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

Jonathan McGrath
Department of Forestry, Wildlife and Fisheries
University of Tennessee

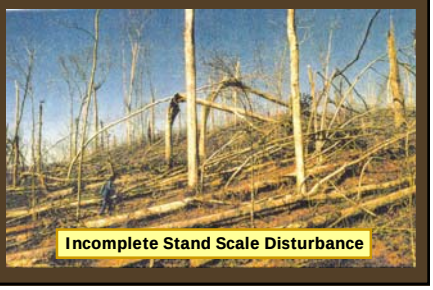
Outline

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**



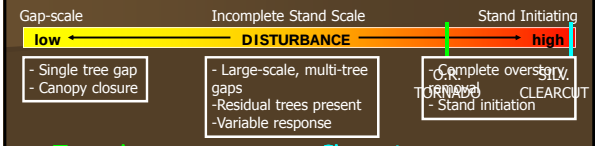
Background Information

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

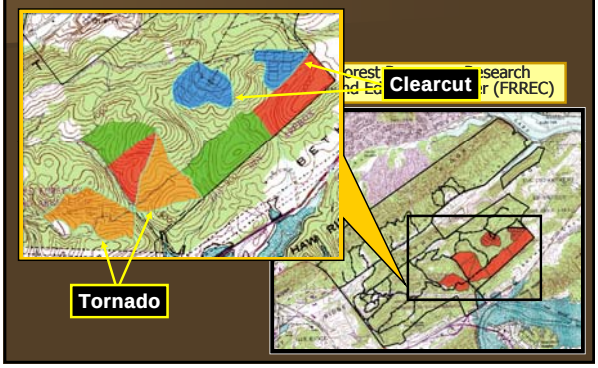
Research Objectives

Quantify stand characteristic differences that exist for:

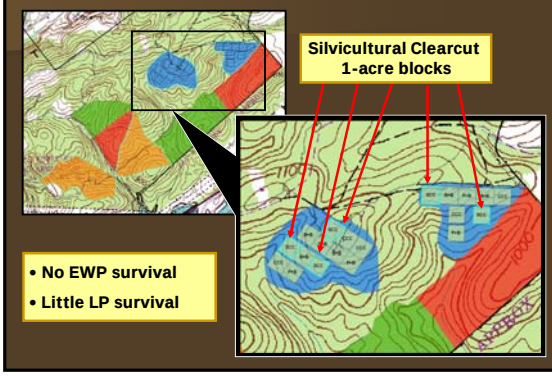
Vegetation
- Species Composition
- Diameter Distribution
- Density
- Diversity

Coarse Woody Debris
- CWD Density
- CWD Volume
- CWD Biomass

Methods – Study Site

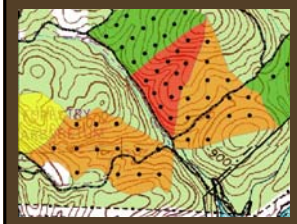


Methods – Study Site



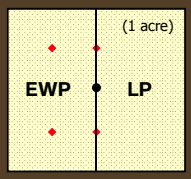
Methods – Plot Design

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

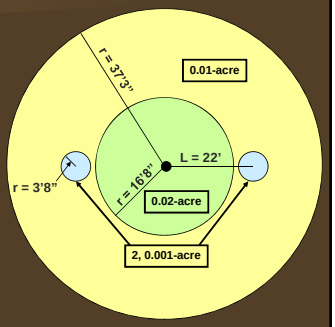


Methods – Vegetation

Overstory:
- Trees ≥ 4.5″ DBH

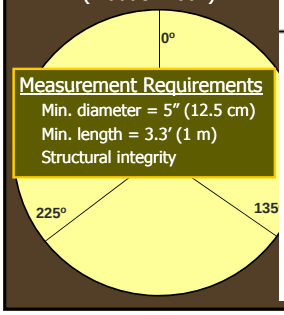
Midstory
- Trees 1.5″ to 4.4″ DBH

Understory
- Woody ≥ 4′ tall
- Woody < 4′
- Herbaceous

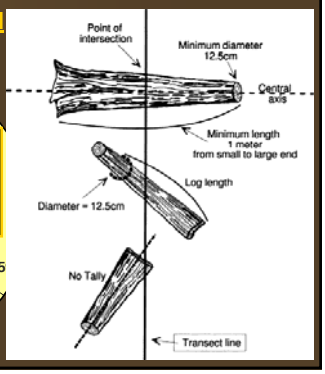


Methods – CWD

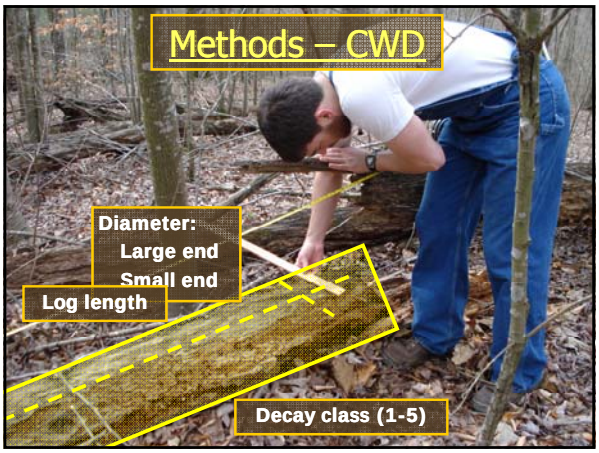
Line Intersect Method
(Waddell 2002)



Measurement Requirements
Min. diameter = 5″ (12.5 cm)
Min. length = 3.3′ (1 m)
Structural integrity



Methods – CWD



Methods – Analysis

Importance Values (IV)
– Rel. Dom. + Rel. Dens. = 200
Shannon Diversity (H')
CWD density, volume, biomass

Mann-Whitney Analysis

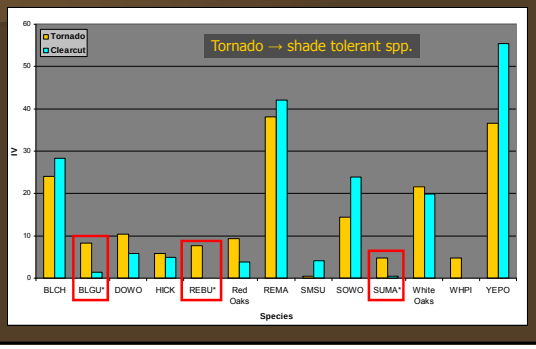
Non-metric Multidimensional Scaling (NMDS)

Analysis of Similarity (ANOSIM)

$\alpha = 0.05$

Results & Discussion

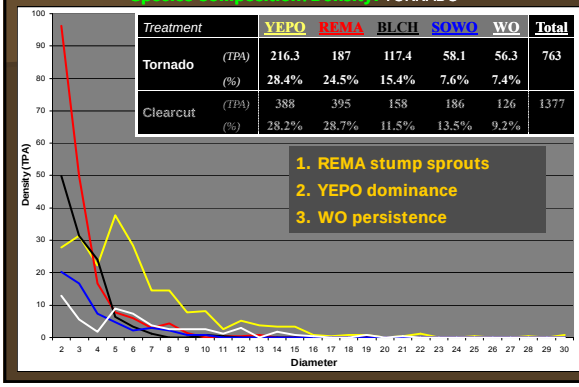
Species Composition: Importance Values



Results & Discussion

Species Composition/Density: TORNADO

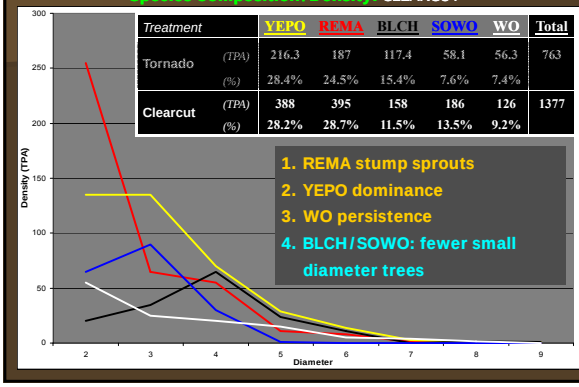
Treatment		YEPO	REMA	BLCH	SOWO	WO	Total
Tornado	(TPA)	216.3	187	117.4	58.1	56.3	763
	(%)	28.4%	24.5%	15.4%	7.6%	7.4%	
Clearcut	(TPA)	388	395	158	186	126	1377
	(%)	28.2%	28.7%	11.5%	13.5%	9.2%	



Results & Discussion

Species Composition/Density: CLEARCUT

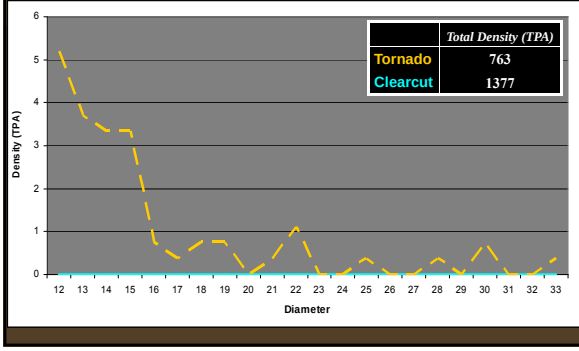
Treatment		YEPO	REMA	BLCH	SOWO	WO	Total
Tornado	(TPA)	216.3	187	117.4	58.1	56.3	763
	(%)	28.4%	24.5%	15.4%	7.6%	7.4%	
Clearcut	(TPA)	388	395	158	186	126	1377
	(%)	28.2%	28.7%	11.5%	13.5%	9.2%	



Results & Discussion

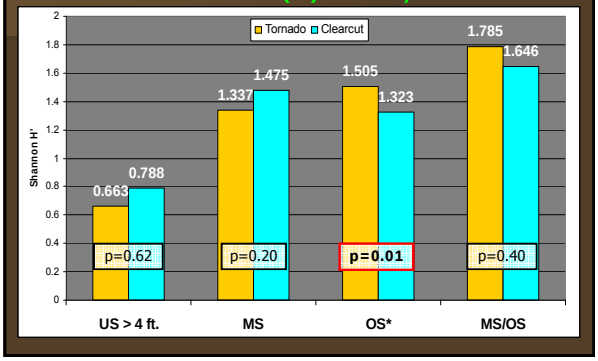
Diameter Distribution

	Total Density (TPA)
Tornado	763
Clearcut	1377



Results & Discussion

Shannon (H') Diversity



Results & Discussion

Coarse Woody Debris

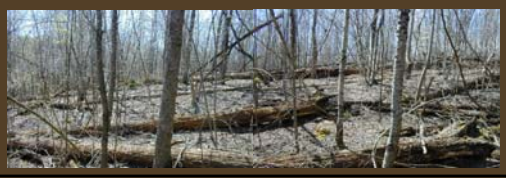
CWD attribute	**Tornado**	**Clearcut**	p-value
Volume (ft^3/ac)*	635.9	155.2	0.0057
Density (logs/ac)*	108.1	42.4	0.0129
Biomass (tons/ac)*	0.666	0.089	0.0023

4.1 x greater
From blown down trees
7.5 x greater
From tree tops

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

Tornado

- Incomplete stand-scale disturbance
  - Multi-aged stand
- Complex stage of development
  - Accelerated succession
- Residual canopy causes:
  - Lower stem density
  - More shade tolerant species composition

(Miller et al. 2006)

Clearcut

- Stand initiating disturbance
  - Even-aged stand
- Stem exclusion stage development
  - Set back succession
- 2x the density
  - better form trees
  - greater competitive = greater height growth

(Clatterbuck and Hodges 1987)

Management Considerations

Coarse Woody Debris

Tornado

CWD composition: large and small logs

Clearcut

CWD composition: tree tops only

Larger logs → longer decay rate (Stevens 1997)

- Longer nutrient cycling (Mattson et al. 1987, Hunter 1990)
- Longer habitat availability (Greenberg et al. 2001, 2003, 2004)

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

UNIVERSITY of TENNESSEE
Agricultural Experiment Station
Forest Resources Research and Education Center

Questions?