Soil Scarification to Improve Oak Establishment

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Objectives

- Factors influencing oak establishment
- Studies investigating whether soil scarification, in the presence of abundant acorns, can increase the density and/or competitive position of oak reproduction
- Management implications
Factors Influencing Oak Seedling Establishment

- Acorn Production
  - Highly variable with large seed crops 2 to 10 years

- Predation: mammals, birds, insects

- Seed moisture content
  - Temperature and moisture of forest floor
  - Acorn position in forest floor

- Leaf litter depth
Acorn Positions in Forest Floor

- **Unfavorable:**
  1. on litter layer surface
  2. positioned within a thick litter layer

- **Favorable:**
  1. buried 1 to 2 inches deep in soil
  2. in contact with mineral soil, covered with leaf litter that is not too thick

  - Protect against desiccation, extreme temperatures, and predation
Litter Depth Case Study – Stringer and Taylor 1999

- 2 Upland Oak Sites (NE and SW aspects)
- 10 treatment plots
- Burned prior to acorn fall and unburned
- Seeded onto unburned leaf litter and onto burned duff/soil
- Natural leaf fall covering acorns
Litter Depth Case Study – Stringer and Taylor 1999

The diagram shows the establishment percentage of various oak species and chestnut oak in burned and unburned areas. The data indicates that:

- Scarlet Oak: Establishment percentage is higher in unburned areas.
- Chestnut Oak: Establishment percentage is higher in unburned areas, marked with an asterisk.
- White Oak: Establishment percentage is similar in burned and unburned areas.
- N. Red Oak: Establishment percentage is higher in unburned areas, marked with an asterisk.

The asterisks denote significant differences in establishment percentages between burned and unburned areas.
What is Soil Scarification?

- The use of mechanized equipment to create a shallow soil disturbance in desired areas that incorporates acorns into the soil, while providing competition control.
Why Use Soil Scarification?

- Increase germination through incorporation
  - Provides protection from predators
  - Improves germination conditions

- Provides competition control
  - Enhance seedling growth
  - Influence species composition
Scarification Studies

- Disk Scarification
  1. Southern Illinois: Bottomland Oaks

- Bulldozer/brushrake scarification
  1. Southern Illinois: upland oak
  2. Central Pennsylvania: upland oak
    - Fenced, shelterwood
So. IL Bottomland Oak Disking Study

- Two mixed bottomland oak-hickory sites
- Dense poison ivy understory

- Scarification treatment:
  - 42 hp tractor
  - 8 ft field disk
  - Three passes per scarified transect
Disk Scarification
So. IL Bottomland Oak Disking – Results
Impact of Treatment on Oak Seedling Density

![Graph showing the impact of treatment on oak seedling density. The graph compares the seedling density per hectare (Seedlings Ha⁻¹) between control and scarified treatments in Stand A and Stand B before (Pretreatment) and one year after (Year 1) the treatment. The graph indicates a significant increase in seedling density in Stand A after the scarification treatment.]
So. IL Bottomland Oak Disking – Results

Impact of Treatment on Seedling Composition

![Bar Chart]

- **Control**
  - Pretreatment: 5000
  - Post-Treatment: 8000

- **Scarified**
  - Pretreatment: 7000
  - Post-Treatment: 18000

Legend:
- Oaks
- Hickory
- Ash
- Other

Seedlings Ha⁻¹
So. IL Bottomland Oak Disking - Poison Ivy
So. IL Bulldozer and Brush Rake Study

Mature, mixed oak upland forest

- **Scarification treatment:**
  - 78 hp crawler tractor
  - 8 ft, 6-tooth brush rake
  - Rake inserted into the soil approx. 4 inches
  - Operation damaged or uproot midstory trees
Bulldozer/Brush Rake Scarification
Bulldozer Scarification - In Action
So. IL Bulldozer/Brush Rake Study – Results

Impact of Treatment on Oak Seedling Density

The graph shows the comparison of oak seedling density between control and scarified treatments. In the pretreatment year, there was minimal seedling density. However, in Year 1, the scarified treatment showed a significant increase, indicating the effectiveness of the treatment method.
So. IL Bulldozer/Brush Rake Study – Results

Impact of Treatment on Seedling Composition

![Graph showing seedling composition](image-url)
So. IL Bulldozer/Brush Rake Study – Results
Impact of Treatment on Midstory

![Graph showing impact of treatment on midstory species density. The x-axis represents midstory tree species group (Sugar maple, Pawpaw, All other species). The y-axis represents density (stems ha⁻¹). The graph includes data for undamaged and resprout potential states.](image-url)
Pennsylvania Bulldozer/Brush Rake Study

- Mature, Mixed-Oak Stand
- Winter 1992/1993 - Shelterwood harvest
  - Residual Basal area: 55 ft$^2$ ac$^{-1}$
  - Fenced to limit deer browse
- Fall 1993 – Bulldozer/brush rake scarification
  - Supplemental northern red oak acorns
- Winter 1997/1998 - Overwood removed
- May 1999 – 5 year seedling inventories conducted
Pennsylvania Bulldozer/Brush Rake Study – Results

Effect of Treatment on Oak Seedling Density

![Graph showing seedling density over time for Control and Scarified treatments.](image)

- **Pretreatment**: Control and Scarified both show slightly above 0 seedlings Ha⁻¹.
- **Year 1**: Scarified shows a significant increase to around 30,000 seedlings Ha⁻¹, while Control stays around 10,000.
- **Year 5**: Scarified shows a further increase to around 40,000 seedlings Ha⁻¹, while Control shows a slight increase to around 15,000.
Pennsylvania Bulldozer/Brush Rake Study – Results

Effect of Treatment on Oak Competitive Position

- **RM** = Red Maple
- **NRO** = N. Red Oak

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<th>RM</th>
<th>NRO</th>
<th>RM</th>
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- Seedlings Ha⁻¹

The graph shows the effect of treatment on oak competitive position with data collected in both the pretreatment and year five phases.
Overall Trends

- The results suggest scarification may:
  - Increase germination and initial establishment
  - Influence competing vegetation
  - Enhance competitive position of oak seedlings
  - Be a useful management tool in both upland and bottomland forests

Note: abundant acorns must be present
Management Considerations - Utility

- Useful in stands lacking desired advance reproduction
- Equipment mobility allows “precision” application of disturbance

Allows one to easily:
- Treat poorly regenerating areas
- Avoid areas possessing sufficient reproduction or sensitive areas

- Extremely wet or steep terrain may not be conducive to scarification
Management Considerations - Implementation

- Abundant viable acorns **must** be present
  - Supplemental seeding may be necessary

- Timing: Autumn after acorn drop, prior to leaf fall

- Coincide with silvicultural treatment that promotes seedling development

- Extreme dry conditions may influence success
Management Considerations - Scarifiers

- Equipment used should balance traction, scarification intensity, and maneuverability
  - Brush rake (or Salmon blade)
  - Disk
  - Drag-chain

- Dense midstory and/or logging slash may inhibit disking or drag-chain methods

- Compact or displace soil and may bury acorns too deep in wet conditions
More Information

Publications available:

www.uky.edu/~jmlhot2/pubs.html

or

www.ca.uky.edu/forestry