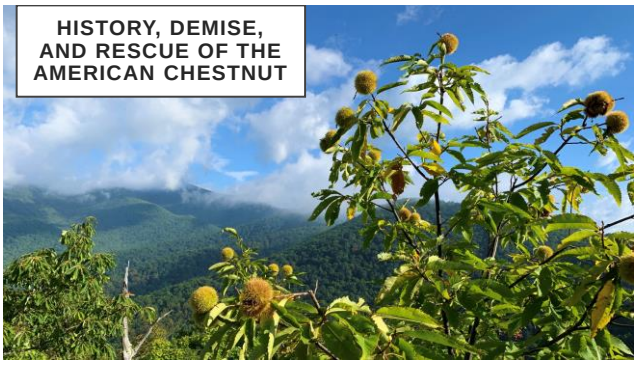


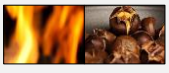
1

AMERICAN CHESTNUT: HISTORICAL VALUE

- Major component of eastern forests
- Fast growth, large, rot resistant
- Highly versatile timber species
- Nuts valuable to wildlife

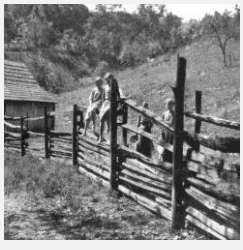
2

American Chestnut: Historical Uses



- Wood Products
- Agricultural
- Medicinal Uses

- Social and Historical Connections



3

PRE-BLIGHT POPULATION AND IMPACT

- 4 billion American chestnut trees
- Very dense populations in some areas
- A disturbance-dependent species

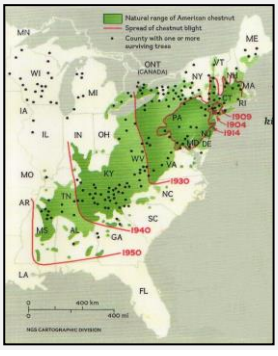
Shenandoah National Park, 1912

Mountainsides white with chestnut blooms near Skyland Cabins, Shenandoah National Park, 1912. Courtesy of Shenandoah National Park, National Park Service, Skyland Glass Slide Photograph Collection, Item #205

4

CRYPHONECTRIA PARASITICA

- Chestnut blight disease
- The fungus enters through bark openings
- It forms a canker and quickly girdles the tree.
- **Does not kill below ground (roots)**



5

6

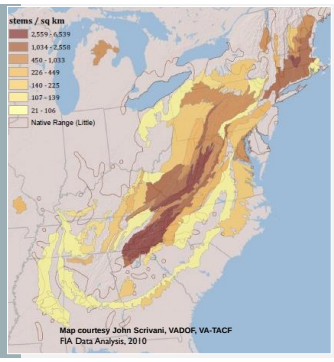
7

8

CURRENT AMERICAN CHESTNUT POPULATIONS

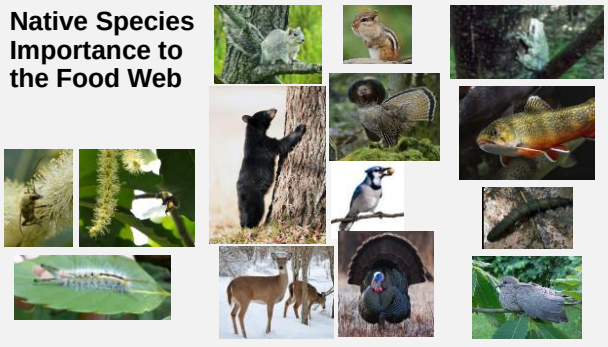
Not threatened, endangered, or extinct but **Functionally Extinct**

430M stems: 84% < 1" dbh



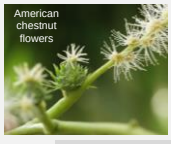
9

Native Species Importance to the Food Web



10

DEPENDABLE AND PLENTIFUL MAST PRODUCTION



American chestnut

White oak

	Diameter (in)	Nuts per tree	Fruiting age (years)
Chestnut	15	600	8
Chestnut	24	6000	8
White oak	20+	8000	20
Red Oak	20+	1600	25

Paillet and Rutter 1989

11

REACHING A BROAD NETWORK OF PARTNERS, SCIENTISTS, AND VOLUNTEERS

- TACF began in 1983
- 5000 Members
- 16 Chapters
- Comprised of Volunteers, Academic, and Public/Private Partners

12

HOW TO MAKE A DISEASE-RESISTANT AMERICAN CHESTNUT?

3BUR

Breeding, Biotechnology, and Bio-control United for Restoration



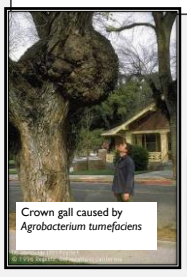

13

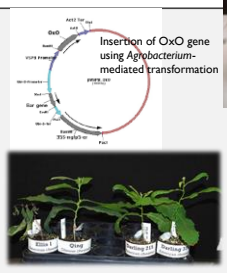
BREEDING

14


15

BIOTECHNOLOGY





16

PERMITTING

- Looking to deregulate in the next 2-5 years.
- Depends on regulatory approval by EPA, **USDA**, and FDA

Recent fall 2020 USDA Public Comment Period Rendered more than 4600 comments with 62% positive for deregulation

17

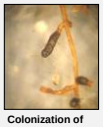
ECOLOGICAL STUDIES OF TRANSGENIC AMERICAN CHESTNUT FOR REGULATORY REVIEW

No difference between transgenic and non-transgenic American chestnut in….


Leaf litter decomposition


Germination of seedlings from chestnut leaf litter


Herbivory on leaves


Colonization of mycorrhizal fungi on roots

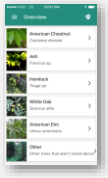

Bee feeding on pollen


Tadpole development after feeding on leaves

ESF

18

GERMPLASM CONSERVATION FOR DIVERSIFYING TRANSGENIC TREES



Document locations of wild trees with TreeSnap

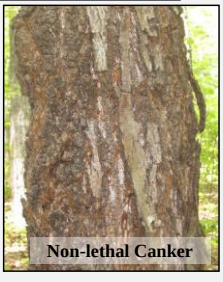
Graft wild trees that do not flower in forest

Collect seed from rare flowering trees

Objective: **Collect seed or graft 1000 wild-type American for use in breeding with blight-tolerant transgenic trees**

19

BIO-CONTROL: HYPOVIRULENCE

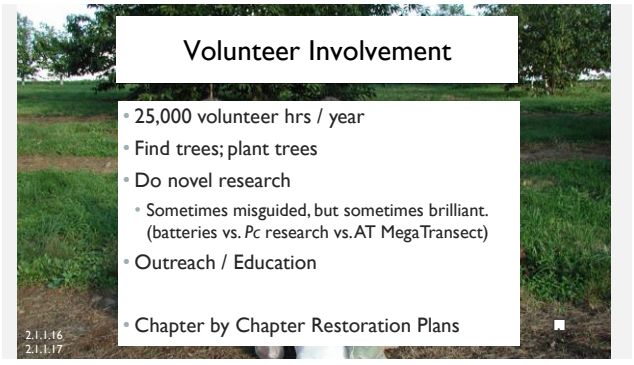


White-type *Cryphonectria parasitica* infected with hypovirus plated with non-infected wild-type Cp

20

Volunteer Involvement

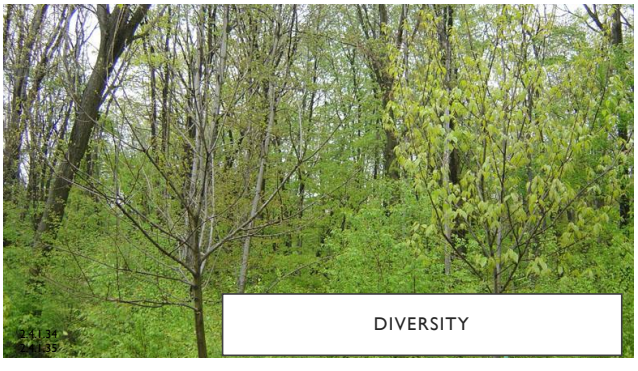
21


Volunteer Involvement
• 25,000 volunteer hrs / year
• Find trees; plant trees
• Do novel research
• Sometimes misguided, but sometimes brilliant. (batteries vs. *Pc* research vs. AT MegaTransect)
• Outreach / Education
• Chapter by Chapter Restoration Plans
2.1.1.16
2.1.1.17

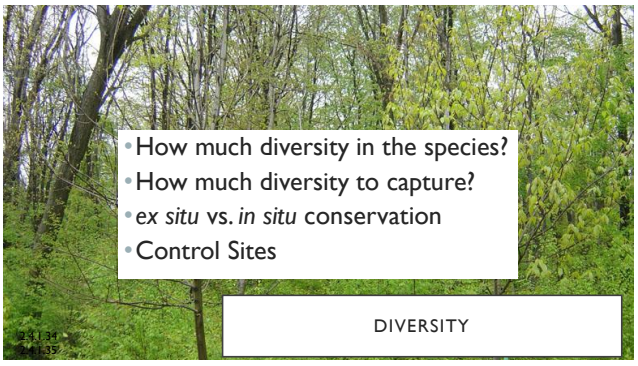
22


MAGNITUDE OF AMERICAN CHESTNUT RESTORATION

23

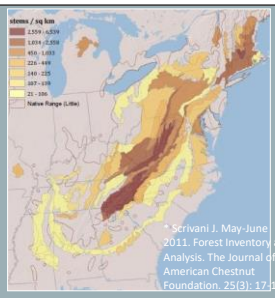

DIVERSITY

24



25

CURRENT STATUS OF WILD CADE



- Dalgleish et al. 2016. *Forests.*
  - 430M Trees
  - 84% sprouts < 1" dbh
- Appalachian Trail Mega-Transect Data
  - 18,376 trees counted
  - 107 were > 4" dbh (0.5%)

26

FLOWERING AMERICAN CHESTNUTS

* 0.5% of 430M = 2.2M

* Need two flowering trees within 500m
  - 100m? 300m? 1.5km?

* Need full sunlight

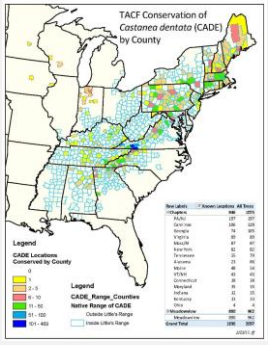
27

EX SITU CONSERVATION

- Challenges of vegetative propagation
  - Doesn't readily root
  - Delayed graft incompatibility and blight infection
  - Tissue Culture on embryos
- Challenges of seed storage
  - Viability drops significantly after first 6 months.
  - 2 years, max

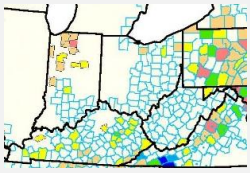
2.4.1. 34

28



NEED TO COLLECT OVER 1000 GENOTYPES FOR DIVERSIFICATION

- Large hole in southern Ohio, southern IN and across WV
- Find trees and document using TreeSnap



29

30

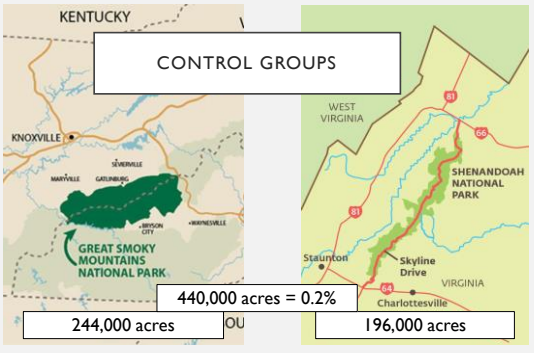
PROTECTION OF WILD TREES

- How much to protect *in situ*?
- Not T&E.
  - Focus on areas with high diversity but low population?
  - Need areas with low diversity at all?
- "Easy" to manage larger populations via clearcuts.
- Protection of individual trees?

2.4.2.35

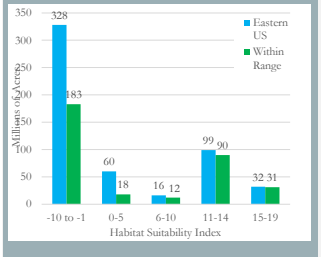
31

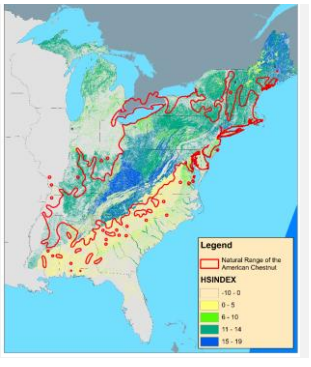
CONTROL GROUPS



32

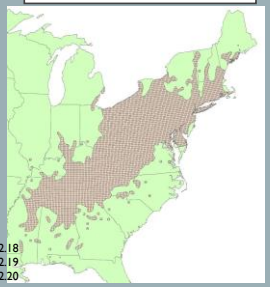
HABITAT SUITABILITY

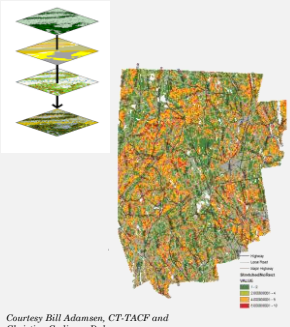




33

INDICES OF CHESTNUT SUITABILITY + 7.5 QUADS



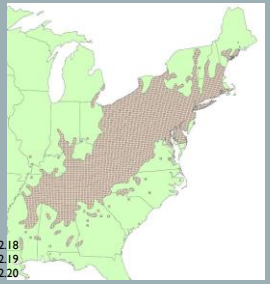


Courtesy Bill Adamsen, CT-TACF and Christine Cadigan, Duke.

2.1.2.18
2.1.2.19
2.1.2.20

34

TRACK BY 7.5 QUADS



- Each Quad 37K Acres
- 5,744 USFS Quadrangles within the Natural Range within the US
- Prioritize by soil suitability
- 1+ planting per quad (given site)
- 300 trees 8 x 8 = 0.5 acres
  - 1/quad = 2,782 acres
  - 0.0003% suitable habitat

2.1.2.18
2.1.2.19
2.1.2.20

35

BEST MANAGEMENT PLANTING PRACTICES AND GUIDELINES AND MONITORING

2.1.4.24
2.1.4.25
2.2.1.27
2.2.1.28
2.2.2.29

36

ESTABLISHMENT AND MAINTENANCE

- How much shade?
- With what other species?
- How many to plant?
  - How much diversity?
- Seeds vs. Seedlings?
- How much weed control and for how long?

37

"BEST" WAYS TO REINTRODUCE

- Seeds vs. Seedlings
- Bareroot vs. containerized
- Forests vs. Fields
- How much vegetation control and how?
- Deer Control vs. Big Seedlings?
- Fencing vs. Tree Shelters vs. Cages

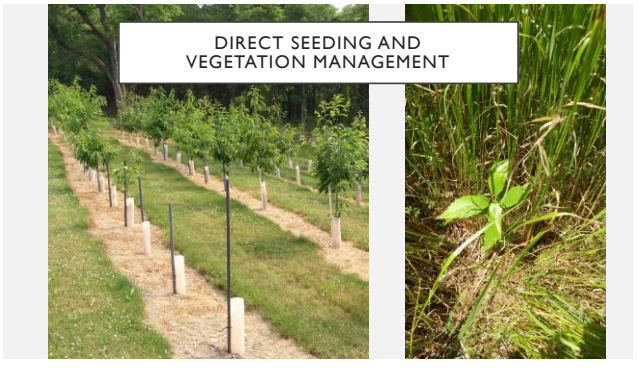
38

REINTRODUCTION TRIALS, WILD AMERICANS, & UNSELECTED MATERIALS

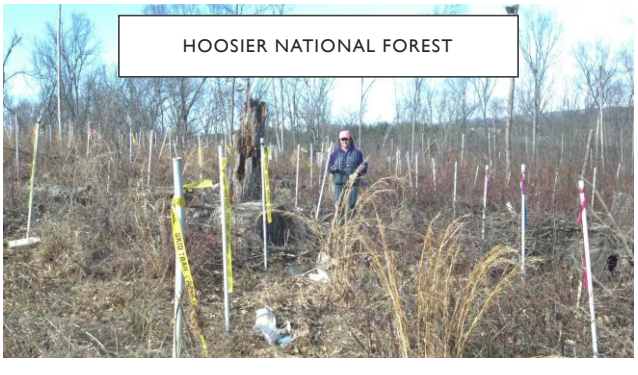
39


COMPETING VEGETATION / TREES

40


DIRECT SEEDING AND
VEGETATION MANAGEMENT

41


HOOSIER NATIONAL FOREST

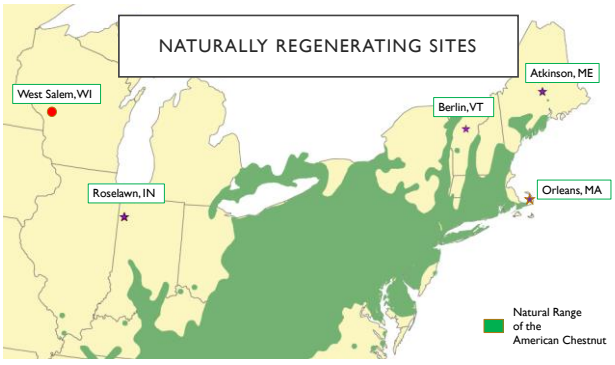
42

BEST MANAGEMENT PRACTICES FOR ESTABLISHMENT

- Testing task Force Protocol
- Various Planting Manuals
- SFI BMP
- Fact Sheets

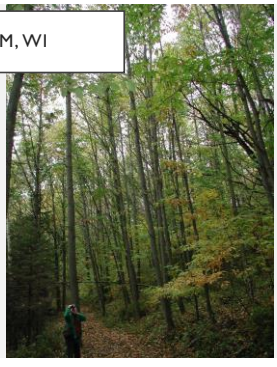
43

NATURALLY REGENERATING SITES

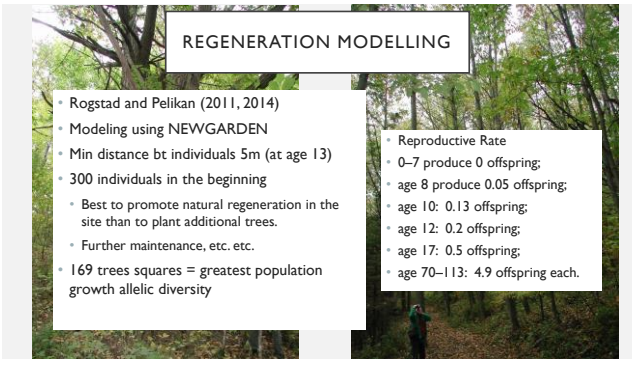


44

WEST SALEM, WI



45

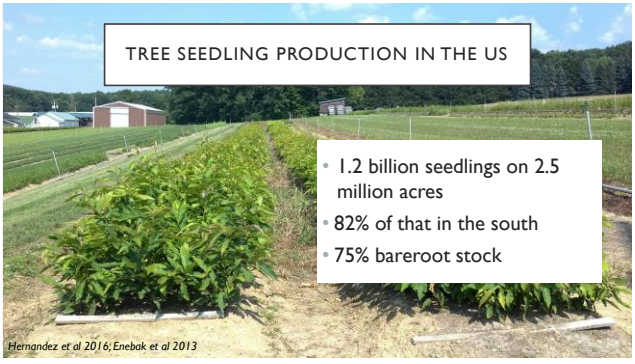

REGENERATION MODELLING
• Rogstad and Pelikan (2011, 2014)
• Modeling using NEWGARDEN
• Min distance bt individuals 5m (at age 13)
• 300 individuals in the beginning
◦ Best to promote natural regeneration in the site than to plant additional trees.
◦ Further maintenance, etc. etc.
• 169 trees squares = greatest population growth allelic diversity
• Reproductive Rate
• 0–7 produce 0 offspring;
• age 8 produce 0.05 offspring;
• age 10: 0.13 offspring;
• age 12: 0.2 offspring;
• age 17: 0.5 offspring;
• age 70–113: 4.9 offspring each.

46

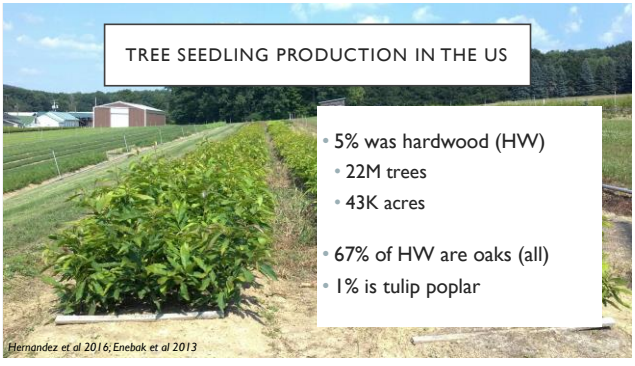
47


2.1.3.21
2.1.3.22
2.1.3.23
2.3.1.32
2.3.1.33
SEED AND SEEDLING PRODUCTION

48



49



50

ANNUAL CHESTNUT SEEDLING PRODUCTION?

Assume 1% current seedling production

431 acres / year
220,000 trees / year
= 550 trees / acre

1% of range (1M acres)?
> 2,000 years

51

ANNUAL CHESTNUT SEEDLING PRODUCTION?

1% = 431 acres / year
1% = 220,000 trees / year
= 510 trees / acre

17,000 acres = 39 years
50 years = 21,550 acres

52

MAGNITUDE OF RESTORATION

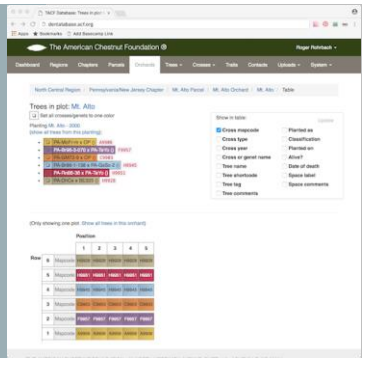
53

CATALOGUING EFFORTS

dentataBase

* Mapping
* Real-time data entry and retrieval
* Trait Creation and Chronological Observation Entry
* Personnel tracking
* Open-source for integration with other software/databases

2.1.4.25
2.1.2.31



54

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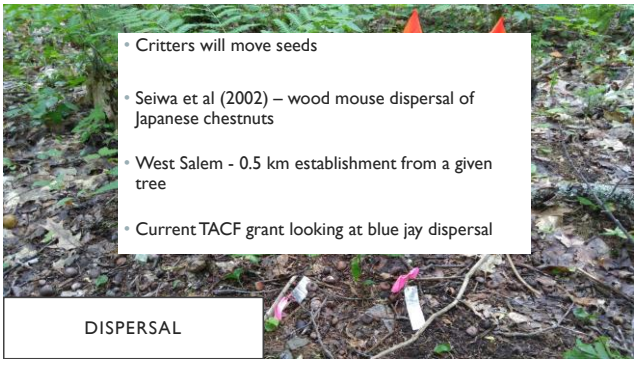
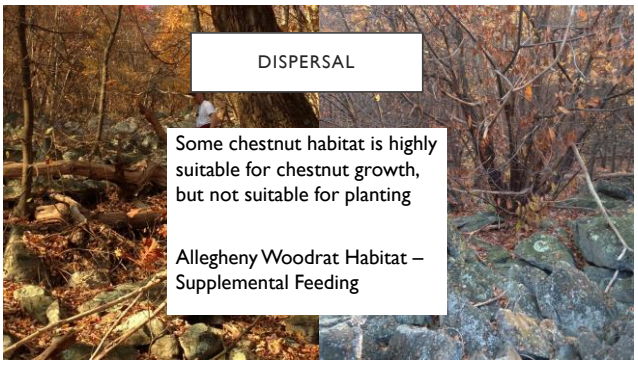


56

HURDLES

- Explosive deer populations
- Invasive competitors
  - Stiltgrass, multiflora rose, bittersweet, honeysuckle, mile-a-minute,
- Other diseases and pests:
  - Phytophthora cinnamomi, sudden oak death, granulate ambrosia beetle, Asian Longhorn beetle, spotted lantern fly……
- 180 million acres – original range
  - What is the best Habitat?
  - How to prioritize and how much to plant?

57



58

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WHAT WE DON'T KNOW AND HOW TO PRIORITIZE THAT WORK

- **How much resistance is necessary to begin restoration sites?**
- **Diversity**
  - How localized do materials need to be?
  - How far can materials be moved?
  - How much diversity to plant in a given stand?
  - How is that defined?
- **Goals for planting**
  - Climate change?
  - Short-term vs. long-range goals?
  - How much seed/seedling production?
  - Internal production vs. external?
- **Silviculture / Dispersal**
  - Effect of site quality?
    - Suitability vs. Resources Available
  - Introgression with wild/planted trees?
  - Even-aged stands vs. uneven-aged stands?
  - Clearcuts vs. shelterwoods vs. open fields, etc.
  - What species to interplant?
  - Protection from deer?
  - MTAs? How long to "control" restoration vs. let other organizations handle it?
- **Logistics**
  - Motivating People?
  - How long to plant vs. letting nature do it

2.5.1.36

60

61