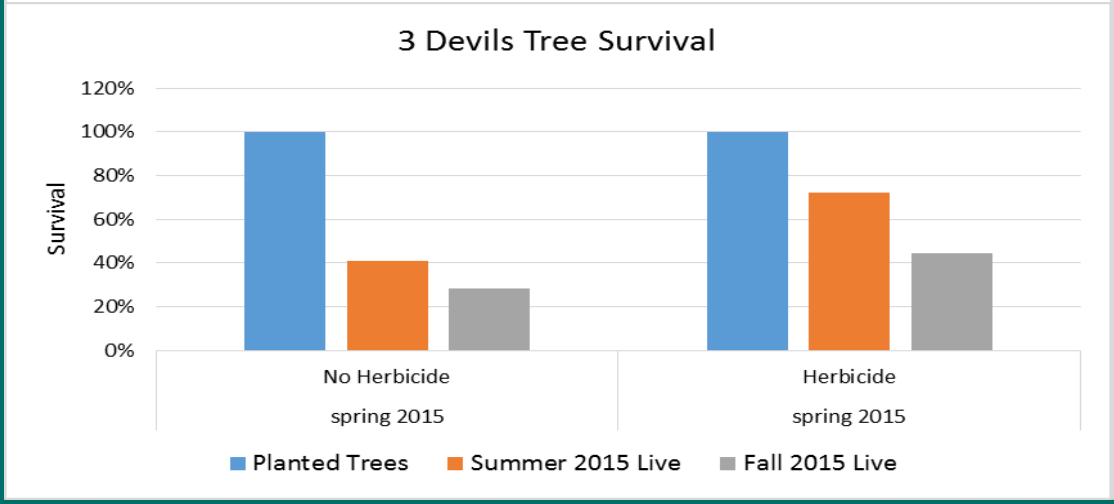
Rainfall by Month from Nearby Mallot and Planting Dates at Carlton

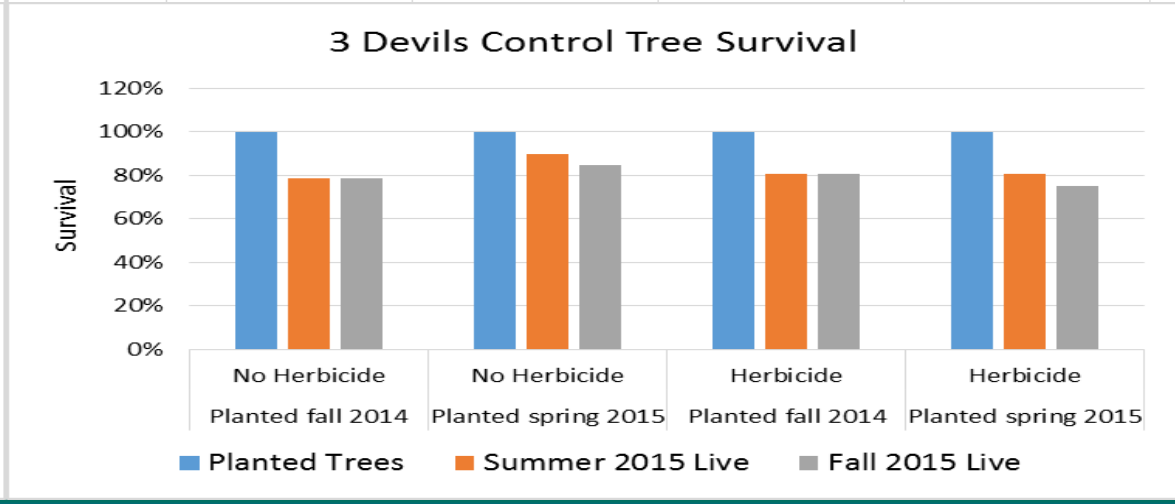


1st Year Survival by Planting Date and Herbicide





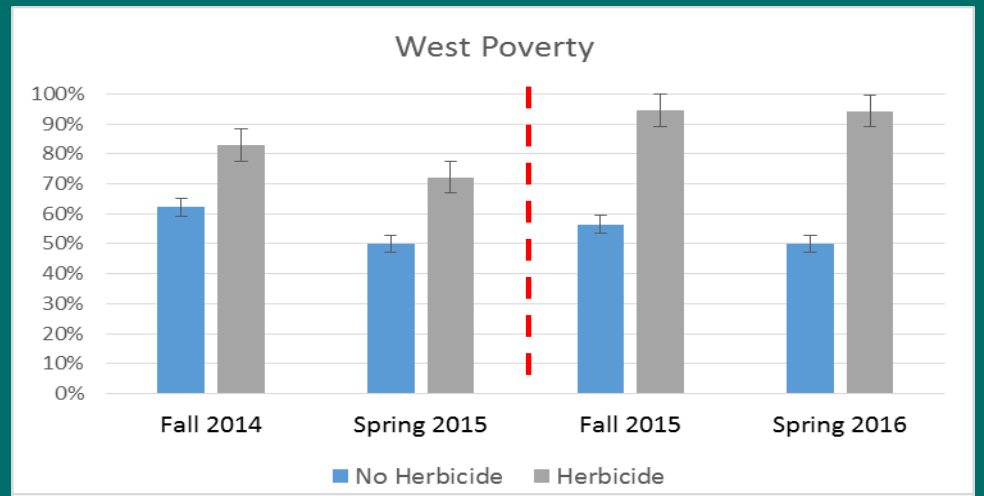


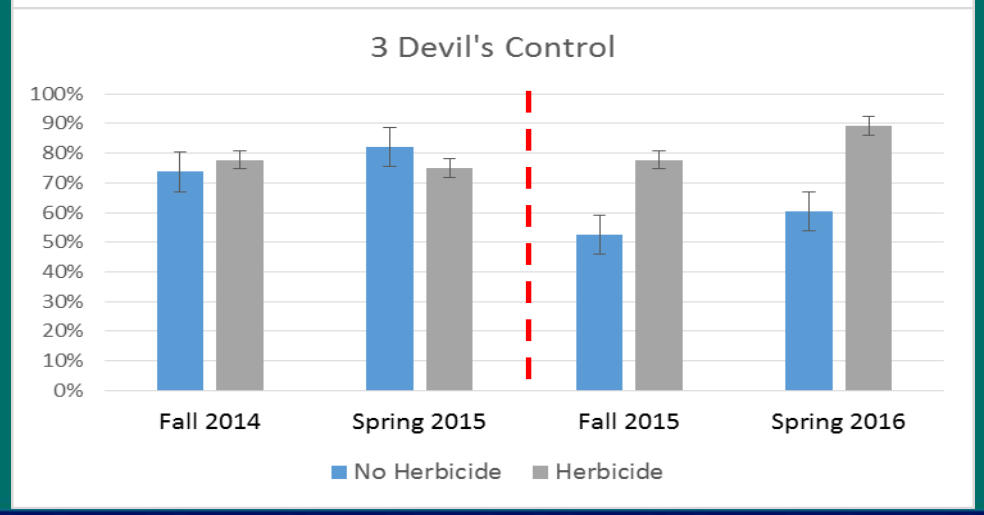


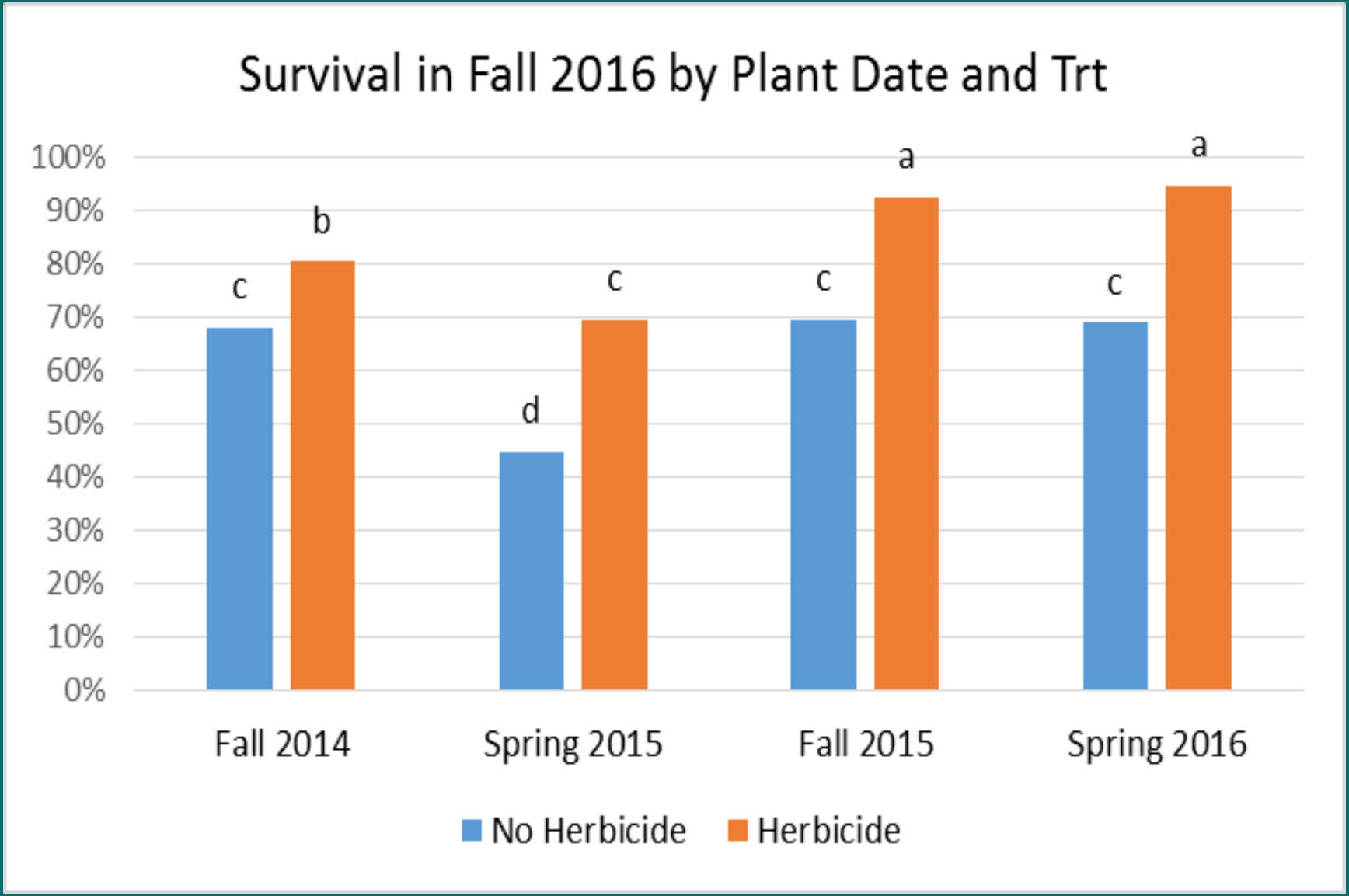
Fall 2016 Carlton Survival by Planting Date and Herbicide

Two Years | One Year Delay

Two Years | One Year Delay







Overall:

- Fall planting as effective as spring
- One year delay not a problem
- Herbicides improved survival by 23%
- Without herbicides planting <243 tpa would require replanting

Carlton Survival

- High levels of Late summer mortality without herbicides
  - Grasses likely cause
- Velpar improved survival on 3 of 4 sites
  - Up to 85% vs. 25%
  - Target veg cover is less than 20% in year 1
- Velpar improved survival in 13 of 14 combinations of date and site
- One date/site showed insignificantly better survival without Velpar
  - Also had lowest veg cover %

Herbicide and Survival Results

- 3 of 4 sites reduced veg cover to about 20% in year one
  - Vegetation measurement plot size vs spot treatment size
  - Essentially the treated area was entirely free of competitors
- Grasses most common competitor
- Grass most problematic competitor
  - Water pumps
  - Don’t need to survive the fall
- Grasses reduced by about 50%
- Other life forms barely affected

Statistical Conclusions

- Spring or Fall Planting – insignificant
- Wet or dry 1st growing season very significant
- Herbicides
  - most significant variable for survival, for one year, two years, & delayed or not
  - Mid-season survival in dry year insignificant
  - In wet year, herbicides significant to first year survival
- Delay not a problem after accounting for moisture
  - But, herbicide site prep more important following a delay

Operational Questions and Outcomes

- Rates of Vegetative recovery
  - Rapid, often >50% in year one
- Herbicides (only on PP)
  - Raised PP survival by 23%
  - Untreated seedlings had high late summer mortality
  - Likely essential on these poor sites
- Species
  - DF more problematic, than WL or PP
  - DF seedling quality an issue?
- Season of planting
  - WL better in fall
  - DF worse in fall
  - PP uncertain, but may benefit from root growth in fall plantings
- Delayed reforestation
  - Herbicides more important if delaying
  - 1 year delay not a problem if weather cooperates with a cool wet summer
  - Delay may be problematic in hot, dry years

Where We Don't Salvage – Can We Rely on Natural Regeneration

- What is Important:
  - Proximity to live trees
    - Seed weight, numbers, release
  - Species
    - Serotiny and potential release over time
  - Periodicity matters
    - Frequency of cone crops varies
  - Location matters
    - Geographical differences within species
  - Timing of the burn
    - Seed maturation and release
- What Info Might be Lacking
  - Assessments of pre-fire stand conditions
    - Presence of current cone crop
  - Comprehensive severity assessment
    - Suggest prompt aerial surveys to assess level of Tree mortality
    - Typical BAER reports not sufficient
  - Which locations are more frequent seed producers
    - Not all locations are equal producers
    - Takes time, experience and effort to track

Timing of Burn, Salvage and Natural Regeneration

- Fires prior to mid-August to early September not likely to have viable seed
  - Late season fires have the chance for viable seed
  - Cones very fire resistant
  - Cones do not mature on dead trees
- Salvage timing affects natural regen potential
  - Seed is not stored in the soil
  - Seedlings germinate in the spring
  - New seedlings can be damaged by salvage operations
- Earlier salvage is better for
  - Timber Value - Bugs and crud
  - Forest Ecosystem recovery

Actual Natural Regeneration Results

- Table had scattered germinants and established seedlings
  - September burn allowed cone ripening and seed maturation
  - Many sites have nearby live trees
  - Higher elevation = more naturals
  - LPP sites = more naturals
- Carlton earlier burn, August
  - No naturals encountered
  - No cone ripening or seed maturation on dead trees
  - Long distances to live trees

Future Efforts

- Monitoring of studies will continue
- Analysis is incomplete
- Expanding into more productive Tower and Carpenter Road areas burned in 2015
- Herbicide work
- Natural regeneration across environmental gradients

2015 Fires – High Site, Post-Salvage Reforestation

- Six sites selected, two each in
  - DF, GF and WH/WRC plant associations
- Planting with and without spot herbicides
- Ponderosa pine on drier sites
- Western larch on moister more productive sites

Conclusions

- Some dry sites likely to revert to grass or shrubland
- Vegetation recovers rapidly – fire adapted
- Social discount rate lower than opportunity cost
  - Yields positive NPV on very low productivity sites
- Reforestation success not assured
  - Herbicides improved survival by over 20%
  - Herbicides may not be enough
- Fall planting can be a viable alternative
  - Weather
- 1 year Delayed planting may not be problematic
- Retain sufficient live trees to avoid planting

Sylvis WL Study Site

Acknowledgements

- NE Region: Phil Anderson, Jake Townsend, and others
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- SE Region: various current and former foresters