



**PotlatchDeltic.**

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Seedling Performance Metrics:  
A Standardized Monitoring  
Approach

*March 3, 2020*



# Background

- Worked for the USFS at White River Ranger District during college
- Graduated from WSU, BS Forest Management
- 1990: Started working at Potlatch Greenhouse as Assistant Seedling Production Supervisor
- 1993: Promoted to Seedling Production Supervisor
- 2009: Potlatch Greenhouse closed
- 2010: Promoted to Silviculturist. Current responsibilities include seed and seedling procurement for Idaho



# Outline:

- 🌲 PotlatchDeltic North Idaho Planting Program
- 🌲 Nursery Inspections
- 🌲 Root Growth Potential Test
- 🌲 Box Audits
- 🌲 Garden Plots
- 🌲 Transects
- 🌲 Summary







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# PotlatchDeltic North Idaho Planting Program

# PotlatchDeltic North Idaho Planting Program:

- 🌲 1990 to 2009
  - 🌲 1.9 to 6.5 million per year
  - 🌲 Majority grown in-house
  - 🌲 59 million seedlings
- 🌲 2010 to present
  - 🌲 4.8 to 8.4 million per year
  - 🌲 All seedlings contract grown
- 🌲 What do 6 million seedlings look like (styro 8s)?
  - 🌲 72,500 blocks
  - 🌲 27 miles of blocks
  - 🌲 27,300 boxes
  - 🌲 910 pallets at 30/pallet
  - 🌲 38 refrigerated vans







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## Nursery Inspections

# Nursery Inspections



## 🌲 When?

- 🌲 Twice a year
- 🌲 June or early July
- 🌲 October

## 🌲 Importance

- 🌲 Early identification of issues (spring)
- 🌲 See your seedlings prior to being boxed (fall)
- 🌲 Opportunity to see different species or block sizes

## 🌲 Actual examples from inspections



# Poor Germination



- 🌲 Seedlot related?
- 🌲 Cultural?
- 🌲 Time to re-sow?
- 🌲 How will poor germination effect the planting program?



# Answers.....

- 🌲 Seedlot related
- 🌲 Not a cultural issue
- 🌲 Too late to re-sow
- 🌲 Oversow will fill the gap





# Popcorn Buds

- Identified on improved Douglas-fir seedlings during fall nursery visit.
- Higher percentage than “normal”.
- Concerned about how the seedlings will grow in the field.



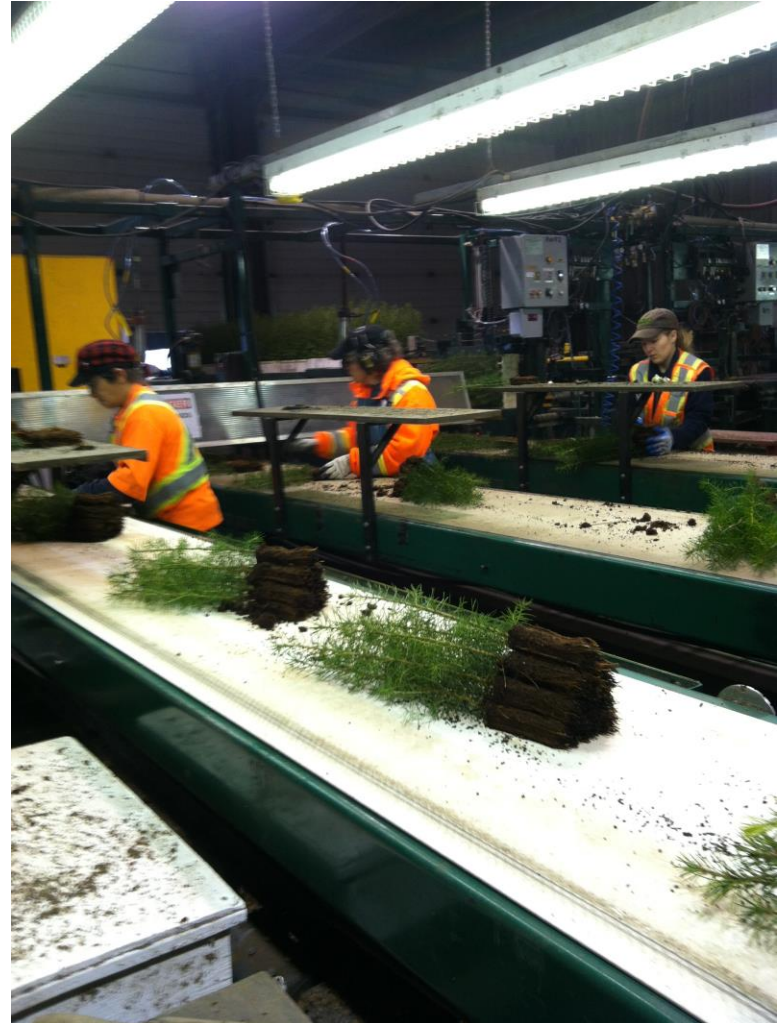


# Popcorn Buds – Now what?

- 🌲 Work closely with nursery.
- 🌲 Increase sample size of inventory measurements.
  - 🌲 Helps to identify number of seedlings affected.
  - 🌲 Helps to see how seedlings compare to minimum contract specifications.
  - 🌲 Make adjustments to minimum specs?
- 🌲 Send random sample of popcorn bud seedlings for independent testing at University of Idaho, Pitkin Nursery. Including:
  - 🌲 Frost hardiness
  - 🌲 Root growth potential
  - 🌲 Shoot growth
- 🌲 Nursery is also running seedling tests, so we will compare results.

## Popcorn Buds – Packing Results:

- ▲ Majority of popcorn buds did not meet contract minimum specs and were culled.
- ▲ Overall results across 3 seedlots, 10% of packed seedlings have popcorn buds.
- ▲ Popcorn bud seedlings packaged separately, and boxes labeled accordingly.
- ▲ Spring plant seedlings in identified areas for follow up on growth and performance.





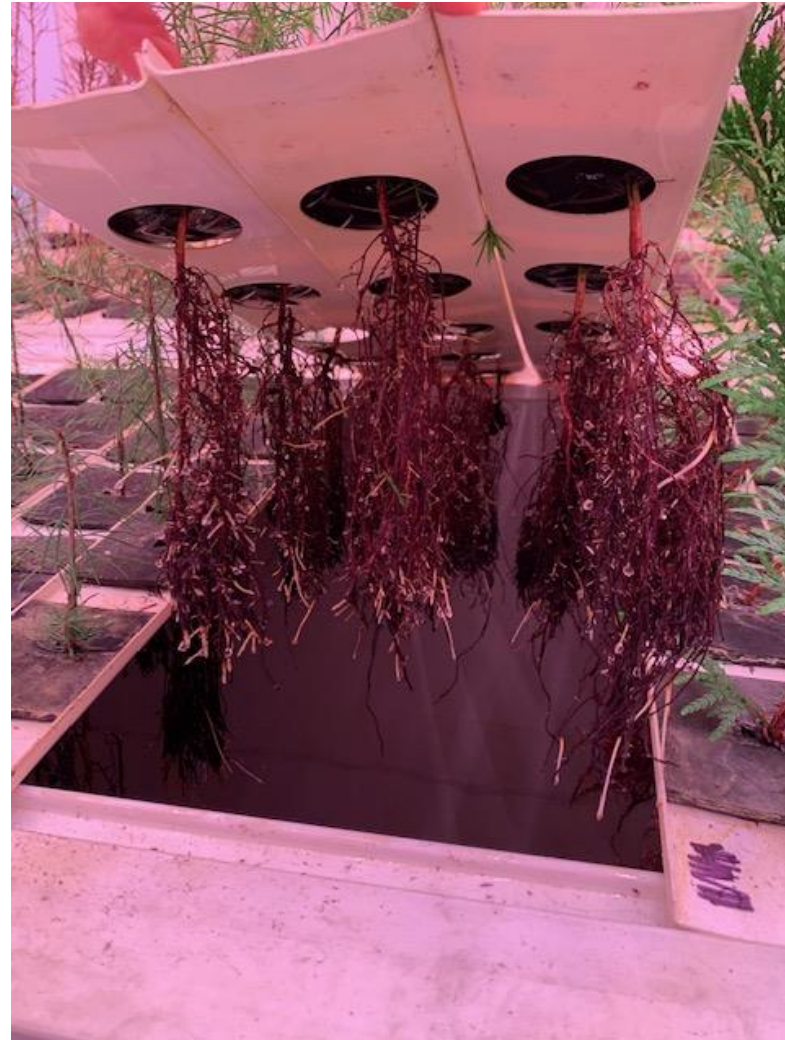
# Popcorn Buds – Frost Hardiness Results

- Results showed no difference in frost hardiness from other nurseries growing improved interior Douglas-fir.



## Popcorn buds – Root Growth Potential Results:

- 🌲 Roots actively growing in test.
- 🌲 No issues identified with root performance.
- 🌲 Formal results from RGP test not yet available.





# Popcorn Buds – Shoot Growth Results

- Visual examination shows majority of seedlings have broken bud and are growing.



# Popcorn Buds – Shoot Growth Continued





# Nursery Inspection Summary:

- 🌲 Seedlings respond to their environment, both positively and negatively.
- 🌲 Seedling changes may be dramatic and happen in a short period of time.
- 🌲 If you don't inspect nursery, you will not see changes and issues.
- 🌲 Important to inspect seedling crops, at the very least, in the fall.
  - 🌲 You are aware of seedling quality.
  - 🌲 Opportunity to work with nursery on issues.
  - 🌲 No surprises at planting site when you open the box.



# Nursery Inspections: Opportunity to see different block sizes and species





# Western larch grown in 3 different styroblock sizes





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## Root Growth Potential Tests



# Root Growth Potential Testing of Seedlings

## 🌲 Goals:

- 🌲 Working with University of Idaho Pitkin Nursery to develop consistent RGP testing protocol.
- 🌲 Multi year evaluation of results.
- 🌲 Answer some of our questions:
  - 🌲 Do species respond and score differently to RGP testing?
  - 🌲 Is there link between RGP and field performance?
- 🌲 Began working with UI Pitkin Nursery in 2015.
- 🌲 UI Pitkin Nursery has worked diligently to improving testing facilities and protocol.
- 🌲 2019 test results were consistent by species and reflect improvements made at UI Pitkin Nursery in the testing protocol.



# University of Idaho, Pitkin Nursery, RGP Testing Facility





# RGP Final Measurements



# Root Growth Potential Testing – Douglas-fir results

## 2017-2018 RGP Test Results

Spp	Size	Avg Root Count
DF	8	11
DF	8	20
DF	8	21
DF	8	33
DF	8	35
DF	8	37
DF	8	40
DF	8	47
DF	8	51
DF	8	57
DF	8	60
DF	8	60
DF	8	61
DF	8	62
DF	8	77
DF	8	85

## 2018-2019 RGP Test Results

Spp	Size	Year	Season	Average Root Count
DF	8	19	Sp	23
DF	8	19	Sp	33
DF	8	19	Sp	37
DF	8	19	Sp	38
DF	8	19	Sp	39
DF	8	19	Sp	41
DF	8	19	Sp	45
DF	8	19	Sp	47
DF	8	19	Sp	47
DF	8	19	Sp	47
DF	8	19	Sp	50
DF	8	19	Sp	57
DF	8	19	Sp	64
DF	8	19	Sp	85
DF	8	19	Sp	100



# Root Growth Potential Testing – western larch results

## 2017-2018 RGP Test Results

Spp	Avg Root Count
WL	6.47
WL	6.53
WL	9.67
WL	12.27
WL	14.13
WL	18.33
WL	18.80
WL	21.47
WL	22.60
WL	23.73
WL	25.67
WL	26.20
WL	27.27
WL	28.40
WL	30.07
WL	30.53
WL	31.00
WL	32.33
WL	38.13
WL	38.80
WL	39.40
WL	39.87
WL	49.07

## 2018-2019 RGP Test Results

Spp	Average Root Count
WL	14
WL	14
WL	28
WL	39

# Root Growth Potential Testing of Seedlings - Summary

- 🌲 Douglas-fir and western larch are tested annually.
- 🌲 Seedlings are randomly pulled and shipped directly from nursery.
- 🌲 Seedlings are freezer stored until tested.
- 🌲 RGP results are shared with nurseries during first nursery inspection.
- 🌲 Continue research on RGP and field performance.





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## Box Audits

# Box Audits



- 🌲 Began auditing boxes in spring 2011.
- 🌲 Sample 1% of each seedlot/nursery combination.
- 🌲 Audit completed shortly after delivery and prior to planting.
- 🌲 Measure:
  - 🌲 Trees per box
  - 🌲 Height
  - 🌲 Caliper
  - 🌲 Evaluate roots and plug integrity
  - 🌲 Note any seedling defects



# Box Audit Advantages

- 🌲 Verifying contract specifications.
- 🌲 Issues are identified before seedlings go to the field.
- 🌲 If an issue arises, it can be quantified to determine impact.
- 🌲 Nursery can inspect boxes remaining at their facility.
- 🌲 Share results with nursery.

# Box Audits – the beginning.....

Hdgt's Van #3

**Potlatch** 35 min. to check seedlings *All bundles counted  
Five " counted trees  
Three " measured trees*

### Seedling Box Check

Date: 5-4-11 Nursery: \_\_\_\_\_ Performed by: \_\_\_\_\_  
 Species: DF Stock Size: 8 Seed-Lot Information: 05-96  
 Area: Hdgt's Van #3  
 Box Count Target 220 Actual 200

Height (cm) Average 25

13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34+

Caliper (mm) Average 4

2.5	3	3.5	4	4.5	5	5.5	6

Root Development Acceptable  Not Acceptable \_\_\_\_\_ % Acceptable \_\_\_\_\_  
 Top Development Acceptable  Not Acceptable \_\_\_\_\_ % Acceptable \_\_\_\_\_

Defect Forked Top \_\_\_\_\_ Stem Damage \_\_\_\_\_  
 Multiple Trees 1 Bud Damage \_\_\_\_\_

COMMENTS (moldy seedlings, excess water, crushed box, etc.)  
 \_\_\_\_\_  
 \_\_\_\_\_

ACTION PLANS

Who	What	When




# 2011 Box Audit Results

## 2011 Box Audit Summary - DF8

Date	Seed Lot Information	Average Height (cm)	Average Caliper (mm)	% Acceptable			Comments
				Root	Shoot	Box Count	
05/12/2011	DF8-CL-Z1 Zone 1	26.7	4.3	100%	100%	100%	Good Trees
04/19/2011	DF8-CL-Z1 Zone 1	25.4	4.1	95%	100%	100%	
04/21/2011	DF8-CL-Z2 Zone 2		3.5				
05/06/2011	DF8-CL-Z2 Zone 2	34.0	4.0				
05/19/2011	DF8-CL-Z2 Zone 2	65.2	3.6	100%	100%	100%	
04/24/2011	DF8-CL-Z2 Zone 2	34.0	3.8	100%	100%	100%	Trees all over 34 cm. Trees appear healthy. Irregular box counts.
05/23/2011	DF8-CL-Z2 Zone 2	63.4	3.6	100%	100%	100%	1 bundle has mold on the needles. Root wads seem dry. Several boxes have random # of trees. 360 extra trees in 91 boxes.
06/07/2011	DF8-CL-Z2 Zone 2	58.1	3.9	100%	100%	100%	One tree in each inspected bundle (2 trees) have cork screwed boles.
04/25/2011	DF8-CL-Z2 Zone 2	34.0	4.1	100%	95%	100%	Some corkscrewed seedlings. Also, lots of boxes with more than 240 trees.
05/12/2011	DF8-CL-Z4 Zone 4	31.2	3.5	97%	97%	100%	Dry plug from loose packing in plastic shipping bags.

# Box Audits - Now

 <b>Seedling Box Audit Requirements</b> <span style="float: right;">&lt;NEW&gt;</span>									
Header									
CardID	Date	District	Species	Nursery	Seedlot	Stock Size	Label Box Count	Actual Box Count	Completed By
273163063031	No Date								
Inspection									
Tree #	Height (cm)	Caliper (mm)	Acceptable?	Defect	Seedling Comment General				
1			<input type="checkbox"/>						
2			<input type="checkbox"/>						
3			<input type="checkbox"/>						
4			<input type="checkbox"/>						
5			<input type="checkbox"/>						
6			<input type="checkbox"/>						
7			<input type="checkbox"/>						
8			<input type="checkbox"/>						
9			<input type="checkbox"/>						
10			<input type="checkbox"/>						
11			<input type="checkbox"/>						
12			<input type="checkbox"/>						
13			<input type="checkbox"/>						
14			<input type="checkbox"/>						
15			<input type="checkbox"/>						
16			<input type="checkbox"/>						
17			<input type="checkbox"/>						
18			<input type="checkbox"/>						
19			<input type="checkbox"/>						
20			<input type="checkbox"/>						
Summary									



# 2019 Box Audit Results – defect by species

Row Labels		Caliper below contract specs	Damaged Top	Forked Top	Height below contract specs	Multiple Seedlings	Poor Roots	Roofs fill less than 2/3 of plug/media on less 2/3 of plug	Grand Total	% Good Seedlings
DF	2793	53	1	4	2	2	22	4	2881	97%
ES	58	1					1		60	97%
GF	76	3			1				80	95%
LP	701	7	1			10	1		720	97%
PP	255			1			4		260	98%
RC	20								20	100%
WL	2724	78	7	8	10	35	26		2888	94%
<b>Grand Total</b>	<b>6627</b>	<b>142</b>	<b>9</b>	<b>13</b>	<b>13</b>	<b>47</b>	<b>54</b>	<b>4</b>	<b>6909</b>	

# 2019 Box Audit Results – defect by nursery

Row Labels		Caliper below contract specs	Damaged Top	Forked Top	Height below contract specs	Multiple Seedlings	Poor Roots	Roots fill less than 2/3 of plug/media on less 2/3 of plug	Grand Total	% Good Seedlings by Nursery
	1171	13		1	1	2	8	4	1200	97%
	115	5		1					121	97%
	1742	18	2		4	15	7		1788	95%
	357	10	1				12		380	97%
	97	2			1				100	98%
	1259	66	4	8	6	24	13		1380	100%
	357	18		1	1		3		380	94%
	369	4	1			6			380	97%
	357	2	1						360	99%
	803	4		2			11		820	98%
<b>Grand Total</b>	<b>6627</b>	<b>142</b>	<b>9</b>	<b>13</b>	<b>13</b>	<b>47</b>	<b>54</b>	<b>4</b>	<b>6909</b>	



# 2019 Box Audit Results – Average Douglas-fir caliper by nursery

Row Labels	TFA- Kfalls	TFA- Nisqually	RCSII	PRTHB	PRTHR	ROCHEST	WFS	Grand Total
DF-82-50 Blackwell Hump			4.39			3.51		3.95
DF-CL-Z1 Zone 1					3.40			3.40
DF-CL-Z2 C/L Zone 2			3.88		3.41			3.50
DF-CL-Z4 C/L Zone 4						3.19		3.19
DF-CL-Z4 Zone 4							3.70	3.70
DF-CL-Z5 Zone 5			3.87				3.80	3.85
DF-CL-Z6 Zone 6	4.44	4.07						4.39
DF-CL-Z7 Zone 7	4.58			3.40	3.67	3.48		3.73
DF-CL-Z8 Zone 8	4.22				3.44	3.67		3.94
<b>Grand Total</b>	<b>4.39</b>	<b>4.07</b>	<b>3.89</b>	<b>3.40</b>	<b>3.53</b>	<b>3.48</b>	<b>3.78</b>	<b>3.99</b>

# 2019 Box Audit Results – Average western larch caliper by nursery

Average of Average Caliper (mm)	Column Labels					
Row Labels						Grand Total
WL-06-33 Shanghai			3.45			3.45
WL-63494 BCMoF	4.24	3.30		3.87	3.64	3.87
<b>Grand Total</b>	<b>4.24</b>	<b>3.30</b>	<b>3.45</b>	<b>3.87</b>	<b>3.64</b>	<b>3.86</b>

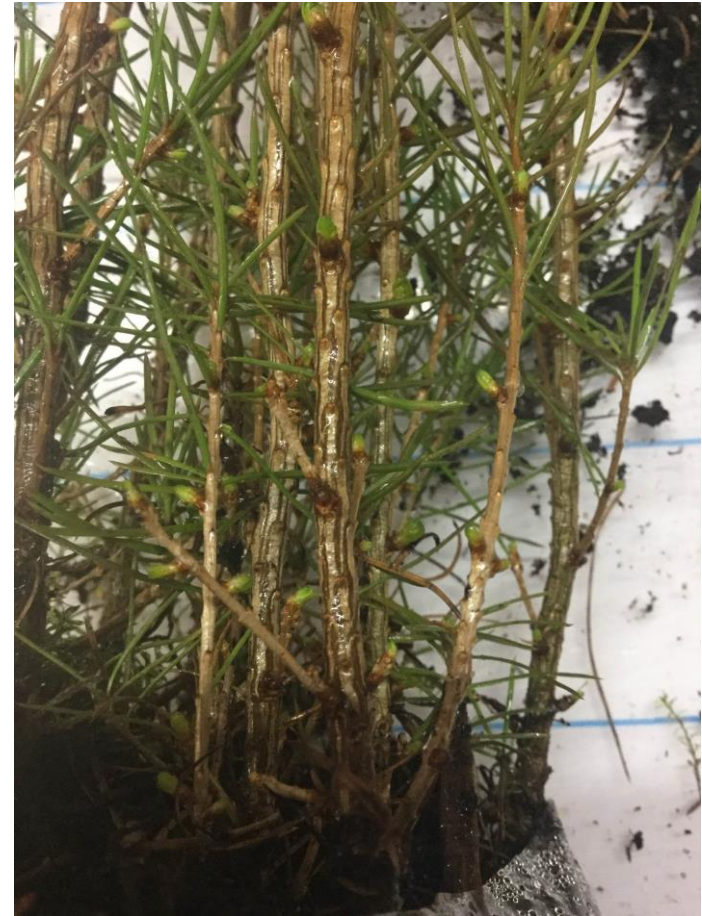


# 2019 Box Audit Issues Identified





# 2019 Box Audit Issues Identified





# 2019 Box Audit Issues Identified





# 2019 Box Audit Issues Identified





# 2019 Box Audit Good Seedlings Identified



# Box Audit Summary

- 🌲 Box audits results are reported weekly to each nursery.
- 🌲 Complete results by nursery are reported during first inspection.
- 🌲 Contracts now have appendix regarding box audits and penalties associated with packing poor quality and under spec seedlings.
- 🌲 PotlatchDeltic is using data to build a data base.








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## Garden Plots

# Garden Plots




## Purpose:

-  One location on each District for evaluation of seedlings.
-  If issues identified in garden plot then know to look in field.
-  Not a side by side comparison of nurseries.

## History:

-  Started in spring 2013.
-  Planted Douglas-fir and western larch.
-  20 seedlings from each seedlot and nursery combination.

## Protocol:

-  Permanently label both of ends of a row (block size, seedlot information and nursery).
-  End of season measurements.
-  Samples taken for testing, as needed.



# Garden Plots









# Garden Plots






# Garden Plots

## Results:

-  First garden plot installation identified issue with second year survival of Douglas-fir.
-  Systematic review of entire reforestation program.
-  Additional sampling and testing of nursery stock and out planted seedlings.
-  Closer monitoring and documentation.

## Summary:

-  All three Districts have permanently fenced sites for garden plots.
-  Remeasure all garden plots in fall.
-  Create a data base of early seedling growth.





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# Transects

# Transects

## 🌲 Purpose:

- 🌲 Improve reforestation program by identifying and quantifying planted seedling mortality.
- 🌲 Determine if related to:
  - 🌲 Site
  - 🌲 Site preparation
  - 🌲 Seedling attributes

## 🌲 Installation Procedures:

- 🌲 Semi-random selection of stands
    - 🌲 Evenly distributed between Districts
    - 🌲 Representation in pre-determined elevation bands
  - 🌲 Transects are installed within one month of planting.
  - 🌲 Two transects per stand.
  - 🌲 Permanently monumented.
  - 🌲 Evaluate seedlings and vegetation.
- 🌲 First year transects are remeasured in the fall and annually thereafter.



# Transect Evaluation Includes:

- 🌲 Seedling data
  - 🌲 Height
  - 🌲 Caliper
  - 🌲 Survival
  - 🌲 Cause of damage or mortality
- 🌲 Percent and type of vegetation cover.
- 🌲 Report on 1<sup>st</sup> and 2<sup>nd</sup> year survival by species.
- 🌲 Build database.

# Transect Establishment

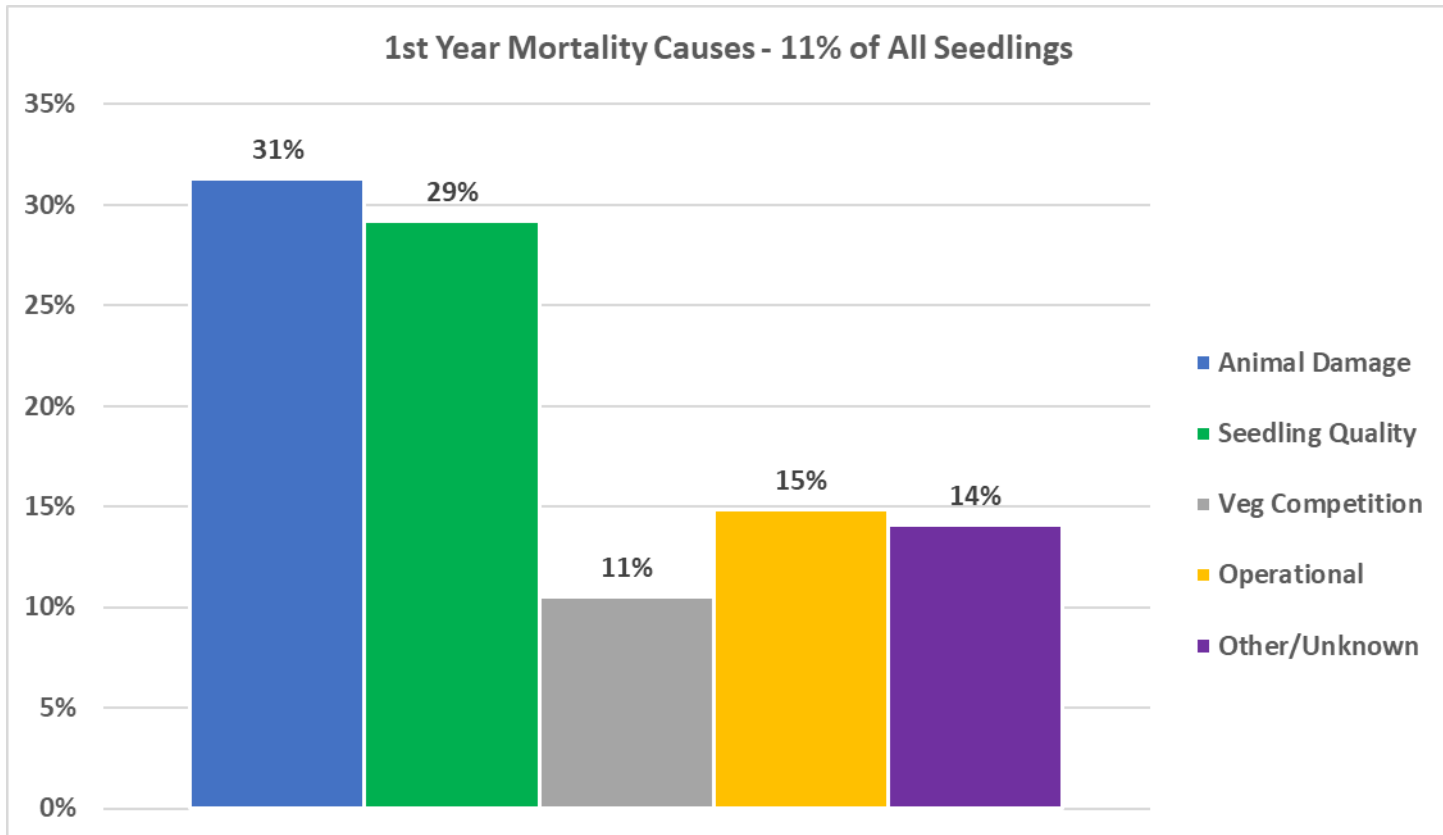




# Transect 6-Year Survival Results

Seedling Survival Transect Plot Summary					
Install Year (Planting Yr)	Transects (#)	Stands (#)	Seedlings Sampled	1 Year Survival	2 Year Survival
2014	39	24	1,120	89%	79%
2015	43	21	2,150	92%	83%
2016	26	13	1,300	93%	70%
2017	23	12	1,150	80%	65%
2018	23	12	1,142	87%	83%
2019	18	9	900	96%	N/A
<b>TOTAL</b>	<b>172</b>	<b>91</b>	<b>7,762</b>	<b>89%</b>	<b>77%</b>

# Transect Data: 1<sup>st</sup> Year Mortality Causes





# Transect Summary

- ▲ Low cost
- ▲ Evaluates seedling survival as it relates to several factors.
- ▲ Data from transects:
  - ▲ Will be used to evaluate current practices
  - ▲ Identify opportunities for improvements
  - ▲ Identify possible research projects
  - ▲ Verify model for early stand growth





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## Summary



# Why check so many items? Nurseries, RGP, Box Audits, Garden Plots, Transects.....

Assumptions:	
436	TPA
\$350	\$/M for seedlings
\$100	\$/M for planting

Acres	Planted Seedlings	Total
500	218,000	\$ 98,100
1,000	436,000	\$ 196,200
2,500	1,090,000	\$ 490,500
5,000	2,180,000	\$ 981,000
10,000	4,360,000	\$ 1,962,000
20,000	8,720,000	\$ 3,924,000
25,000	10,900,000	\$ 4,905,000



No surprises when you open the box on the planting site!





# Successful plantations (3-year-old Garden Plot)



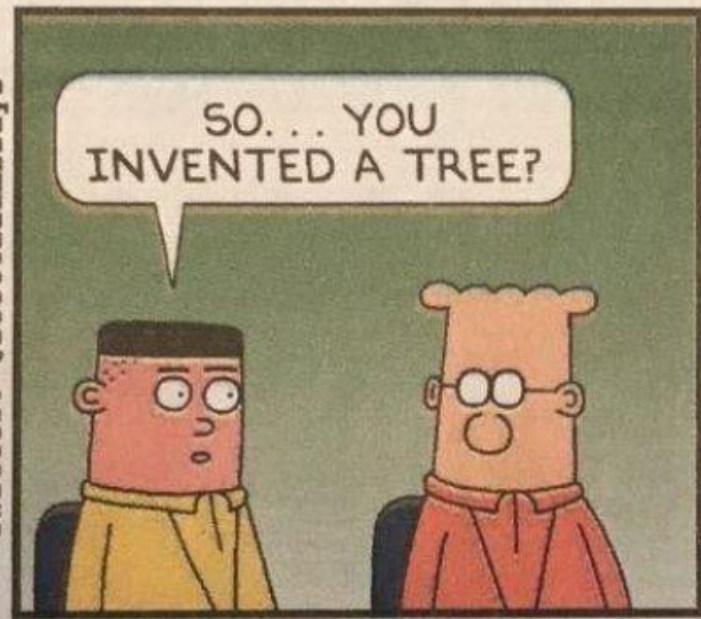


# Any Questions?

## DILBERT by Scott Adams



Twitter: @scottadamssays







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