Oak Savanna and Woodland Decline...

Presently 0.029% (6,442 ac) of the original extent of oak savanna remains (Ness, 1996).

One of the most imperiled ecosystems in N.A. (Ness and Peterson, 1995)

Light reductions and resource gradient loss due to successional advance has led to widespread plant diversity losses (Reedstrom, 2004)

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Woody Encroachment and Herbaceous Layer Development

- Woody sub-canopies common, encouraged by thinning and reduce herbaceous layer
- Compete
- Alteration (Ness et al., 1999)
- Fire alone often ineffective in reducing extent (Ness et al., 1999)
- Herbaceous layer sapling density
- Growing season fires suppress woody vegetation better than dormant-season fires (Brock et al., 2000; Ness and Van Lear, 1996)
- Reducing midstory canopies has important consequences for savanna restoration (Ness et al., 1999)

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Cooperative Oak Ecosystem Restoration Project

Monitor Community Level Responses
- Woody Plants
- Herbaceous Plants
- Songbirds

Determine the efficiency of management techniques in restoring open oak ecosystems

Objectives:
- To determine any differential effects of woody midstory herbicide treatments applied after late growing-season vs. dormant-season fire on:
  1. Woody Plant Community
     - Stem Density (stems/acre)
     - Species Groups
     - Oaks, Conifer, and Others
     - Dime Class Groups
  2. Herbaceous Ground Layer
     - Richness and Diversity
     - Seed Class
     - Grasses, Forbs, and Legumes
Methods: COERP Study Sites

- Edge of Appalachian Preserve (DH TNC)
- Daniel Boone National Forest
- Green River Game Lands NCWRC
- Land Between the Lakes National Recreation Area
- Catoosa Wildlife Management Area (TWMA)

A Brief History of Catoosa WMA

- Forests established during 1920s following agricultural abandonment and logging
- History of free-range, seasonal (summer) grazing during 1930 – 40s (abundant big bluestem)
- Associated spring fires
- Southern Pine Beetle killed virtually all short-leaf 1999
- Salvage cutting initiated 2000
- Prescribed fire and the initiation of the oak savanna restoration project followed

Oak Savanna Restoration in the Mid South
Catoosa WMA Herbicide Study Stands

Legend
- Herbicide Plots
- Catoosa Roads
- Streams
- Cutler Cones (03m buffer)
- Water Divides

Legend:
- Herbicide Plots
- Catoosa Roads
- Streams
- Cutler Cones (03m buffer)
- Water Divides

- 1
- 2
Methods: Herbicide Application

- Foliar spray with backpack sprayers: 3% solution of Carson 3A (triclopyr amine)
- 1% non-ionic surfactant
- Triclopyr vs. Imazapyr
- Foliage sprayed until thoroughly wetted (not dripping)
- Target considerations

- 4.5 ft tall, <1 in DBH
- Density stump sprays that collectively added to >1 in DBH
- >5 ft tall, hedges and shrub with no solution
- A new generation stem of desirable species left untreated per plot (randomly)
- Conducted on Sept 23rd and 24th (2011) after initial fires and pre-treatment data collection

Statistical Analysis

CRD Split Plot Design with covariates:
- Whole Plot: Fire Occurrence
- Sub Plot: Herbicide

- ANOVA Models for each dependent-compare treatment means (F-test)
- Covariates:
  - Slope, Slope Position, Aspect
  - Canopy Coverage, Herbicide Use
  - Growth Traits
  - Skewness/ Kurtosis normality: $\sqrt{n}$
  - SAS PROC MIXED (SAS Inc., Cary, NC)
  - LSD mean Separation

Results: Seedling Stem Density

No herbicide or burn/canopy effects
Consistent year effect
Results: Sapling Stem Density

A difference of 250 stems/acre

ANOVA P-Value Table: Highlighted Effects
Dependent Covariates H*Y T*Y H*T*Y
Oaks None 0.0039 0.0039 0.0039
Oak Competitors None 0.0039 0.0039 0.0039
Other Species AvgCC, Aspect 0.0039 0.0039 0.0039

Results: Sapling Stem Density

A difference of 27.4 stems/acre

ANOVA P-Value Table: Highlighted Effects
Dependent Covariates H*Y T*Y H*T*Y
Total AvgCC, BA 0.2381 0.2381 0.2381
Oak Competitors AvgCC 0.4156 0.4156 0.4156
Other Species AvgCC, BA 0.0361 0.0361 0.0361

Results: Sapling Stem Density

A difference of 5.23 stems/acre

ANOVA P-Value Table: Highlighted Effects
Dependent Covariates H T*Y H*T*Y
Total AvgCC, BA 0.0207 0.0207 0.0207
Oak Competitors AvgCC 0.4156 0.4156 0.4156
Other Species AvgCC, BA 0.0361 0.0361 0.0361
**Results: Herbaceous Response**

Diversity, Richness, %Forb, %Graminoid, %Legume

No herbicide effects

Future considerations

TTH effect on Herbicidal Treatment

**Cost Considerations**

- Recorded time/plot and chemical use/plot
- Calculated Cost/Acre

**Table:**

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Plot Averages</th>
<th>Grov. Averages</th>
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<tbody>
<tr>
<td>Labor</td>
<td>$48.80</td>
<td>$51.81</td>
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<tr>
<td>2% Spray Chemical</td>
<td>$25.32</td>
<td>$28.37</td>
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<tr>
<td>1:1 Hack-and-Squirt Chemical</td>
<td>$4.21</td>
<td>$3.95</td>
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<tr>
<td>Total</td>
<td><strong>$78.33</strong></td>
<td><strong>$84.13</strong></td>
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</tbody>
</table>

**Discussion continued...with Literature?**

- The use of herbicides is limited in oak woodland and savanna restoration...and so in research (Ladley et al., 2009; McCord, 2009; McCord and Harper, 2010)
- Effective in pine savanna management (Askey and Castellanos, 2006; Walker and Nilsson, 2006; Freeman and Jones, 2009)
- Growing-season effects as late as October...most studies on spring or no later than September first (Goury et al., 2006; Bouc and Van Leer, 1995; Waldrop and Lloyd, 1993)
- Often used for oak regeneration release (Ladley, 1995; Leitman et al., 1999)
Conclusions and Management Implications

- Midstory herbicide treatments reduced the cover and density of woody plants.
  - Herbicide reductions < 1% line alone
  - Most successful following late growing-season fire
  - Reduced longer-term changes that fire did not affect

Woody reductions occurred without harming desirable vegetation
- No effect on diversity, richness, herb cover, and legume cover
- Increased groundcover coverage, increasing fine fuels
- Reduced embers and embers

Affordable
- Future monitoring will determine if:
  - greater benefits to the herbaceous layer exist
  - the magnitude of the difference between treated and un-treated plots
  - following subsequent fire warrants the added restoration costs

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  - NCRCC
  - TNC
  - QU
  - Fire Learning Network
  - UT
  - REU
  - EIPW
  - NREES
  - Joint Fire Science Program

Major Advisers: Dr. Pat Keyser
Graduate Committee

Literature Cited:


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Questions?