

The Target Seedling Concept: An Integrative Tool to Facilitate Regeneration Success

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PURDUE
UNIVERSITY

Forest Regeneration



Natural

Artificial



The Target Seedling Concept:

**“Targeting specific
physiological and
morphological
characteristics that can be
quantitatively linked to
reforestation success”**

Target Seedling Concept Began With Commercial Forestry

Prescriptions for
Reforestation
Sites Were
Expanded to
Include Not Only
Species, But Also
Stock Type



Traditional Linear One-Way Nursery System



Plant Materials Are Grown
at the Nursery...

...and Shipped to the
Outplanting Site

...with Little or No Feedback

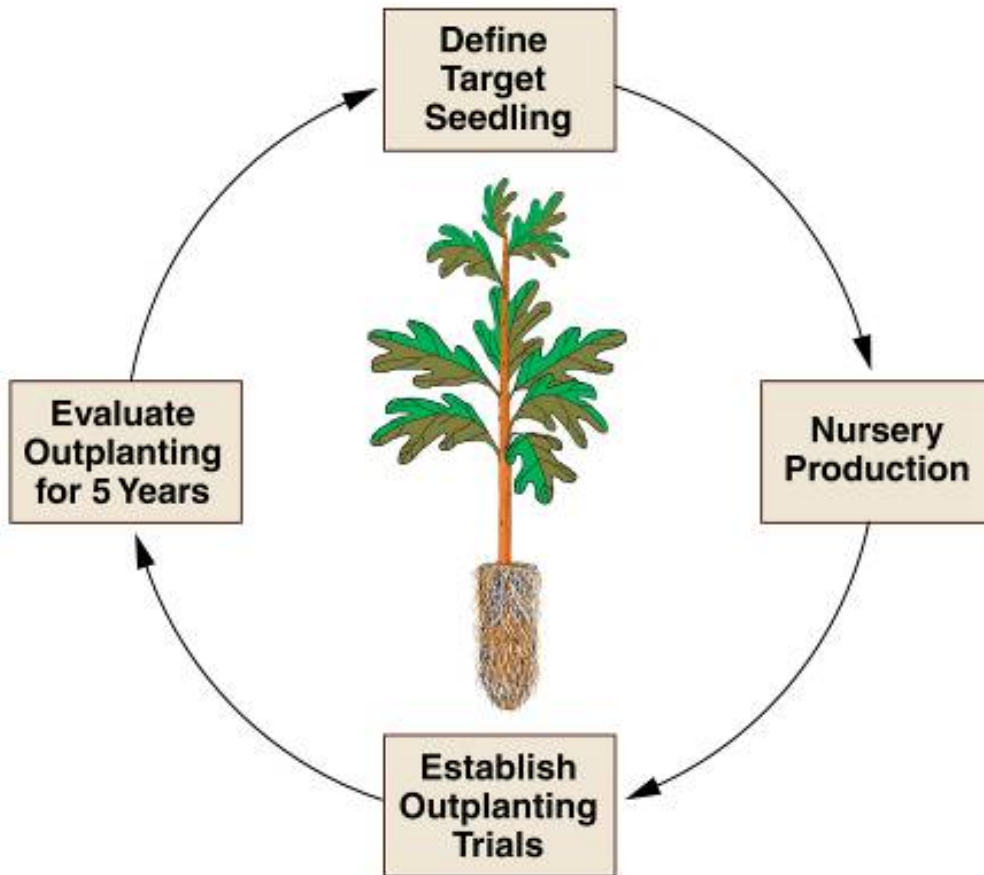
“One Size Fits All” Does Not Apply to all Planting Projects

- *Quality is “Fitness for Purpose”*
- *Defined on the Outplanting Site*



Target Seedling Concept Involves the Seedling User

Nursery
Manager + Seedling
Customer



*This Circular
Feedback
System Starts
and Ends at the
Outplanting Site*

Six Aspects of the Target Seedling Concept

1. Objectives of Outplanting Project

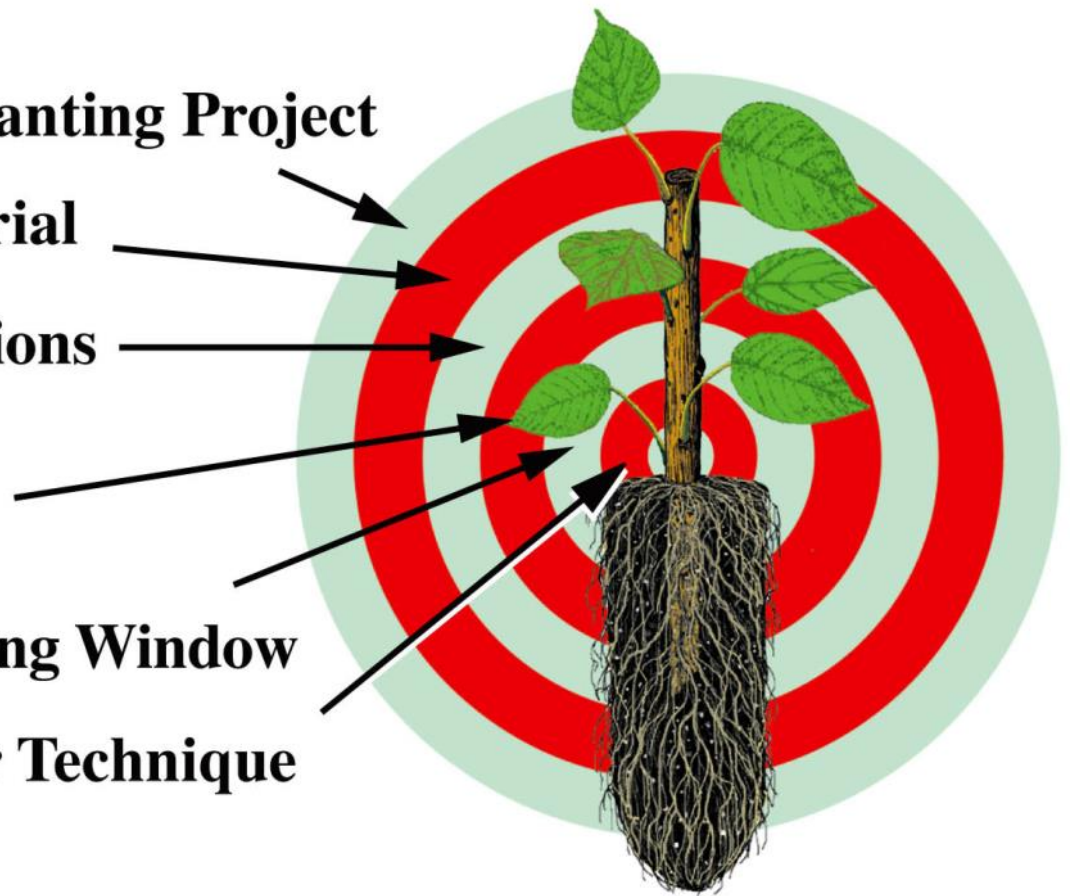
2. Type of Plant Material

3. Genetic Considerations

**4. Limiting Factors on
Outplanting Site**

5. Timing of Outplanting Window

6. Outplanting Tool or Technique



1. Objectives of the Outplanting Project

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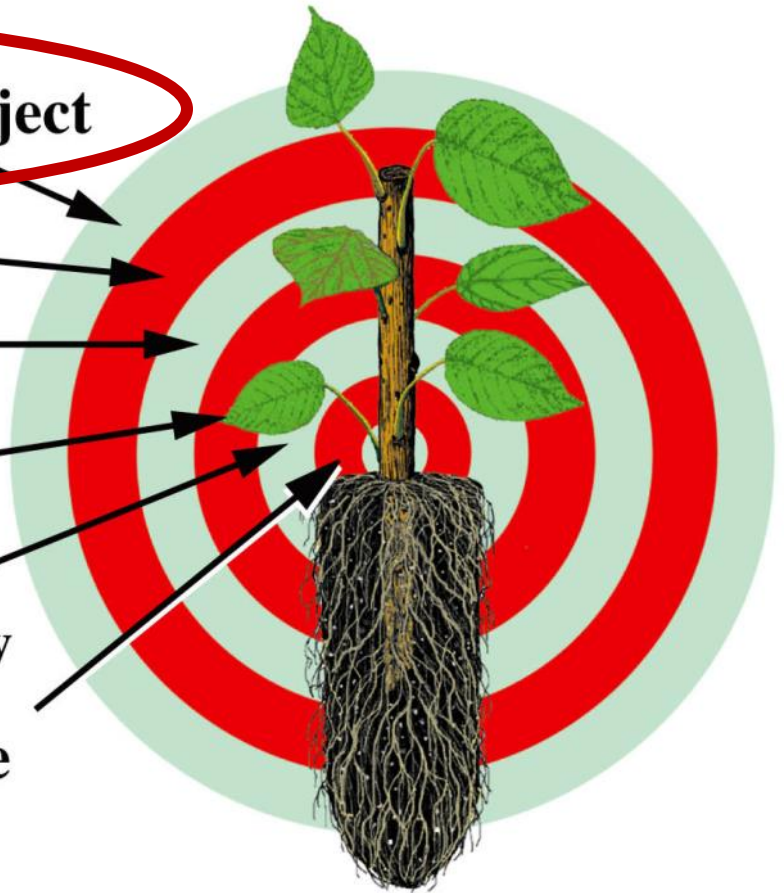
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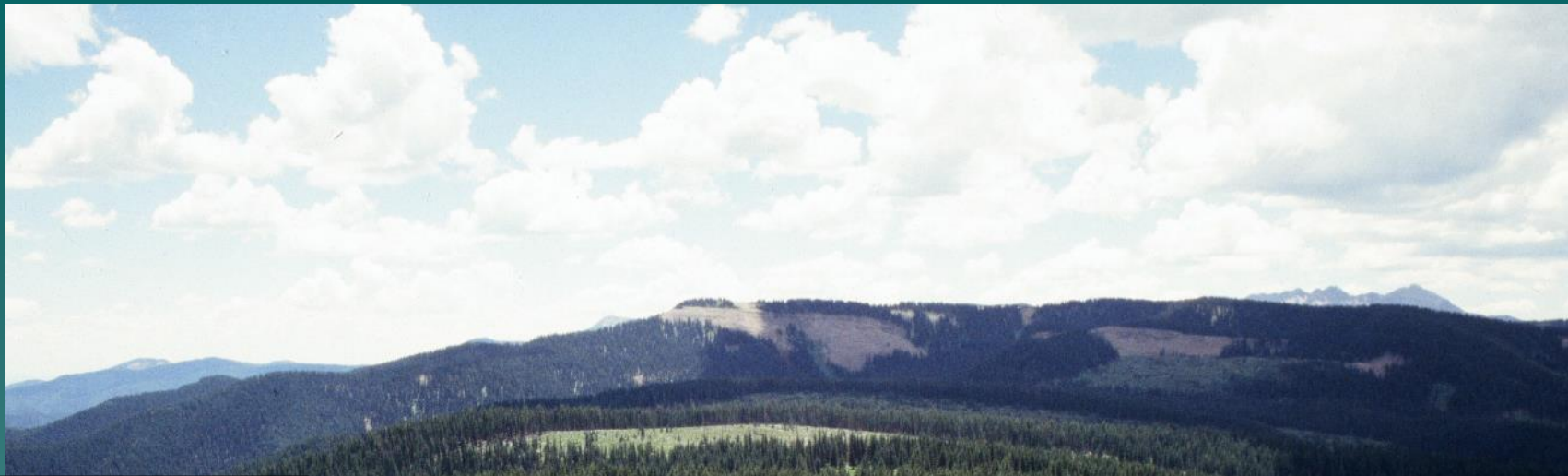
Intensively managed forestry plantations



**Short-Rotation Crop Trees –
Three-Year Old Eucalyptus in Costa Rica**



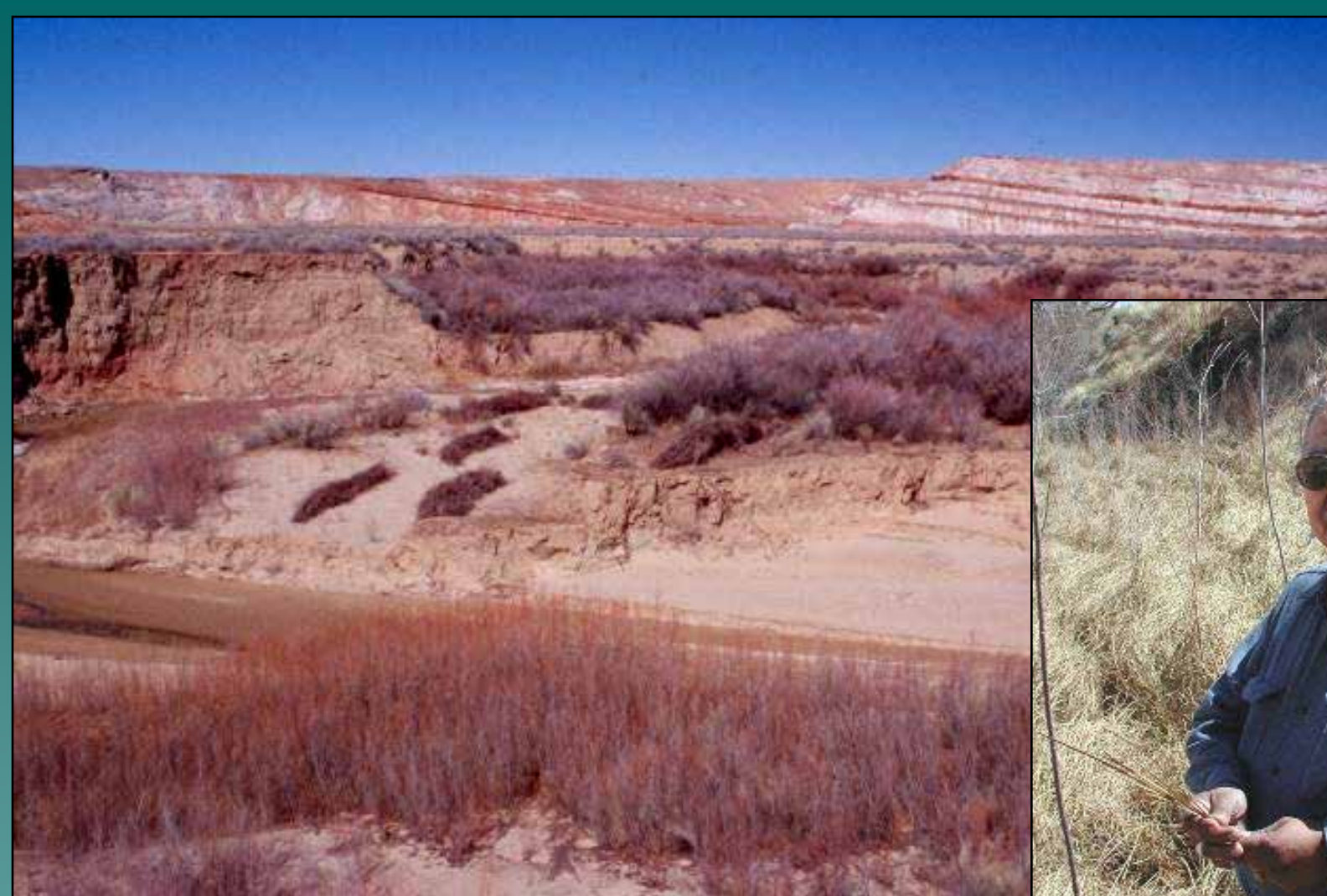
**Wildfire Restoration – The “Biscuit” Fire
In SW Oregon Burned 500,000 acres
Of Commercial Forest and Wilderness**



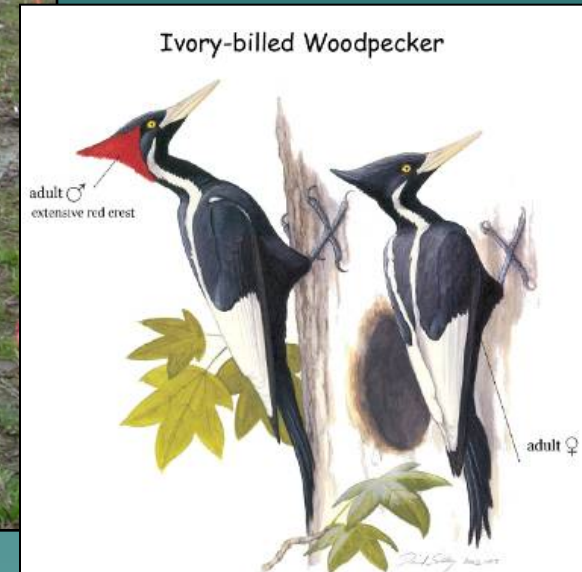
Restoration of High Elevation Salvage Clearcuts San Juan NF, Colorado



Restoration of Mangroves Kolonia, Yap

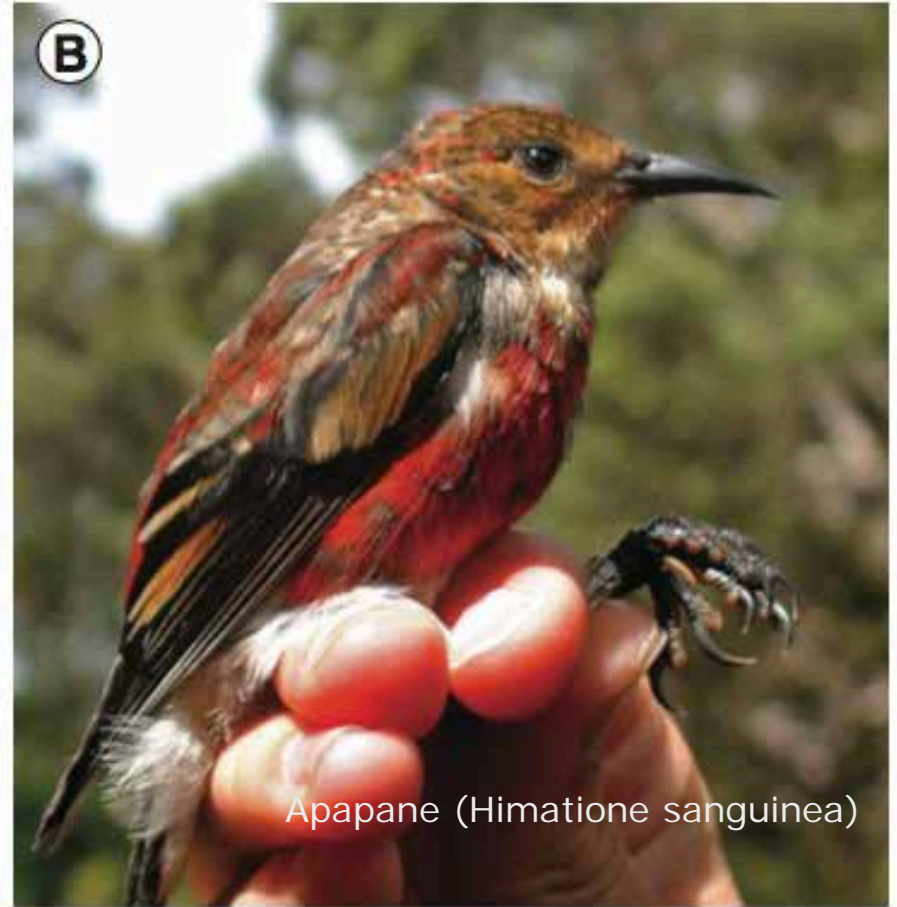


**Replace Invasive Species with Native Plants
Willows and Cottonwood For Replacing
Tamarisk and Russian Olive on Hopi Reservation**



Creating Habitat for Endangered Species Bottomland Hardwoods, Delta Region

“We heard about your lost bird that was found. It is a hopeful sign”
- Elders of Noongar tribe in Western Australia



Creating Habitat for Endangered Species Hakalau National Wildlife Refuge, Hawaii

4. Limiting Factors on Outplanting Site

1. Objectives of Outplanting Project

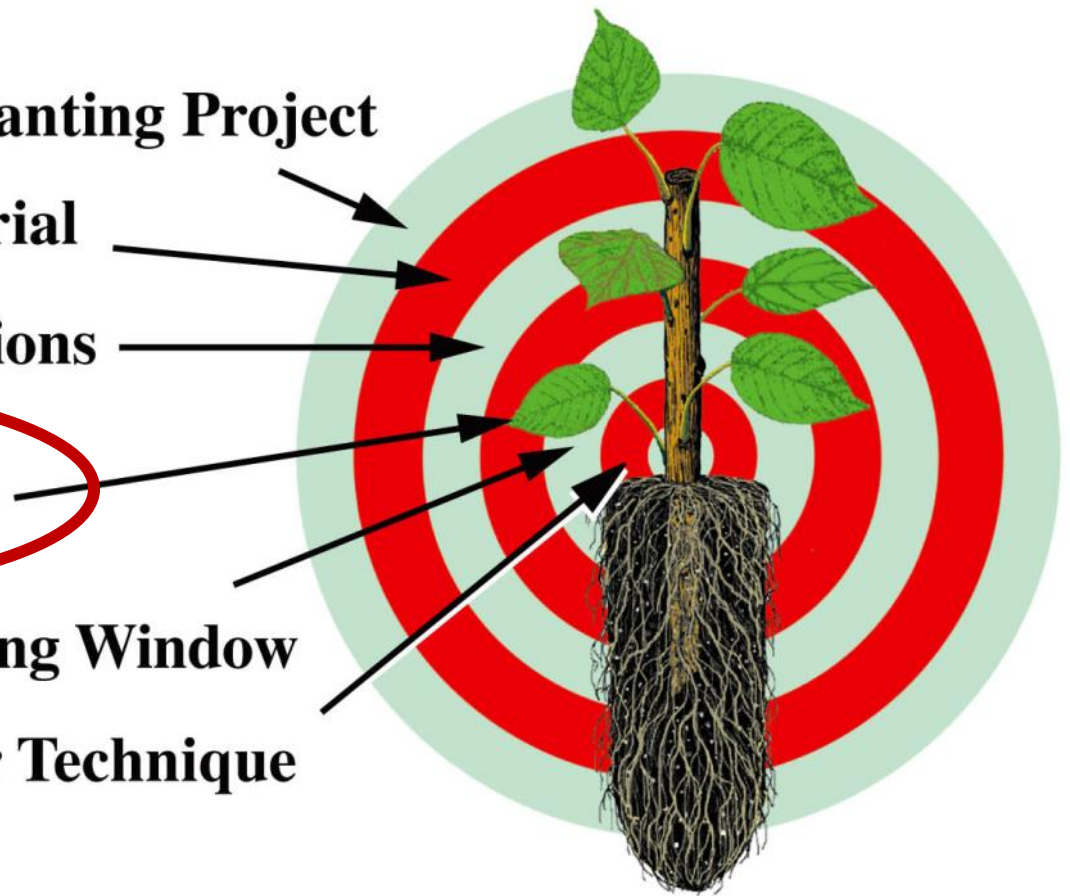
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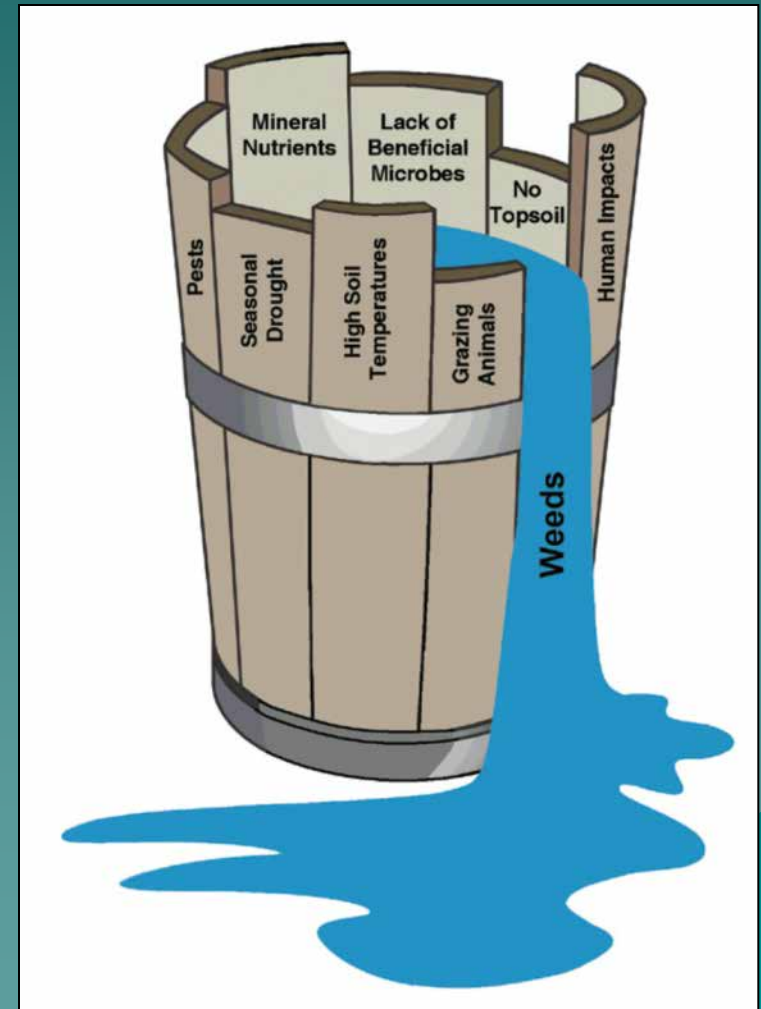
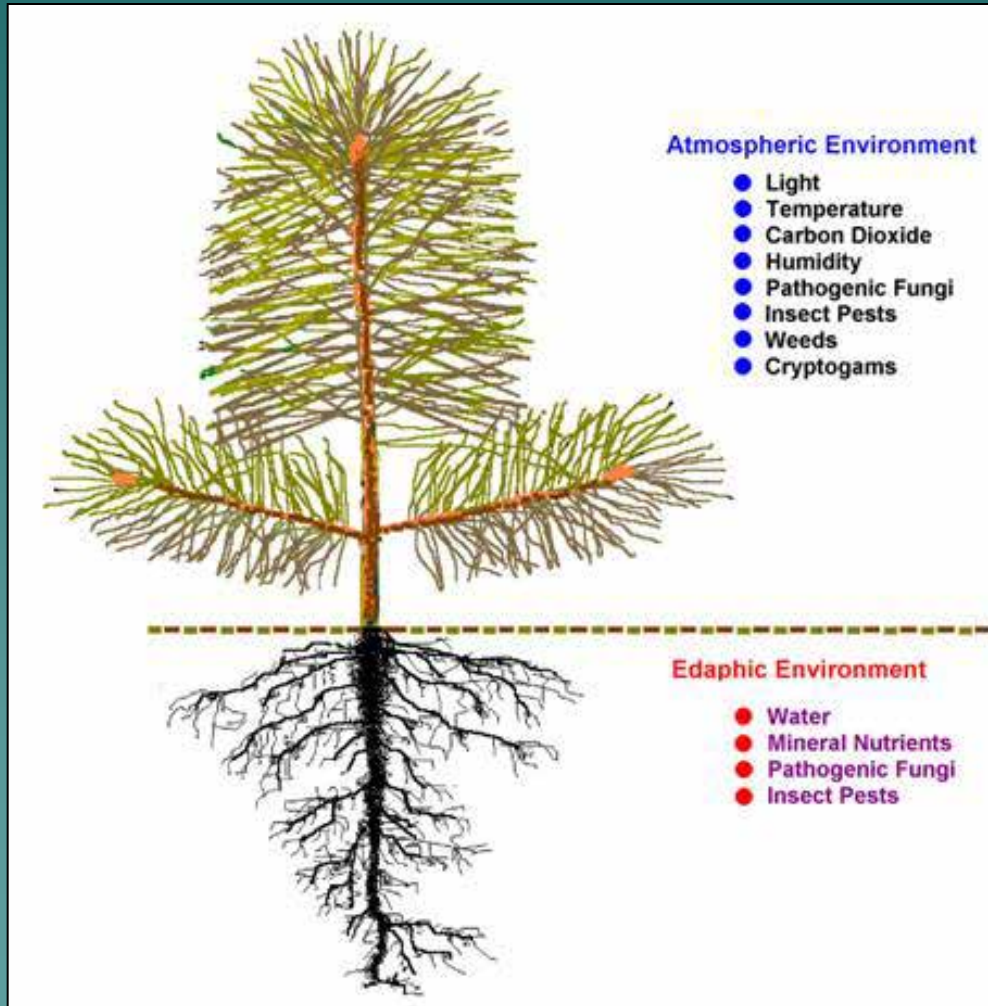
4. Limiting Factors on Outplanting Site

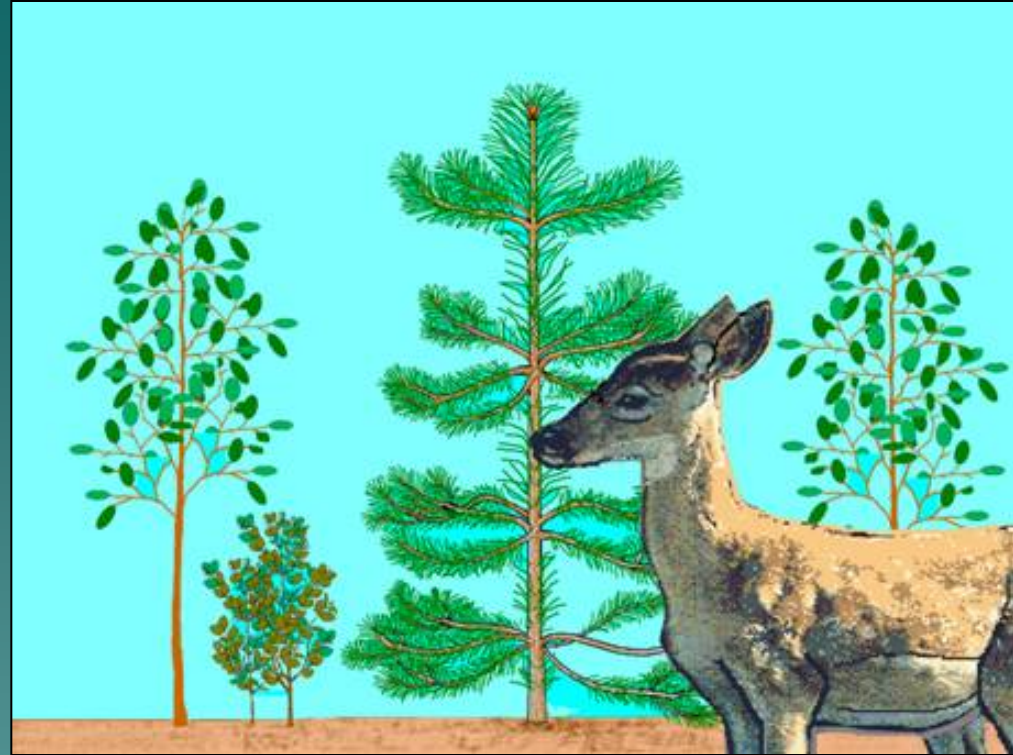
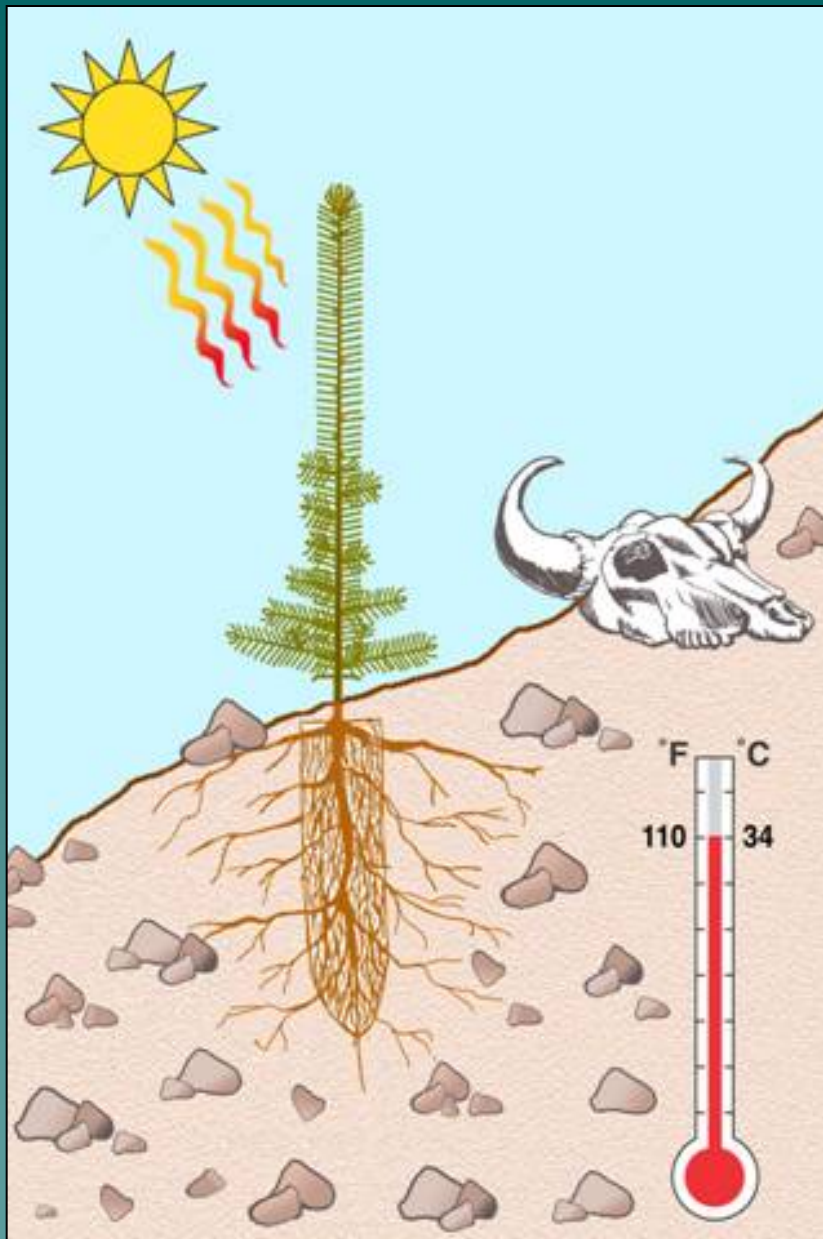
5. Timing of Outplanting Window

6. Outplanting Tool or Technique



Ecological Principle of Limiting Factors





**...but Competing Vegetation
and Animal Browsing are
Becoming More Critical**

Soil Moisture is Most Common Limiting Factor

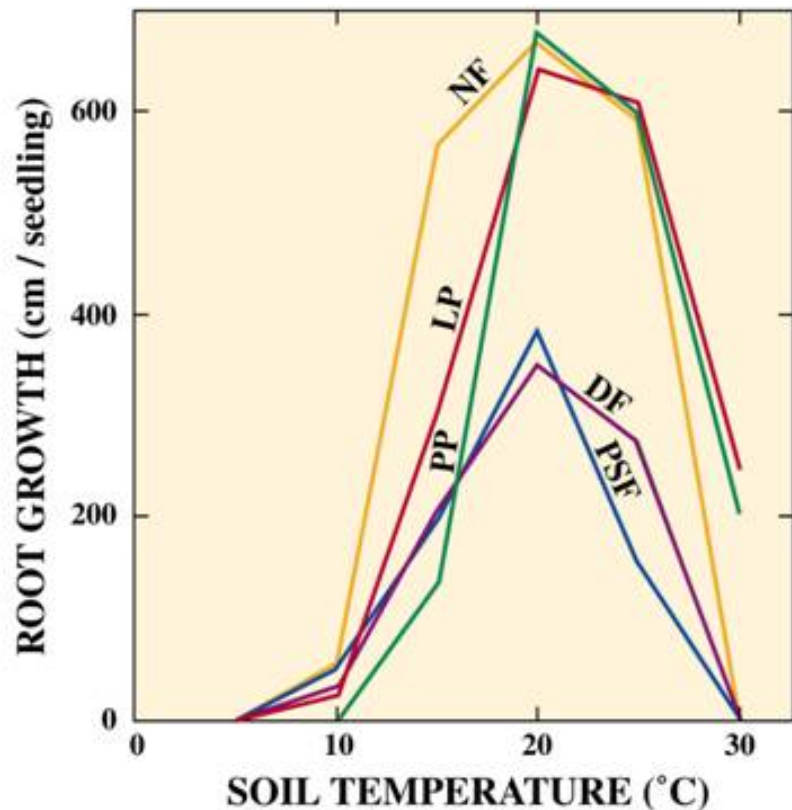
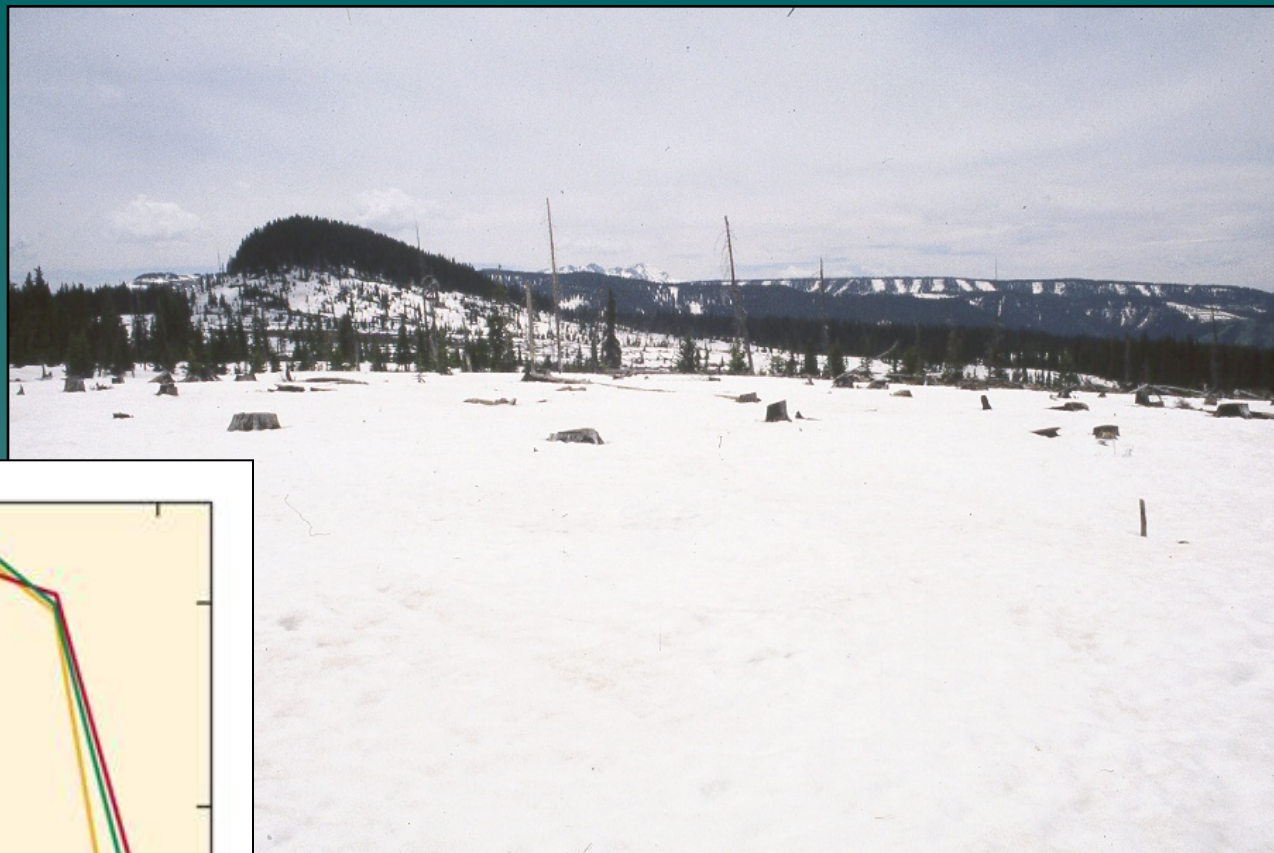
Browse Damage





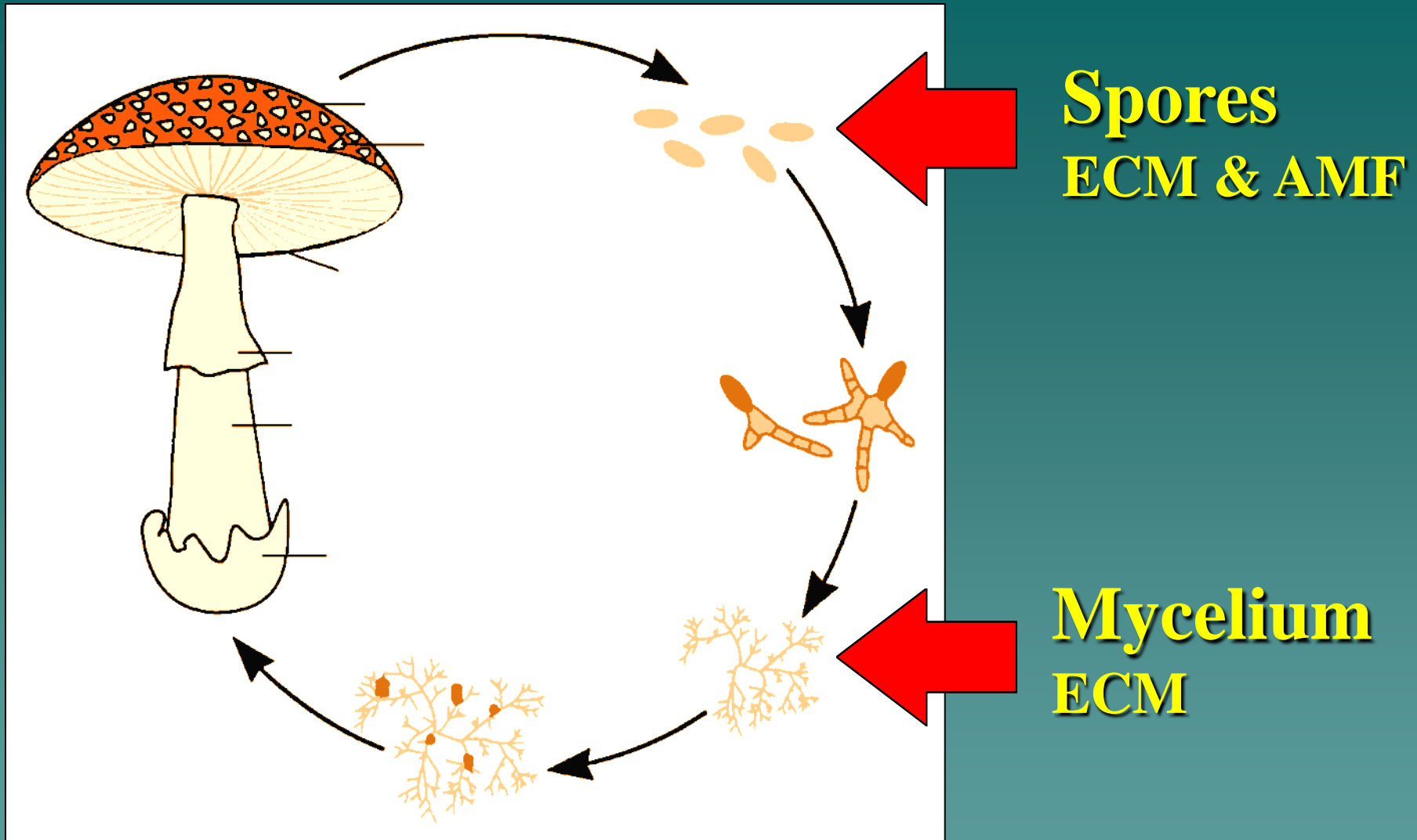
*Competing Vegetation -
Dependent on Opening Size*





**Soil Temperature
Can Be as Limiting
as Soil Moisture**

Lopushinsky & Max (1990)



Beneficial Microorganisms (e.g., Mycorrhizal Fungi)
– Types of Inocula and Proper Species







3. Genetic Considerations

1. Objectives of Outplanting Project

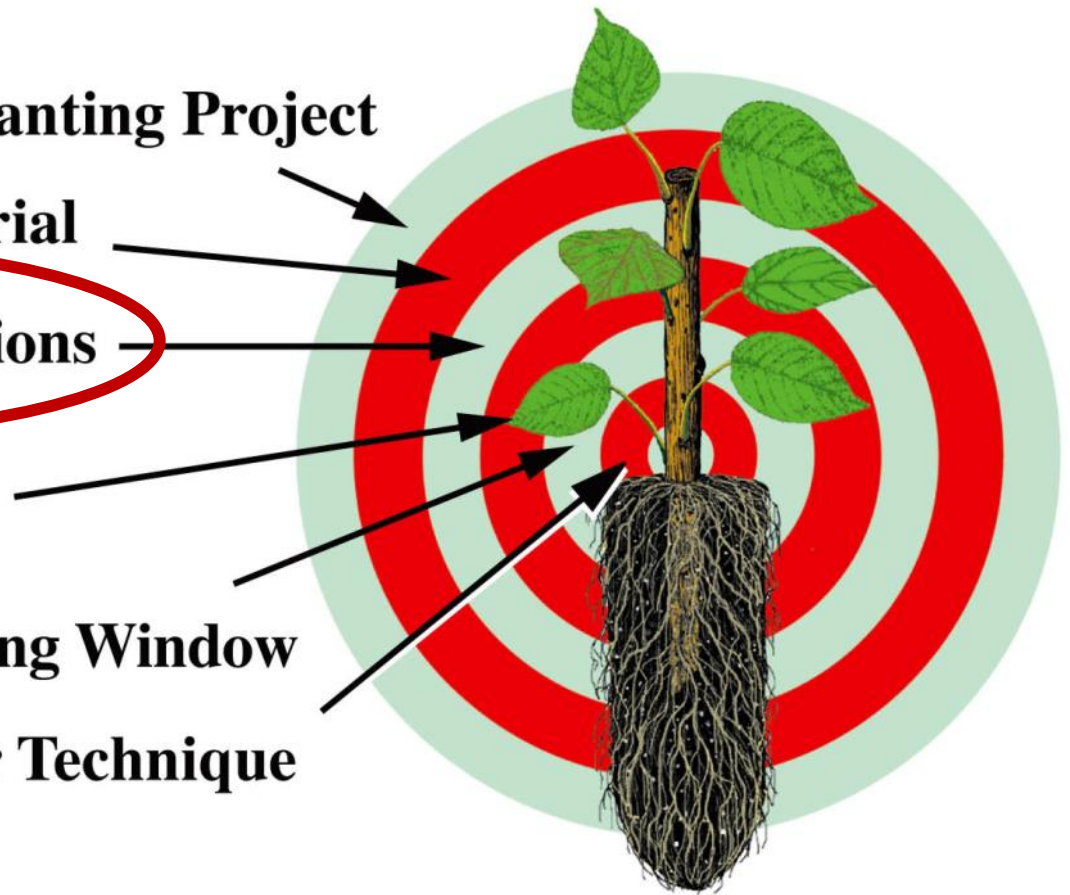
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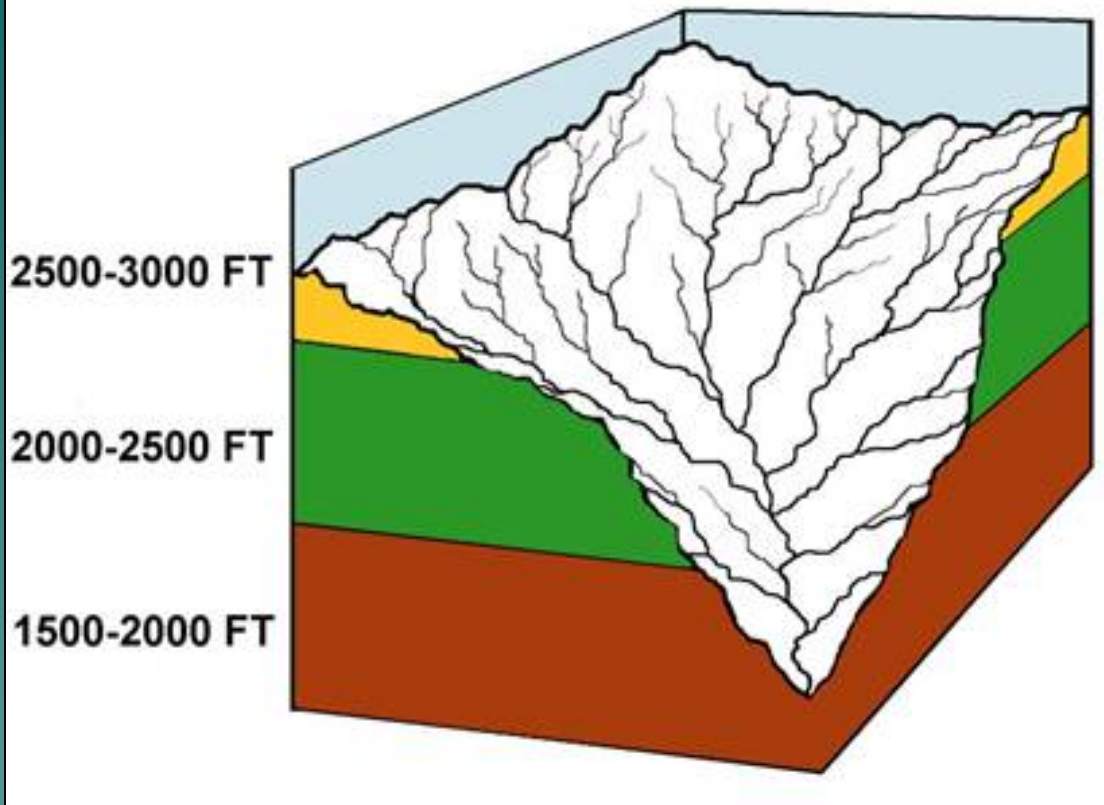
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SEED ZONE 563

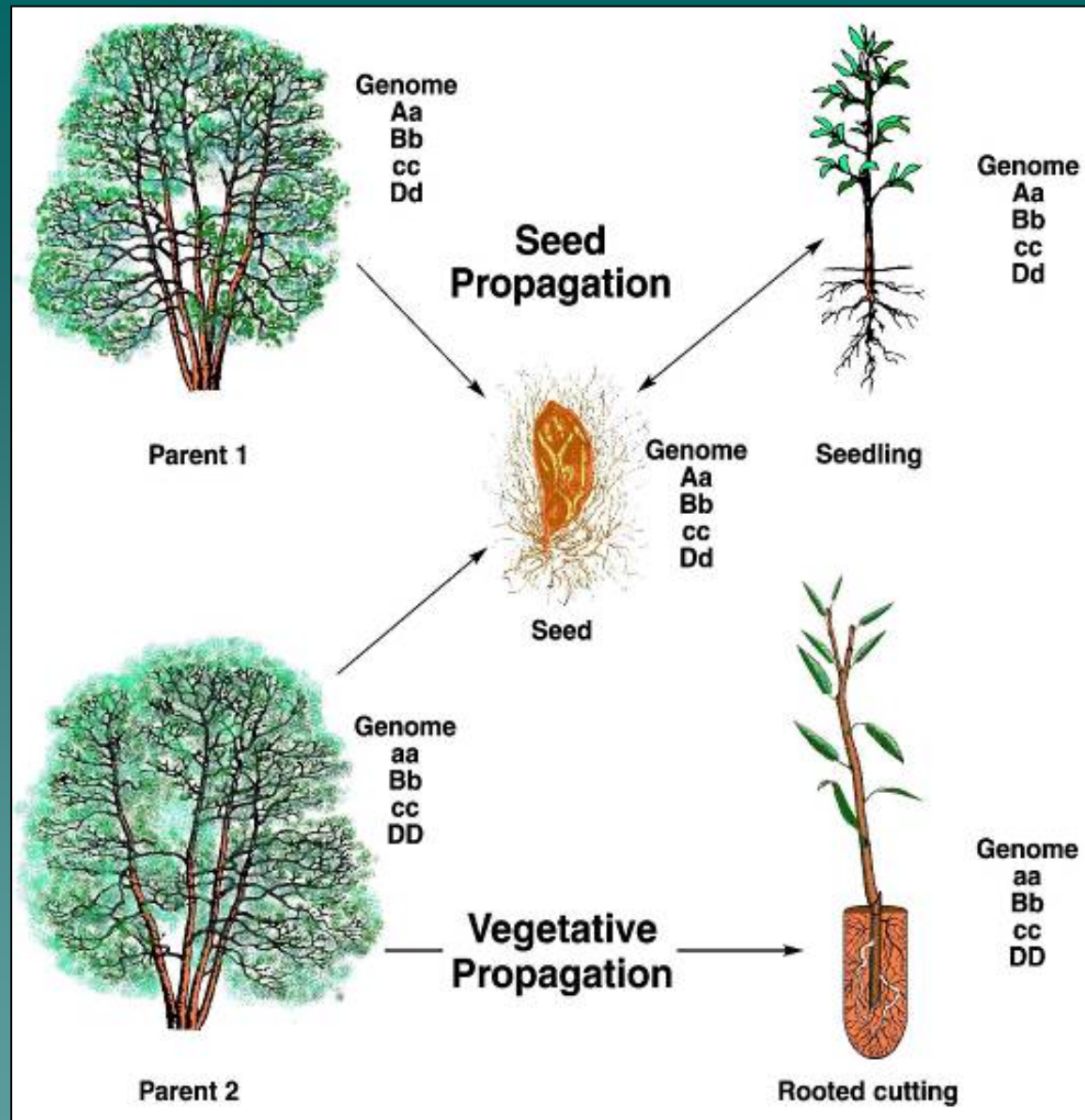


In Western USA, Tree Seeds and Seedlings are Managed by "Seed Zones"



...Local Sources Are Best, Unless Tests Prove Otherwise

***Collect From
As Many Plants
As Possible
Through the
Project Area***



**Collect Seed and Cuttings to:
A. Preserve Genetic Diversity**



**Collect Seed and Cuttings to:
B. Preserve Sexual Diversity of Dioecious
Species Like Willows and Cottonwoods**



**Collect Seed and Cuttings to:
C. Maximize Timber Gain**



**Collect Seed and Cuttings to:
C. Maximize Timber Gain**



Collected
D. Inco

gs to:
tance



2. Type of Plant Material

1. Objectives of Outplanting Project

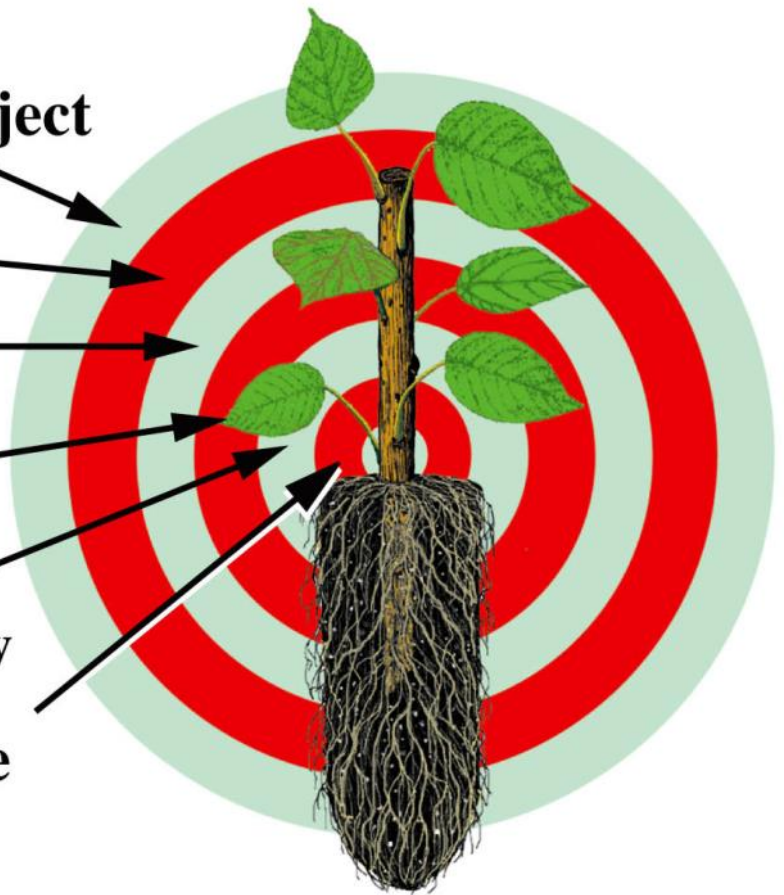
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Bareroot Seedlings



Container Seedlings

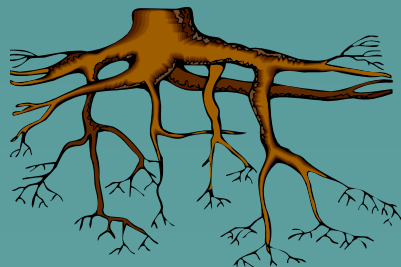
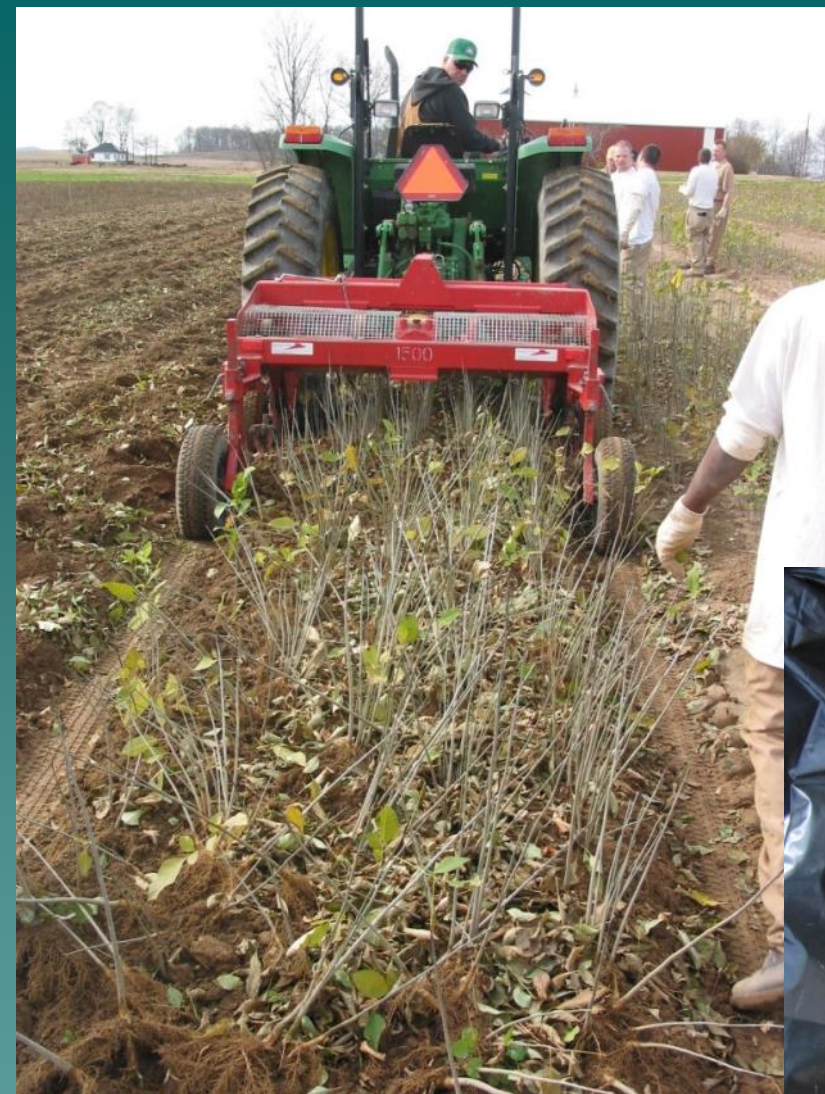
Traditional Nursery Stock Types

Bareroot Seedlings



Vallonia State Tree Nursery, IN

Loss of Root-Soil Contact and Fine Roots



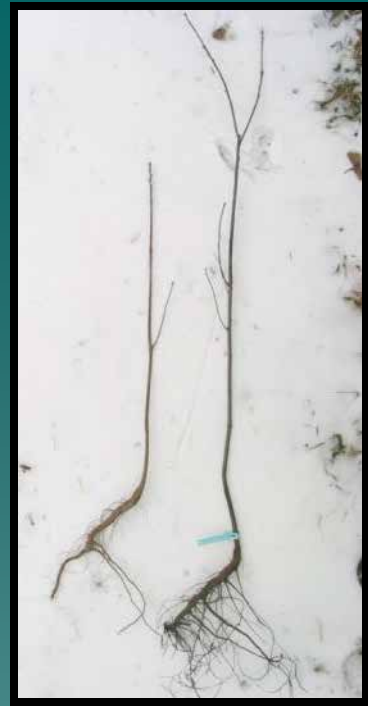
...Trend Toward Large Seedlings



2+1 Douglas-fir for Coastal Oregon

Container Stock

- *Roots undisturbed in media – less transplant stress*
- *Uniform crop*







**Ray Leach
Cone-tainer**
10 cu in (164 ml)



D40 Deepot
40 cu in (656 ml)



TP49 Treepot
0.43 gal (1.6 l)



TP414 Treepot
0.74 gal (2.8 l)



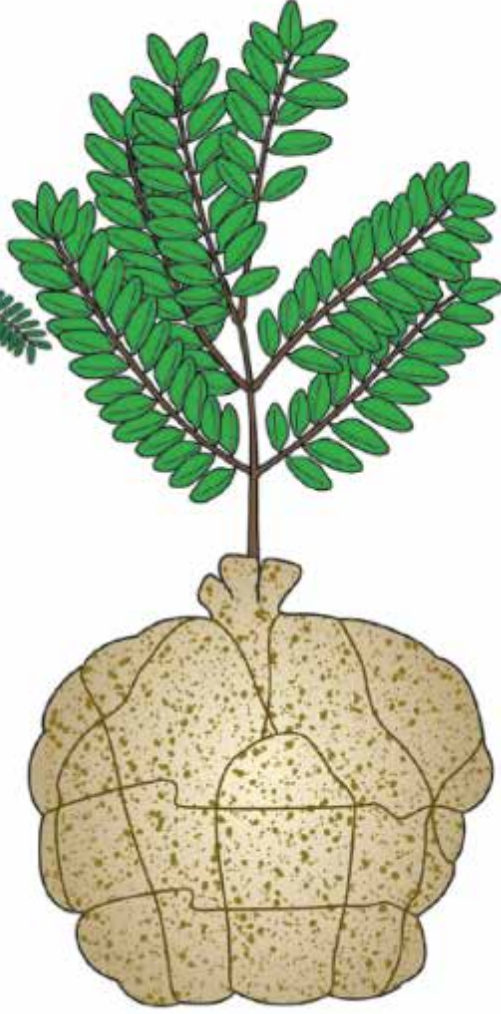
TP616 Treepot
1.64 gal (6.2 l)



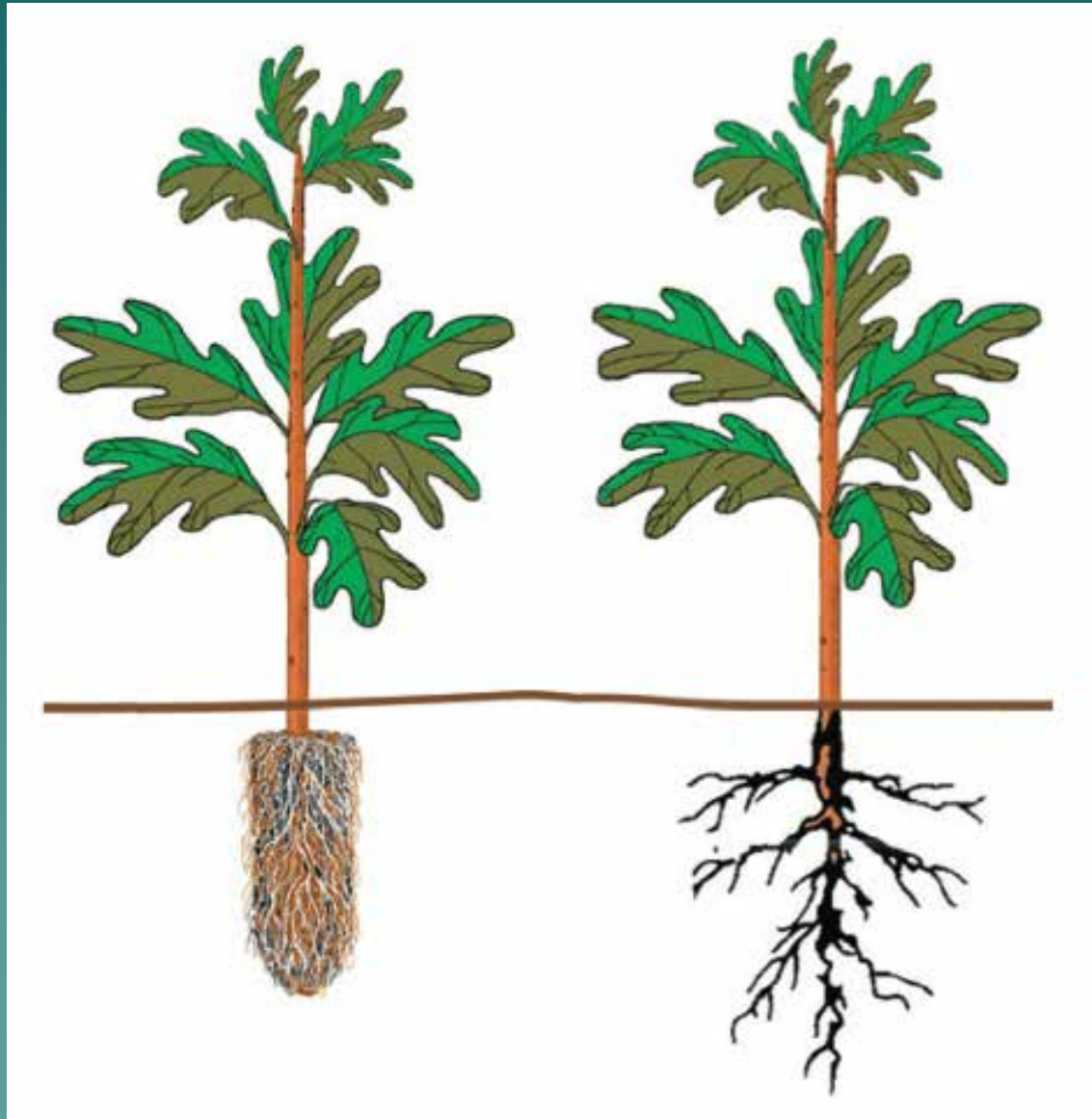
PVC Tallpot
variable volume



Ball-and-Burlap
variable volume



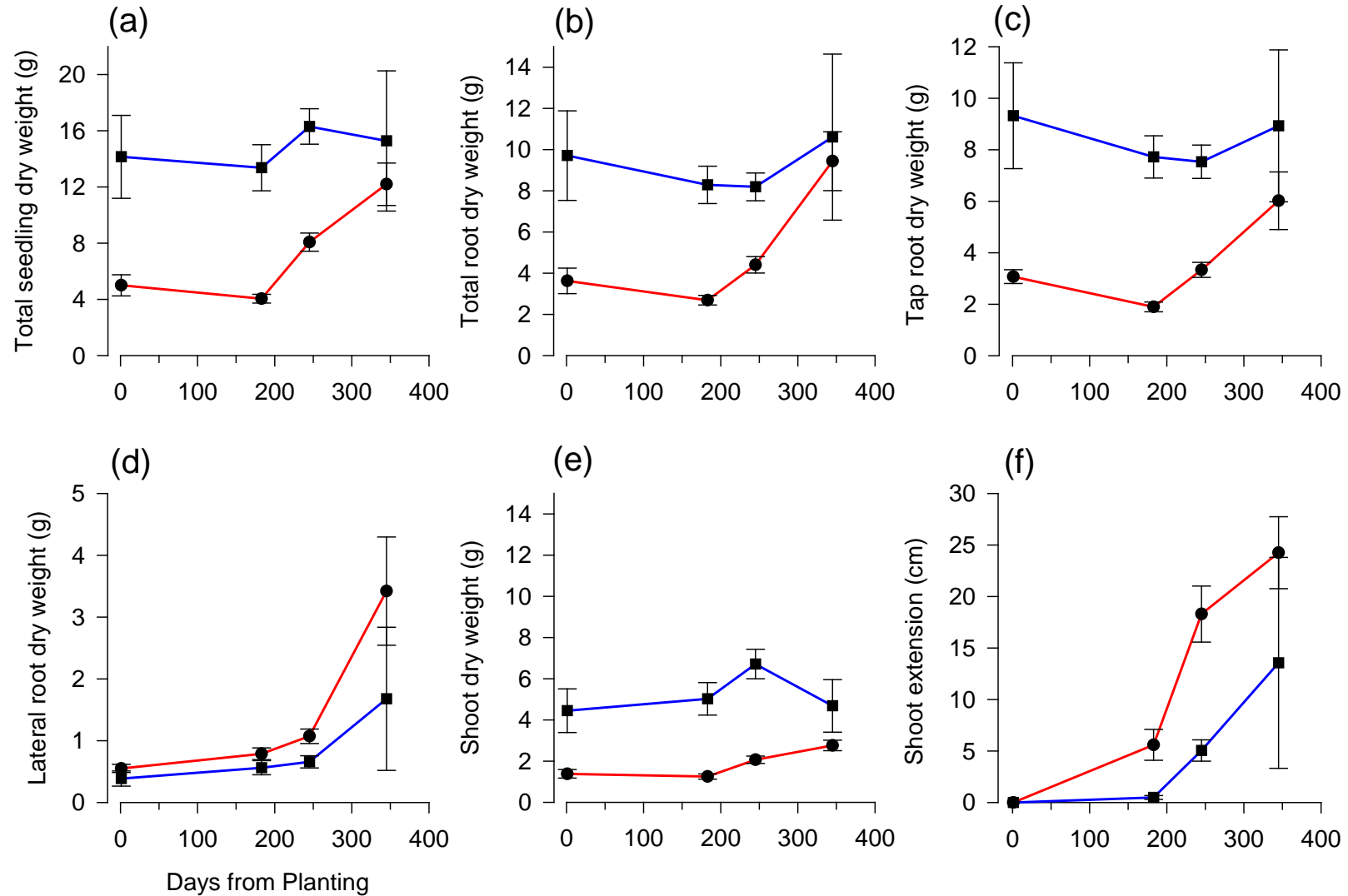
Root System Structure



Root System Structure



Stocktype comparison of *Quercus rubra* in Ontario



Wilson et al. 2007

● Container ■ Bare-root

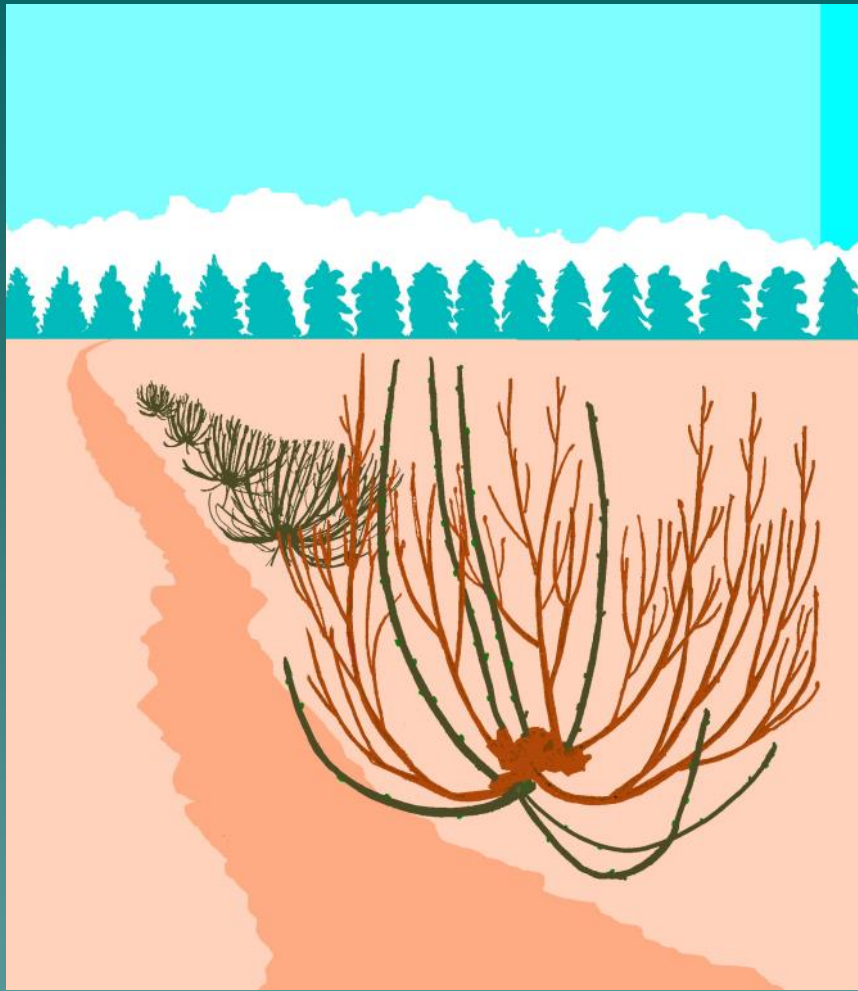
Rapid Response Reforestation: One-year old Stocktypes



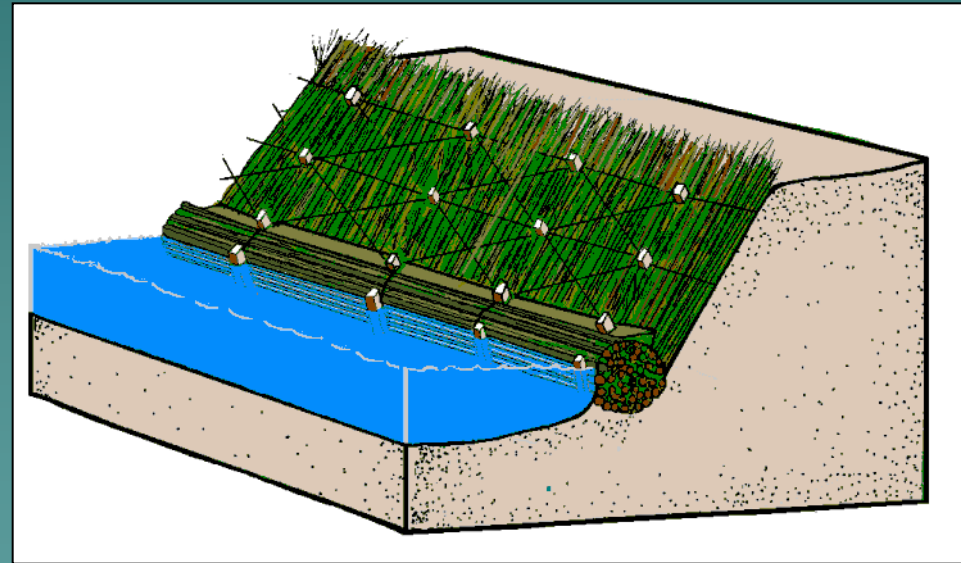
**1+0
Seedling**

**Jiffy
Plug+1**

**Styro-2
Plug+1**



**Rooted Cuttings
from Stooling Beds**



**Bioengineering
Structures
(e.g., Brush Mattress)**



Native Grass and Forb Seed

JH Stone Nursery, OR



**“Root Stock” Harvested
From 2-year Bareroot Beds
Mason State Nursery, IL**

5. Timing of Outplanting Window

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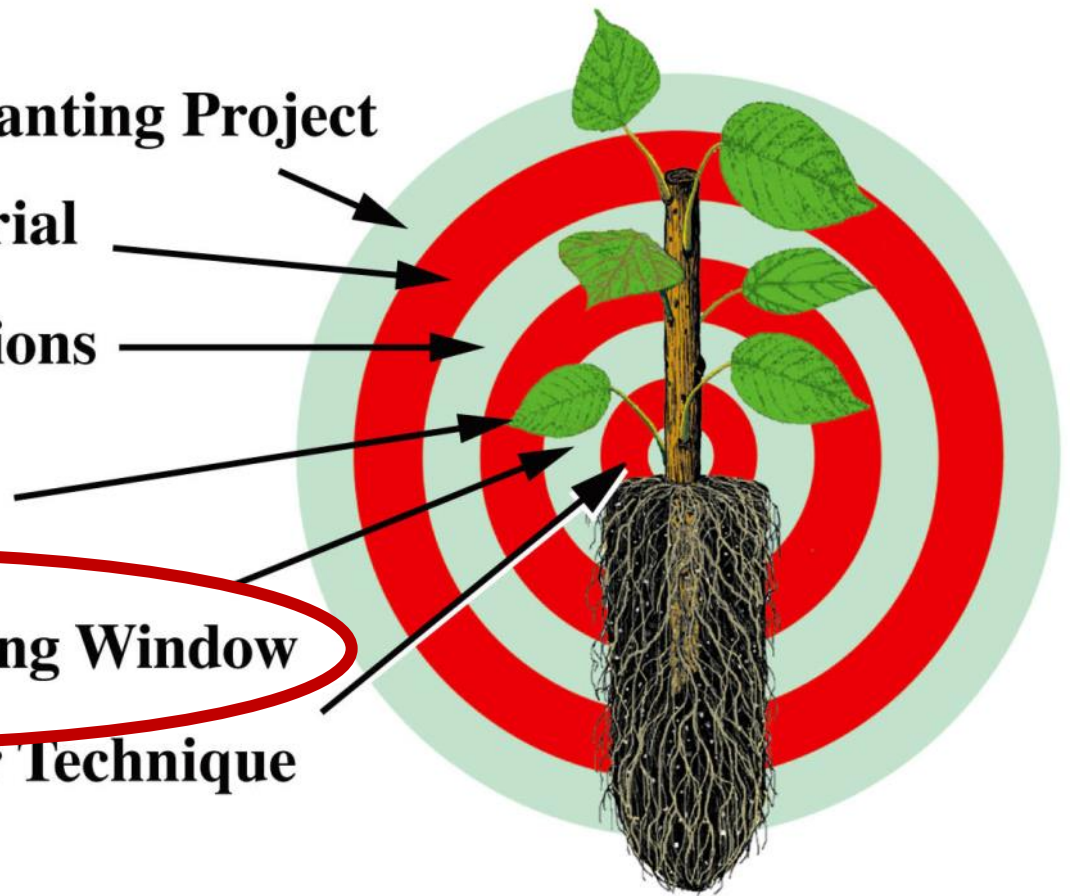
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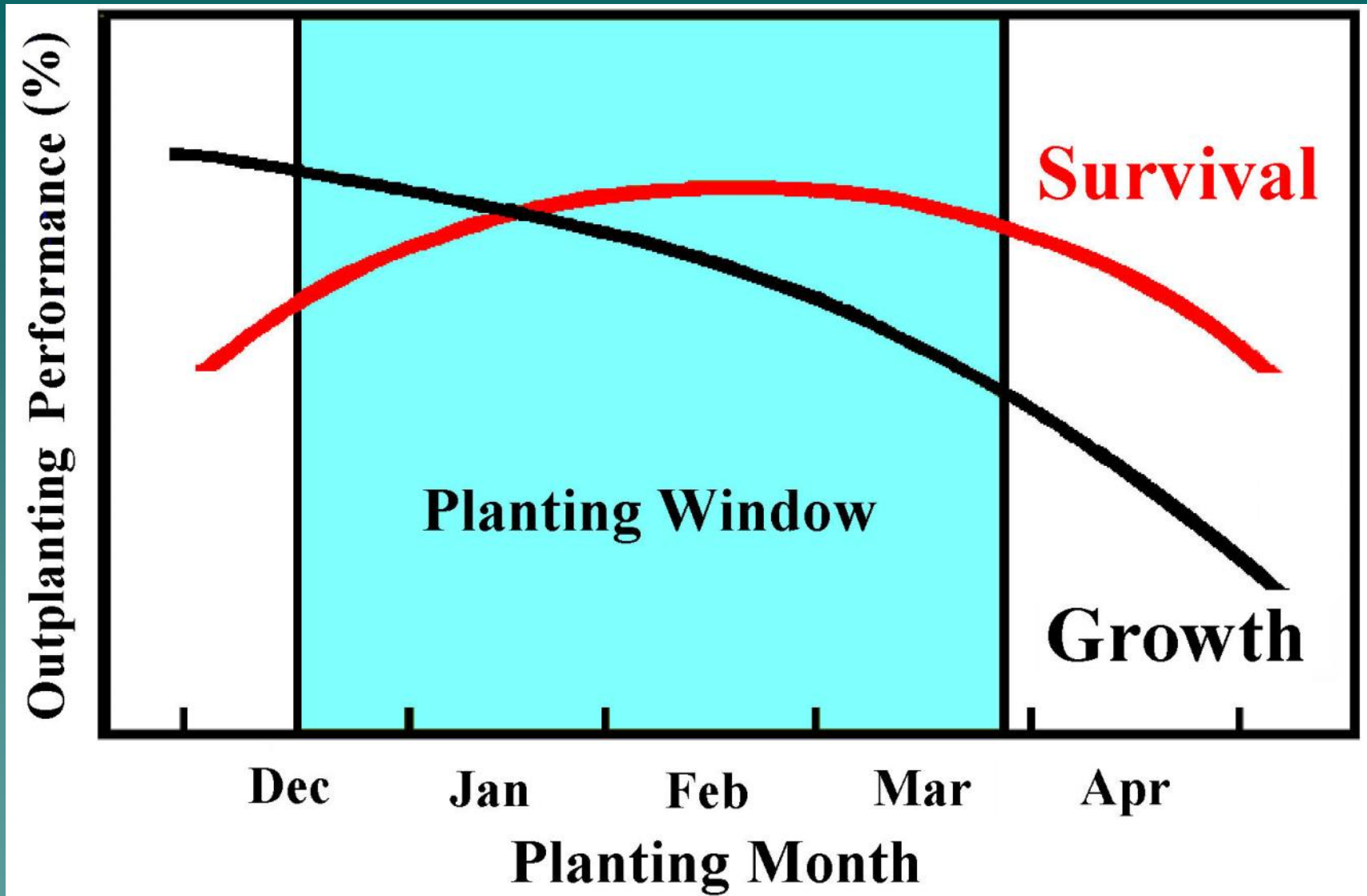
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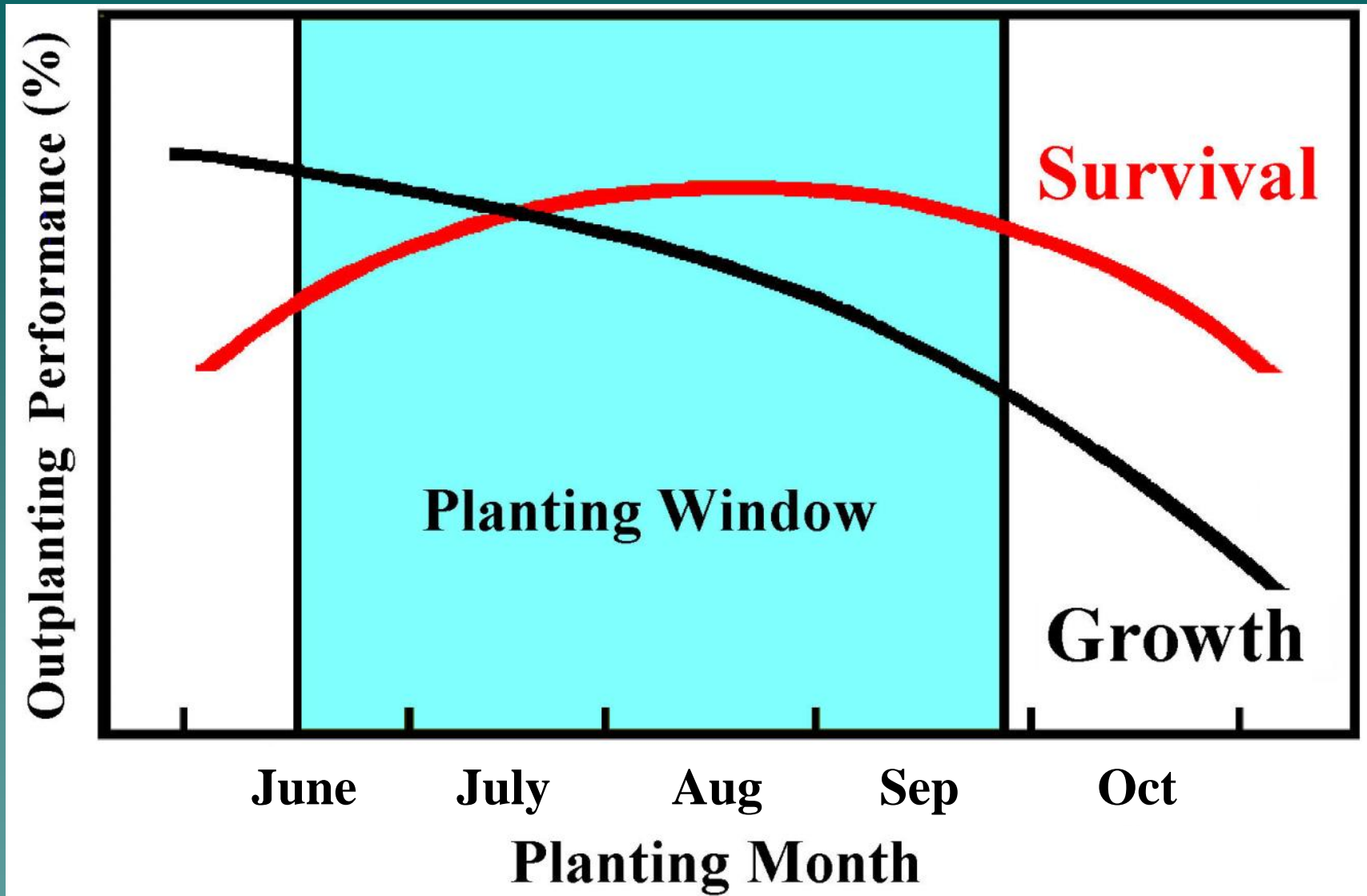
5. Timing of Outplanting Window

6. Outplanting Tool or Technique





Example: Traditional Mid-Winter Window in Pacific Northwest



Example: Reforestation in Mexico

“New” Outplanting Windows in Interior of western USA



- ✓ *Summer or Fall
Outplanting*
- ✓ *“Hot Plant”
Container Stock*

Scheduling for Outplanting Windows

Table 6.1.4 — Comparison of crop production schedules for four typical container seedling stock types

Seedling stock type	Year one												Year two												Year three				
	J a n	F e b	M a r	A p r	M a y	J u n	J u l	A u g	S e p	O c t	N o v	D e c	J a n	F e b	M a r	A p r	M a y	J u n	J u l	A u g	S e p	O c t	N o v	D e c	J a n	F e b	M a r	A p r	M a y
1 + 0 Container fall outplant	[Scheduling pattern for 1+0 Container fall outplant in Year one]												[Scheduling pattern for 1+0 Container fall outplant in Year two]												[Scheduling pattern for 1+0 Container fall outplant in Year three]				
1 + 0 Container spring outplant	[Scheduling pattern for 1+0 Container spring outplant in Year one]												[Scheduling pattern for 1+0 Container spring outplant in Year two]												[Scheduling pattern for 1+0 Container spring outplant in Year three]				
2 + 0 Container summer outplant	[Scheduling pattern for 2+0 Container summer outplant in Year one]												[Scheduling pattern for 2+0 Container summer outplant in Year two]												[Scheduling pattern for 2+0 Container summer outplant in Year three]				
Plug + One fall outplant	[Scheduling pattern for Plug + One fall outplant in Year one]												[Scheduling pattern for Plug + One fall outplant in Year two]												[Scheduling pattern for Plug + One fall outplant in Year three]				
Legend	Procure & treat Seeds or Cuttings		Active growth		Hardening		Dormant		Transplanting		Harvesting		Storage		Outplanting														

Plan Backwards When Scheduling Nursery Stock!

6. Outplanting Tool or Technique

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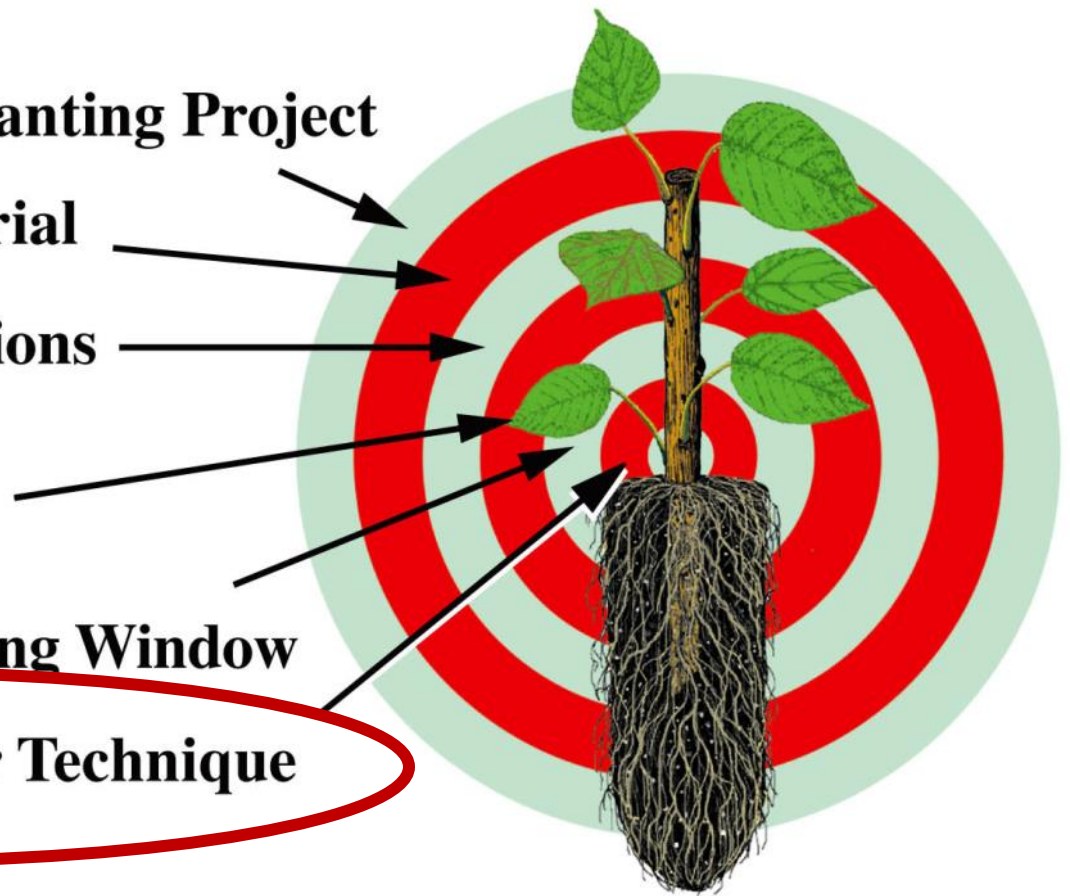
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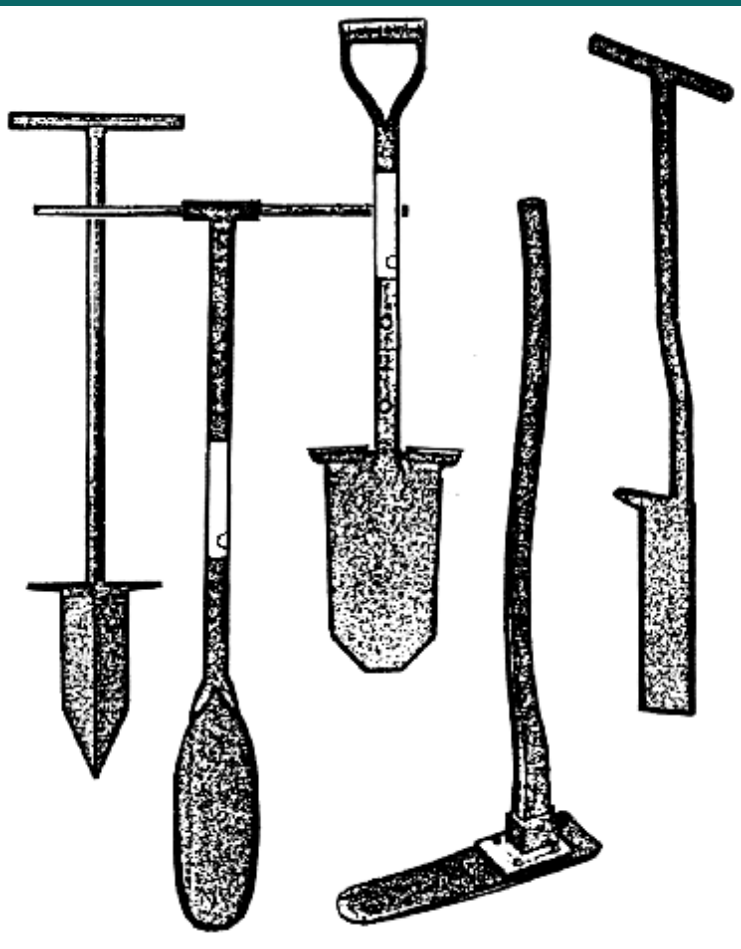
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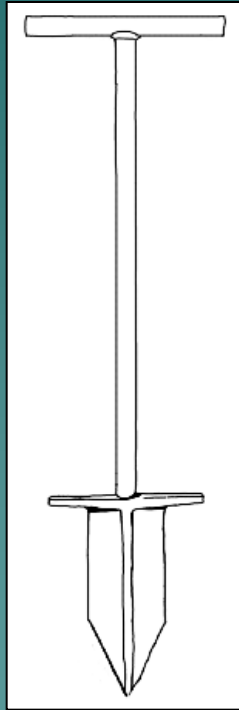
6. Outplanting Tool or Technique





**Choose the Right Tool for the Site,
Stocktype, and Crew's Skill**

Outplanting Tools – “That’s the Way We’ve Always Done It”

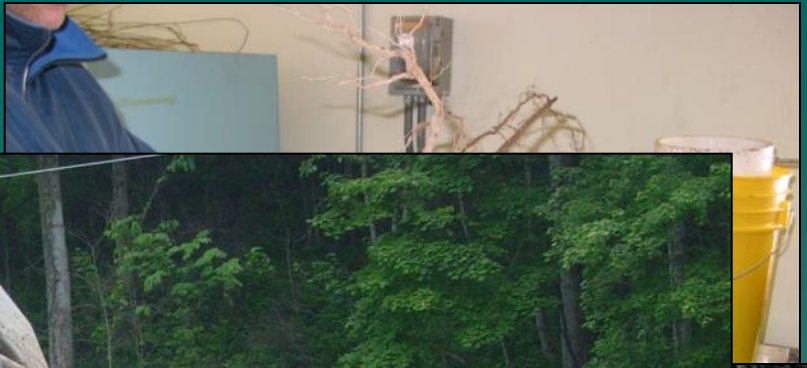


One-Dimensional Roots from Slit Planting



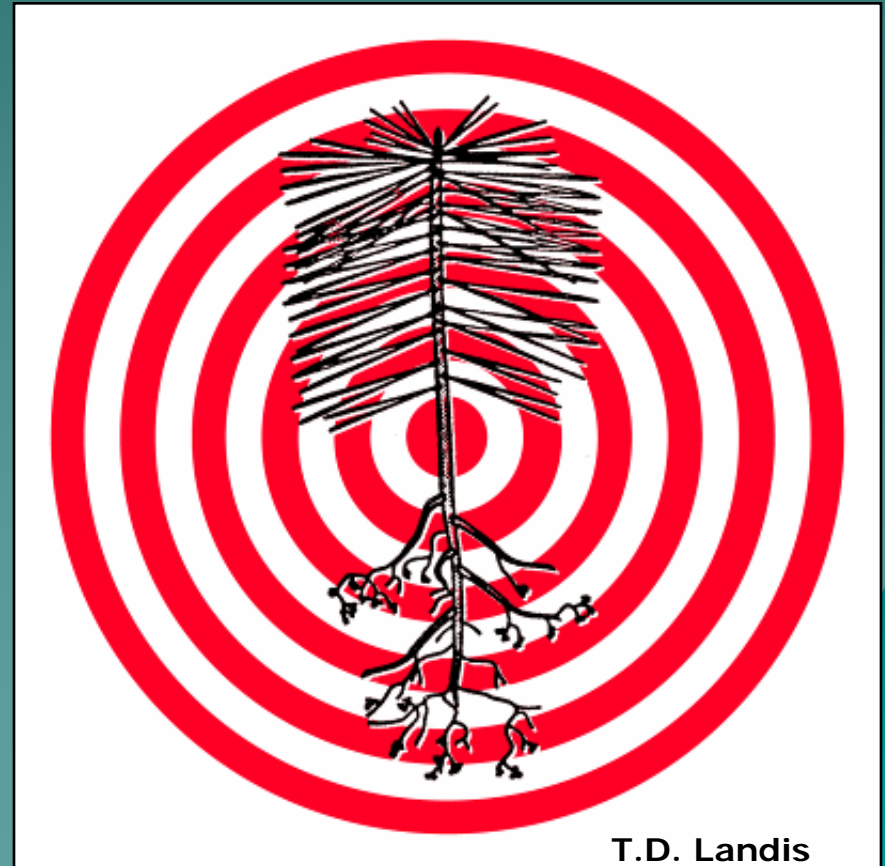
Soil Replacement??





“One Size Fits All” Does Not Apply to all Planting Projects!!

*Quality =
“Fitness
for
Purpose”*



T.D. Landis

Questions??



Silvicultural Systems & Regeneration

- Objectives
 - Methods of Regeneration
 - Silvicultural Systems

Silvicultural Systems & Regeneration

- Regeneration - Natural vs. Artificial

Natural Regeneration



Artificial Regeneration



Silvicultural Systems & Regeneration

- Regeneration – Seedlings vs. Sprouts

Seedlings

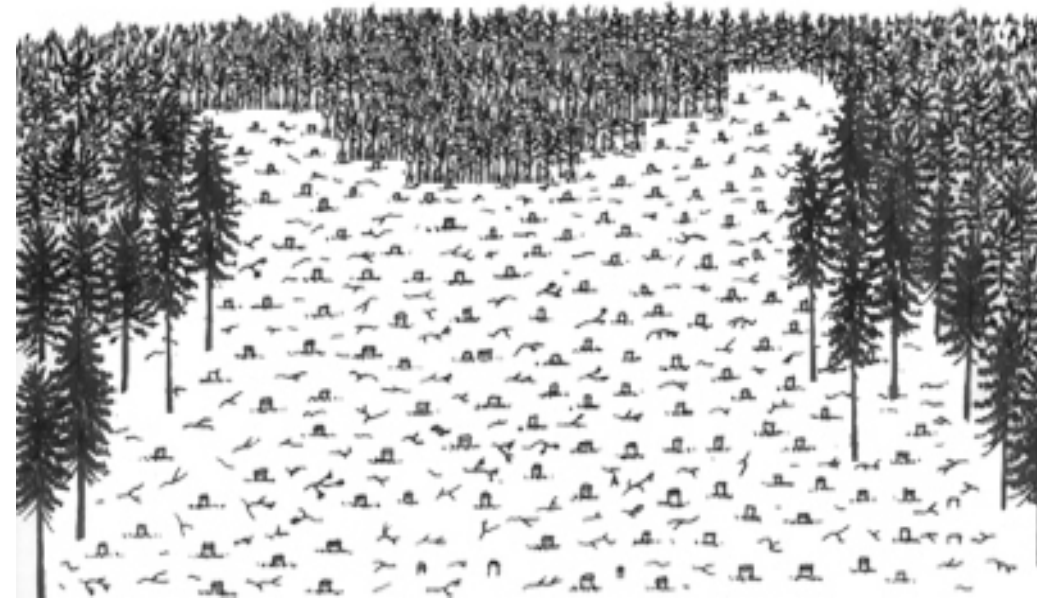


Sprouts



Silvicultural Systems & Regeneration

- Regeneration - Clearcutting



Clearcut: removal of the entire stand in one cutting with reproduction obtained artificially or from seeds germinating or dispersing after the clearing operation

Silvicultural Systems & Regeneration

- Regeneration - Seed-tree



•**Seed-tree:** removal of the stand in one cutting, except for a small number of 'seed trees' left singularly or in small groups to provide the seed source for the establishment of regeneration of the next stand

Silvicultural Systems & Regeneration

- Regeneration - Shelterwood



• **Shelterwood:** removal of the old stand in a series of cuttings, extending over a relatively short portion of the rotation, by means of which the establishment of regeneration of the next stand occurs under the partial shelter of 'seed trees'

Silvicultural Systems & Regeneration

- Regeneration - Selection



• **Selection:** continual creation or maintenance of uneven-aged or multi-cohort stands by means of occasional cutting of single trees (single tree selection) or groups of trees (group selection), and establishment of regeneration in the resulting gaps

Silvicultural Systems & Regeneration

Table 2.—Biological legacies associated with wind, fire, and bark beetle disturbances

Legacy	Disturbance agent								
	Wind			Fire*			Beetle		
	Tree	Gap	Stand	Tree	Gap	Stand	Tree	Gap	Stand
Live, mature trees	NA	Few/ Absent	Few/Absent	NA	Few	Few	NA	Species dependent	Species dependent
Seedling bank	Possible	Possible	Possible	No	No/Rare	Rare	Possible	Possible	Possible
Intact understory	Possible	Yes	Yes	No	Rare	Rare	Possible	Yes	Yes
Snags	NA	Few	Few	Yes	Abundant	Abundant	Yes	Abundant	Abundant
Logs	Yes	Abundant	Abundant	No	No	Common	No	No	No
Uproots	Yes	Abundant	Abundant	No	No	No	No	No	No
Mineral seedbed	Yes	Yes	Yes	Yes	Yes	Abundant	No	No	No

Table 3.—Biological legacies associated with common regeneration harvest methods as traditionally applied

Legacy	Method					
	Even-aged		Two-aged		Uneven-aged	
	Clearcut with site prep	Seed tree with site prep	Shelterwood with site prep ¹	Shelterwood with reserves and site prep	Group selection	Single-tree selection
Live, mature trees	No	Few/No	No	Yes	Few/No (in group)	n.a.
Seedling bank	No	No	Yes	Yes	Possible	Possible
Intact understory	No	No	No	Possible	Possible	Possible
Snags	No	No	No	No	No (in group)	n.a.
Logs	Few/No	Few/No	Few/No	Few/No	Few/No (in group)	No
Uproots	No	No	No	No	No	No
Mineral seedbed ²	Yes	Yes	Yes	Yes	Possible	Possible