Assessing Anthropogenic and Natural Disturbance: Forest Response to Clearcut and Tornado Disturbances

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Outline
Introduction and Justification for Research
Research Objective
Methods
Results and Discussion
Management and Research Considerations

Background Information
February 21, 1993: F3 tornado hits Oak Ridge, TN
UT Forest Resources Research and Education Center (FRREC)
- 352 total acres damaged
- 249 acres heavily damaged

Incomplete Stand Scale Disturbance
**Background Information**

1989: Clearcut on Chestnut Ridge
- Site prep/Mixed pine-HW stands
- Planted EWP and LP on 20' x 20' spacing

4 Treatments
- 5 – 1 ac. Replicates
  - Cut & Burn
  - Herbicide & Burn
  - Commercial Clearcut
  - Silvicultural Clearcut

**Stand Initiating Disturbance**

**Background Information**

- **Tornado**
  - Heavy Incomplete Stand-Scale Dist.
  - Residual overstory trees standing

- **Clearcut**
  - Stand Initiating Dist.
  - No residual trees

**Justification for Research**

Natural vs. Anthropogenic disturbance: What’s the difference?
- Public Lands: Forest Mgmt. → Ecosystem Mgmt.
- Forestry = Disturbance Engineering

Similar site/time
- 4 year difference between disturbance
- Adjacent stand/Similar site conditions
**Research Objectives**

Quantify stand characteristic differences that exist for:

- Vegetation
  - Species Composition
  - Diameter Distribution
  - Density
  - Diversity
- Coarse Woody Debris
  - CWD Density
  - CWD Volume
  - CWD Biomass

**Methods – Study Site**

- UT Forest Resources Research and Education Center (FRREC)
- Clearcut
- Silvicultural Clearcut 1-acre blocks
  - No EWP survival
  - Little LP survival
**Methods – Plot Design**

- **Tornado**
  - Layout by transect lines
  - \( n = 27 \)

- **Clearcut**
  - 2 plots per 1-acre block
  - \( n = 10 \)
  - If LP present, shift to EWP side of block

**Methods – Vegetation**

- **Overstory:**
  - Trees \( \geq 4.5'' \) DBH

- **Midstory**
  - Trees 1.5'' to 4.4'' DBH

- **Understory**
  - Woody \( \geq 4' \) tall
  - Woody < 4'
  - Herbaceous

**Methods – CWD**

- **Line Intersect Method**
  - (Waddell 2002)
  - Measurement Requirements
    - Min. diameter = 5'' (12.5 cm)
    - Min. length = 3.3' (1 m)
    - Structural integrity
Methods – CWD

Diameter:
- Large end
- Small end
- Log length
- Decay class (1-5)

Methods – Analysis

Importance Values (IV)
- Rel. Dom. + Rel. Dens. = 200
- Shannon Diversity (H')
- CWD density, volume, biomass
- Non-metric Multidimensional Scaling (NMDS)

Mann-Whitney Analysis

Analysis of Similarity (ANOSIM)

α = 0.05

Results & Discussion

Species Composition: Importance Values

<table>
<thead>
<tr>
<th>Species</th>
<th>BLCH</th>
<th>BLGU*</th>
<th>DOWO</th>
<th>HICK</th>
<th>REBU*</th>
<th>Red Oaks</th>
<th>REMA</th>
<th>SMSU</th>
<th>SOWO</th>
<th>SUMA*</th>
<th>White Oaks</th>
<th>WHPI</th>
<th>YEPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tornado</td>
<td>shade tolerant spp.</td>
<td></td>
<td></td>
<td></td>
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Graph showing species composition and importance values.
Results & Discussion

Species Composition/Density: TORNADO

<table>
<thead>
<tr>
<th>Treatment</th>
<th>YEPO</th>
<th>REMA</th>
<th>BLCH</th>
<th>SOWO</th>
<th>WO</th>
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<td>Tornado (%</td>
<td>216</td>
<td>187</td>
<td>117.4</td>
<td>98.1</td>
<td>86.3</td>
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<td>(%)</td>
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1. REMA stump sprouts
2. YEPO dominance
3. WO persistence

Results & Discussion

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1. REMA stump sprouts
2. YEPO dominance
3. WO persistence
4. BLCH/SOWO: fewer small diameter trees

Results & Discussion

Diameter Distribution

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Results & Discussion

**Shannon (H') Diversity**

<table>
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<th>Clearcut</th>
<th>p-value</th>
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<tr>
<td>US &gt; 4 ft.</td>
<td>0.663</td>
<td>0.735</td>
<td>0.62</td>
</tr>
<tr>
<td>MS</td>
<td>1.337</td>
<td>1.478</td>
<td>0.20</td>
</tr>
<tr>
<td>OS*</td>
<td>1.505</td>
<td>1.995</td>
<td>0.01</td>
</tr>
<tr>
<td>MS/OS</td>
<td>1.785</td>
<td>1.646</td>
<td>0.40</td>
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Results & Discussion

**Coarse Woody Debris**

<table>
<thead>
<tr>
<th>CWD attribute</th>
<th>Tornado</th>
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<th>p-value</th>
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<tr>
<td>Volume (ft³/ac)*</td>
<td>635.9</td>
<td>155.2</td>
<td>0.0057</td>
</tr>
<tr>
<td>Density (logs/ac)*</td>
<td>108.1</td>
<td>42.4</td>
<td>0.0129</td>
</tr>
<tr>
<td>Biomass (tons/ac)*</td>
<td>0.666</td>
<td>0.089</td>
<td>0.0023</td>
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</table>

- 4.1 x greater from blown down trees
- 1.5 x greater from tree tops
- 7.5 x greater

Conclusions

**Tornado**
- Shade tolerant
- Lower stem density
- Complex, stratified structure
- More CWD

**Clearcut**
- Shade intolerant?
- Greater stem density
- Even-aged structure
- Less CWD
## Management Considerations

### Vegetation

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<td>Incomplete stand-scale disturbance – Multi-aged stand</td>
<td>Stand initiating disturbance – Even-aged stand</td>
</tr>
<tr>
<td>Complex stage of development – Accelerated succession</td>
<td>Stem exclusion stage development – Set back succession</td>
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<td>Residual canopy causes:</td>
<td></td>
</tr>
<tr>
<td>– Lower stem density</td>
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<tr>
<td>– More shade tolerant species composition</td>
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<td>(Miller et al. 2006)</td>
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Residual canopy causes:
- Lower stem density
- More shade tolerant species composition

(Miller et al. 2006)

### Coarse Woody Debris

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<td>CWD composition: large and small logs</td>
<td>CWD composition: tree tops only</td>
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Larger logs → longer decay rate (Stevens 1997)
- Longer nutrient cycling (Mattson et al. 1987, Hunter 1990)

### Research Considerations

**Limitations**
- Temporal differences exist
- Tornado → high variability
- Clearcut → less area/fewer plots

Basically...comparing two different things!

**Effects**
- Increased probability of a Type II error
- Detected differences are more powerful
Acknowledgements

Advisor: Dr. Wayne Clatterbuck
Committee: Dr. Jen Schwietzer, Dr. Callie Schwietzer, and Richard Evans
Ann Reed
John Mulhouse
Volunteers: Amy Morgan, Kelly Frady, Matthew McCollister