2019 CFLRP Ecological Indicator Progress Report

OVERVIEW

Introduction

In 2011, the National Forest Foundation convened CFLRP participants to develop a set of national indicators. The resulting five indicators are economic impacts, fire risk and costs, collaboration, leveraged funds, and ecological condition. Data to support these five indicators comes from a number of sources, including the Treatment for Restoration Economic Analysis Toolkit, collaboration surveys conducted by NFF, and the Annual Reports.

Projects first reported on ecological indicators in 2014. Since then, the CFLRP staff in the US Forest Service Washington Office have worked with colleagues and partners to review and update to template to make improvements while maintaining a consistent protocol to 2014. The intent of the 2019 CFLRP Ecological Indicator Progress Report is to better understand your progress in advancing ecological outcomes. It is not intended to capture everything about your monitoring activities.

To aid you in filling out this report, we recommend that you read the new 2019 Guidance Document. We also recommend that you reference your past Annual Reports and your 2014 Ecological Indicator Progress Reports. For additional help, please email CFLRP@fs.fed.us.

We appreciate the time and energy you dedicate to completing this progress report. This information is critical for understanding the ecological outcomes of your work, telling the national story, supporting communication and transparency, and sharing successful approaches and practices across the nation.

Thank you!

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2019 CFLRP Ecological Indicator Progress Report

Project Name: Missouri Pine-Oak Woodland Restoration Project

State: Missouri

FIRE REGIME

Narrative - *Note: All boxes in this template will scroll, so you have as much space as you need.*

1. Did you make any changes to your desired condition(s) for fire regime as compared to the 2014 Ecological Indicator Report? Please briefly describe:

Yes ☑ **No** ☐

Changes to VCC from a 3 to 2 or 1 will occur on 60% (75,466 acres) of the NFS acres. Shift VCC 3 to 1 on approximately 32% (40,464 acres) of the landscape and FRCC 3 to 2 on approximately 28% (35,000 acres) of the NFS acres.

2. Did you make any changes to your monitoring methodologies for fire regime as compared to the 2014 Ecological Indicator Report? Please briefly describe:

Yes ☐ **No** ☑

3. Did you use any new or updated baseline data for evaluating your fire regime progress for the purposes of this report? Please briefly describe:

Yes ☐ **No** ☑

4. Did your projects experience any unanticipated developments that positively or negatively affected expected progress towards your desired conditions for fire regime? (e.g. wildfire in the project area, litigation outcome, change in collaborative participation, etc.)

No.

5. What were the most difficult barriers or challenges you experienced in progressing towards your desired conditions for fire regime? If you adapted to address these challenges please provide a brief description of how.

Accomplishing burns within 2-5 year intervals with limited burn windows and fire personnel capacity, while fire targets for the forest increase annually. When burn units are not burned in the appropriate intervals, conditions remain in restoration phase, and do not move towards maintenance phase.

6. Did you include the effects of treatments on areas adjacent to the active treatment area? Yes ☐ No ☑

If yes, please briefly describe your methodology for including these adjacent acres, and describe any work conducted across land ownership in support of desired conditions for fire regime.

No.

Desired Conditions

*In this report, the term "**desired conditions**" refers to landscape and resource conditions (as defined collaboratively by stakeholders and land managers) that you are seeking to achieve and maintain for your CFLRP landscape over the next 10+ years. Desired conditions are outcome-driven not output-driven, and should link to your project's CFLRP proposal while being measurable. (Note: The term "desired condition" is used somewhat differently in the Forest Service's Land Management Planning Process. In that context, it is not time bound, and often represents long-term social, economic and ecological goals, while the term "objective" is used to represent specific, measurable and time-bound benchmarks to be achieved while working toward desired conditions in a forest plan area.) In this report, the term "**landscape**" refers to the landscape identified in your CFRLP project proposal or in subsequently-approved proposal edits. See cover page for links to guidance.*

7. Project-scale Desired Conditions Target for Fire Regime:

79 % change (relative to the desired condition) occurs across 47 % of the project areas by 10/30/2019

100 % change (relative to the desired condition) occurs across 60 % of the project areas by 10/30/2023

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

The total prescribed fire footprint to date is approximately 59,620 acres of the planned 75,466 acres within the 126,388 acres of NFS acres in the CFLRP project area (This does not include maintenance burns which would equal 181,620 acres to date). Seventy-nine percent (59,620 acres of prescribed fire/75,466 acres of planned prescribed fire units) of the project area has moved toward desired fire regime across Forty-seven

Example: Treatments in the project area result in a 23% reduction in potential flame length.
Example: 75% of all prescribed burn projects meet prescription objectives as quantified in burn plan.

8. Landscape-scale Desired Conditions Target for Fire Regime:

74 % change (relative to the desired condition) occurs across 32 % of the landscape area by 10/30/2019

100 % change (relative to the desired condition) occurs across 32 % of the landscape area by 10/30/2023

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

The Missouri Pine-Oak Woodland Restoration landscape is 345,710 acres. Forest Service is 126,044 acres and State, TNC and the Pioneer Forest equal to 150,335 acres within the CFLRP landscape. The MoPWR partners had identified up to approximately 115,860 acres of restoration activities, mainly prescribed fire but some mechanical. To date approximately 21,000 acres is under active fire management on non-Forest

Examples: Modeled ecological departure indicates that forest vegetation is restored to Vegetation Condition Class 1 with low fire hazard across 51% (105,183 acres) of the CFLR landscape; Fuel models indicate reduced likelihood of supporting a stand replacing fire across 8.5% of the CFLR landscape (73,000 acres); Fire-adapted landscapes transition from shrub-dominant understory fuel model to a grass/forb dominant understory fuel model across 50% of the CFLR landscape.

9. Please select the broader goals that are central to your desired condition(s) for fire regime for the Project-scale (P) and Landscape-scale (L) :

P	L	
☑	☑	Reduced risk/likelihood of uncharacteristic wildfires (high severity, widespread, high mortality, active crown fire/crown fire initiation)
☑	☑	Re-establish natural fire regimes and move landscape to historical range of variability and/or natural range of variability
☑	☑	Restore/maintain fire dependent and tolerant species
☑	☑	Restore/maintain native species
☑	☑	Restore/maintain heterogeneity (species, size classes)
☑	☑	Increase use of prescribed fires
☐	☐	Other. Please describe:

10. Please select the key outcomes you are hoping to achieve on the landscape through attainment of the broader goals you selected above:

- ☑ Increase options/opportunities for managers to control/manage wildfires
- ☑ Protect communities and high valued resources/reduce risk of loss
- ☑ Protection of water quality/supply
- ☑ Public and firefighter safety
- ☑ Reduced fire supression costs and avoided costs
- ☐ Other. Please describe:

11. Given these goals, please state the evaluation metric(s) you are using to monitor progress towards your desired conditions for fire regime for this report. Note: This evaluation metric is something you are measuring or counting to monitor fire regime change. It has a unit of measurement attached to it.

Grid Inventory plots,
FQI plots (31 in Cane Ridge, 100 in PIneknot) Reference 2019 Cane Ridge Floristic Quality Assessment Report and 2019 Pineknot Floristic Quality

Examples of fire regime evaluation metrics: basal area in square feet per acre (for tree density), quadratic mean diameter in inches (for tree sizes), litter and duff depths in centimeters (for fire hazard), percent canopy cover (for opennesss), fuels treatment effectiveness, tons of fuel loads removed (for fire hazard), avoided costs

Data and Methodology

12. Select the type(s) of monitoring you used to assess Project-scale (P) and Landscape-scale (L) progress towards fire regime desired conditions for this report. Select all that apply:

P	L	
☑	☑	**Baseline Data Collection** (i.e. was data collected prior to treatment to be used for later comparison?)
☑	☑	**Accomplishment Reporting** (i.e. was progress tracked using acres and miles reported?)
☑	☑	**Implementation Monitoring** (i.e. were the treatments implemented as prescribed?)
☑	☑	**Effectiveness Monitoring** (i.e. were treatments effective at meeting the stated objectives?)
☐	☐	**Effectiveness Monitoring Pilot Study** (i.e. was a trial run conducted to assess considerations of crafting an effectiveness monitoring plan?)
☐	☐	**Ecological Impacts Monitoring** (i.e. were there any unforeseen ecological consequences that could compromise treatment success?
☐	☐	**Other.** Please describe:

13. Select the methodologies used to assess Project-scale (P) and Landscape-scale (L) progress towards fire regime desired conditions for this report. Select all that apply and provide a brief description for each:

P	L	
☐	☐	Field-based sampling/plots:
☐	☐	Remote sensing: ☐LiDAR ☐Aerial photography ☐ NAIP ☐ Landsat ☐ Other:
☐	☐	Treatments implemented (e.g. acres or miles accomplished):
☐	☐	Modeling (include type and indicators used):
☑	☑	Measuring a reduction in the fire risk index: Reference Wildfire Risk Index Pilot Project 2019
☑	☐	Observation/expert opinion: Reported in FACTS
☑	☐	Fuels treatment effectiveness: FTEM
☐	☐	GIS analysis:
☐	☐	Other:

14. Where is the data that is being used for monitoring Project-scale (P) and Landscape-scale (L) progress toward fire regime desired conditions being stored? Select the databases categories that apply and provide a description of the specific datasets being used. Include links if available:

P	L	
☐	☐	FSVeg:
☐	☐	Forest Inventory and Analysis (FIA):
☑	☑	Fuels Treatment Effectiveness Report Database: In FTEM since 2014.
☐	☐	GNN:
☐	☐	VMap:
☐	☐	Feat-Firemon Integrated Database:
☑	☑	FACTS (please select performance measure): ☑ FP-FUELS-NON-WUI ☑ FP-FUELS-WUI ☑ FOR-VEG-EST ☑ FOR-VEG-IMP ☐ OTHER:
☐	☐	Local database:
☐	☐	Inspection reports/contract record:
☑	☑	Other: Grid Plots

Project-scale scoring

From the beginning, CFLRP intended to shift towards desired conditions at the landscape-scale. As the disturbances and processes of interest occur at a landscape-scale, we need a landscape-scale assessment. It's a challenge to look at the impacts at that scale, given the scale itself as well as time delays (e.g. it takes more time to shift outcomes at landscape-scale than project-scale). While landscape-scale is the focus, project-scale assessments allow projects to bring in their monitoring data and look at treatment outcomes.

Each management action funded through CFLRP will have its own project-level objectives that are designed to contribute to achieving desired conditions at larger scales. Project-scale scoring should reflect how well the results of an individual management activity met the objectives for that project. Individual projects may not meet every desired condition of the CFLRP project. Project-scale scoring is conducted by the multi-party monitoring group following completed management activities.

An individual activity might not need to lead to a fully restored acre, but if it sets the landscape up for the next treatment it may still get a good rating. For example if a successful thinning doesn't restore a fire regime, but it sets up landscape for subsequent burns that might, it could still receive a "Green" rating. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 75% or more of our CFLRP project areas.
- **Yellow** = Expected progress is being made towards desired conditions across 26% - 74% of our CFLRP project areas.
- **Red** = Expected progress is being made towards desired conditions across 25% or less of our CFLRP project areas.

Ecological Indicator	Green, Yellow, or Red score and % of the CFLRP project areas resulting in measurable progress as defined above	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Fire Regime	Green 37%, Yellow 63%	Yes

Please briefly describe how you calculated your score.

Green - All treatment units where over-story and mid-story mechanical treatments have been completed within prescribed fire units that have been completed at least once and stand structure is ranges between 30 to 90 basal area and 30 to 80 percent canopy for open and closed woodlands (21,597 acres of mid-story/over-story treatments with one or more prescribed fires/59,620 acres of prescribed fire acres completed to date). Yellow - All prescribed fire acres

Scoring for National Reporting

Landscape-scale scoring

Few (if any) CFLRP-funded Landscapes propose to meet every proposed desired condition on every acre or achieve landscape-scale objectives through the mechanical treatment of every acre within their landscape boundary. Rather, multiple projects with multiple objectives (fire risk reduction, wildlife habitat improvement, stream restoration, etc.) should facilitate meeting these broader objectives. Scoring at the landscape-scale reflects the degree to which individual Landscapes are moving towards Desired Conditions at broader spatial extent. Landscape-scale scoring is conducted by the multi -party monitoring group at each Landscape.

"Expected progress" will be defined using 10-year benchmarks for FY 2010 projects and 8-year benchmarks for FY 2012 projects for each desired condition based on a percentage of the lifetime outcome specified for the landscape in each proposal. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 36 % of our CFLRP landscape area.
- **Yellow** = Expected progress is being made towards desired conditions across 32 % of our CFLRP landscape area.
- **Red** = Expected progress is being made towards desired conditions across 32 % of our CFLRP landscape area.

Ecological Indicator	Green, Yellow, or Red score and % of the landscape across which progress is being made towards desired conditions	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Fire Regime	Green 36%, Yellow 32%, Red 32%	Yes

Please briefly describe how you decided on the percentage thresholds used above for the scoring categories and how you calculated your score.

Green - All treatment units where over-story and mid-story mechanical treatments have been completed within prescribed fire units that have been completed at least once and stand structure is ranges between 30 to 90 basal area and 30 to 80 percent canopy for open and closed woodlands (45,597 acres of mid-story/over-story treatments with one or more prescribed fires/115,860 acres of prescribed fire acres completed to date) It is assumed that all the non-FS restoration acre meet desired conditions for open and closed woodlands. Yellow - All prescribed fire acres with out any mid-story or over-story mechanical treatments (38,023 acres of prescribe fire only/115,860 acres of prescribed fire completed to date).

2019 CFLRP Ecological Indicator Progress Report

Project Name: Missouri Pine-Oak Woodland Restoration | State: Missouri

WATERSHED CONDITION

Narrative - *Note: All boxes in this template will scroll, so you have as much space as you need.*

☑ If watershed condition is not part of your CFLRP proposal and landscape restoration strategy, please let us know by checking this box.

1. Did you make any changes to your desired condition(s) for watershed condition as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☐

2. Did you make any changes to your monitoring methodologies for watershed condition as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☐

3. Did you use any new or updated baseline data for evaluating your watershed condition progress for the purposes of this report? Please briefly describe: **Yes** ☐ **No** ☐

4. Did your projects experience any unanticipated developments that positively or negatively affected expected progress towards your desired conditions for watershed condition? (e.g. wildfire in the project area, litigation outcome, change in collaborative participation, etc.)

5. What were the most difficult barriers or challenges you experienced in progressing towards your desired conditions for watershed condition? If you adapted to address these challenges please provide a brief description of how.

6. Are you using the Priority Watershed(s) identified through the Watershed Condition Framework to focus CFLRP watershed restoration work and monitoring for this report? Yes ☐ No ☐ Our CFLRP does not have Priority Watersheds ☐

If no, please briefly describe why you are not using the Priority Watersheds:

If yes, is there a Watershed Restoration Action Plan (WRAP) developed for the Priority Watershed(s)? Yes ☐ No ☐

7. Our Priority Watershed(s)of focus for this report cover ☐ % of the CFLRP landscape

8. Please select up to three conditions in each category for why it was chosen as a Priority (these are available in the WCATT entry):

Category 1: Resource Values

- ☐ Wilderness
- ☐ Wild and Scenic River
- ☐ Experimental Watershed
- ☐ Municipal Watershed
- ☐ Outstanding Resource Water
- ☐ Species protection area
- ☐ Class 1 Air Shed
- ☐ Other:

Category 2: Concerns and Threats

- ☐ Water Quality
- ☐ Water Quantity
- ☐ Riparian Structure and Function
- ☐ Species Habitat
- ☐ Wildfire Risk
- ☐ Invasive Species
- ☐ Other:

Category 3: Opportunities

- ☐ Improve Condition
- ☐ Maintain Condition
- ☐ Potential Partnership
- ☐ Non-NFS Land Collaboration
- ☐ Larger Scale Restoration
- ☐ Leverage FS funds
- ☐ Socio-economic
- ☐ Other:

Desired Conditions

*In this report, the term "**desired conditions**" refers to landscape and resource conditions (as defined collaboratively by stakeholders and land managers) that you are seeking to achieve and maintain for your CFLRP landscape over the next 10+ years. Desired conditions are outcome-driven not output-driven, and should link to your project's CFLRP proposal while being measurable. (Note: The term "desired condition" is used somewhat differently in the Forest Service's Land Management Planning Process. In that context, it is not time bound, and often represents long-term social, economic and ecological goals, while the term "objective" is used to represent specific, measurable and time-bound benchmarks to be achieved while working toward desired conditions in a forest plan area.) In this report, the term "**landscape**" refers to the landscape identified in your CFRLP project proposal or in subsequently-approved proposal edits. See cover page for links to guidance.*

9. Project-scale Desired Conditions Target for Watershed Condition:

[ ] % change (relative to the desired condition) occurs across [ ] % of the project areas by [ ]

[ ] % change (relative to the desired condition) occurs across [ ] % of the project areas by [ ]

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

[ ]

Examples: Over 50% of roads that will be used for activities in project areas have received or are planned for BMPs; Over 170 acres of riparian area are improved and floodplain reconnected, 2 miles of stream are restored, and dam removal results in 13 miles of fish passage.

10. Landscape-scale Desired Conditions Target for Watershed Condition:

[ ] % change (relative to the desired condition) occurs across [ ] % of the landscape area by [ ]

[ ] % change (relative to the desired condition) occurs across [ ] % of the landscape area by [ ]

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

[ ]

Examples: 50% of the essential projects identified in the watershed WRAP are implemented; Watershed Condition Classification indicates that 14 of the 17 subwatersheds (82% of the CFLRP Landscape Area) are in Condition Class 1 (Properly Functioning); The Watershed Condition Classification for the fire regime and wildfire indicators are improved for 17% of the landscape (30% of the expected treatment area).

11. Please select the indicator(s) below related to watershed condition that you are trying to affect to achieve your quantifiable desired condition(s):

- ☐ Water quality
- ☐ Water quantity
- ☐ Aquatic habitat (fragmentation, woody debris, channel shape and function)
- ☐ Aquatic biota (life-form presence, native species, exotic/invasive species)
- ☐ Improve riparian/wetland vegetation condition
- ☐ Roads and trails (road density, road maintenance, proximity to water, mass wasting)
- ☐ Soils (erosion, productivity, contamination)
- ☐ Fire regime and wildfire (fire condition class, wildfire effects)
- ☐ Forest cover
- ☐ Rangeland vegetation
- ☐ Terrestrial invasive species (extent and rate of spread)
- ☐ Forest health (insects and disease, ozone)
- ☐ Other. Please describe:

12. **Please select the actions you are implementing to work towards your desired condition(s):**

- ☐ Road decommissioning
- ☐ Road maintenance and/or improvement
- ☐ Trail maintenance and/or improvement
- ☐ Mechanical thinning
- ☐ Prescribed fire/controlled burn
- ☐ Culvert replacement
- ☐ Reintroduction of native species
- ☐ Removal of exotic/invasive species
- ☐ Other. Please describe:

13. Please state the evaluation metric(s) you are using to monitor progress towards your desired conditions for watershed condition. Note: This evaluation metric is something you are measuring or counting to monitor watershed condition. It has a unit of measurement attached to it.

Examples of evaluation metrics: Fine sediment volume (mL), fine sediment weight (g), basal area in square feet per acre (for tree density), number of woody debris pieces in a specific size class per stream mile (for fish habitat), stream flow rate (liters/sec), miles of road decommissioned (miles), fish population (number of fish per sweep).

Data and Methodology

14. Select the <u>methodologies</u> used to assess Project-scale (P) and Landscape-scale (L) progress towards watershed condition desired conditions in this report. Select all that apply and provide a brief description for each:

P	L	
☐	☐	National BMP monitoring (protect water quality):
☐	☐	Streambed coring:
☐	☐	Float method (water flow):
☐	☐	Current meter (water flow):
☐	☐	Fish occupancy/use surveys:
☐	☐	Ground-based photo points or photo plots:
☐	☐	Aerial surveys, aerial photography, or remote sensing:
☐	☐	GIS analysis:
☐	☐	Treatments implemented (e.g. acres or miles accomplished) used as proxy for monitoring outcomes:
☐	☐	Modelling used as proxy for monitoring outcomes:
☐	☐	Other:

15. Where is the the data that is being used for monitoring Project-scale (P) and Landscape-scale (L) progress toward watershed condition being stored? Select the <u>database</u> categories that apply and provide a description of the specific <u>datasets</u> being used. Include <u>links</u> if available:

P	L	
☐	☐	GIS database:
☐	☐	County database:
☐	☐	State database:
☐	☐	Tribal database:
☐	☐	Citizen Science database:
☐	☐	Watershed Classification and Assessment Tracking Tool (WCATT):
☐	☐	USFS database of record (e.g. FACTS, WIT, WorkPlan, etc.): *please select performance measure from the table below*
☐	☐	Other:

Performance Measure Shorthand	Description	Database	P	L
BIO-NRG	Green tons from small diameter and low value trees removed from NFS lands and made available for bio-energy production	TIM	☐	☐
FOR-VEG-EST	Acres of forest vegetation established	FACTS	☐	☐
FOR-VEG-IMP	Acres of forestland vegetation improved	FACTS	☐	☐
FP-FUELS-NON-WUI	Acres of hazardous fuels treated outside the wildland/urban interface (WUI) to reduce the risk of catastrophic wildland fire	FACTS	☐	☐
FP-FUELS-WUI	Acres wildland/urban interface (WUI) high-priority hazardous fuels treated to reduce the risk of catastrophic wildland fire	FACTS	☐	☐
HBT-ENH-LAK	Acres of lake habitat restored or enhanced	WIT	☐	☐
HBT-ENH-STRM	Miles of stream habitat restored or enhanced	WIT	☐	☐
HBT-ENH-TERR	Acres of terrestrial habitat restored or enhanced	WIT	☐	☐
INVPLT-NXWD-FED-AC	Highest priority acres treated annually for noxious weeds and invasive plants on NFS lands	FACTS	☐	☐
INVSPE-TERR-FED-AC	Highest priority acres treated for invasive terrestrial & aquatic species on NFS lands	FACTS	☐	☐
RD-DECOM-NON-SYS	Miles of road decommissioned (non-system)	WIT	☐	☐
RD-DECOM-SYS	Miles of road decommissioned (system)	ROADS	☐	☐
RD-HC-IMP	Miles of high clearance system roads improved	ROADS	☐	☐

Performance Measure Shorthand	Description	Database	P	L
RD-HC-MAIN	Miles of high clearance system roads receiving maintenance	ROADS	☐	☐
RD-PC-IMP	Miles of road reconstruction and capital improvement	ROADS	☐	☐
RD-PC-MAIN	Miles of system roads receiving maintenance	ROADS	☐	☐
RG-VEG-IMP	Acres of rangeland vegetation improved	FACTS	☐	☐
S&W-RSRC-IMP	Acres of water or soil resources protected, maintained or improved to achieve desired watershed conditions	WIT	☐	☐
SP-NATIVE-FED-AC	Number of priority acres treated annually for native pests on Federal lands	FAD	☐	☐
STRM-CROS-MITG-STD	Number of stream crossings constructed or reconstructed to provide for aquatic organism passage	WIT	☐	☐
TL-IMP-STD	Miles of system trail improved	TRAILS	☐	☐
TL-MAINT-STD	Miles of system trail maintained	TRAILS	☐	☐
TMBR-SALES-TRT-AC	Acres of forestlands treated using timber sales	FACTS	☐	☐
TMBR-TRT	Acres of forestlands treated to achieve healthier conditions	FACTS	☐	☐
WTRSHD-CLS-IMP-NUM	# of watersheds moved to an improved condition class or sustained in properly functioning condition (Class 1)	WCATT	☐	☐

16. Please describe why the datasets or performance measures you selected in Question 15 above are appropriate for assessing progress towards your watershed desired conditions.

Project-scale scoring

From the beginning, CFLRP intended to shift towards desired conditions at the landscape-scale. As the disturbances and processes of interest occur at a landscape-scale, we need a landscape-scale assessment. It's a challenge to look at the impacts at that scale, given the scale itself as well as time delays (e.g. it takes more time to shift outcomes at landscape-scale than project-scale). While landscape-scale is the focus, project-scale assessments allow projects to bring in their monitoring data and look at treatment outcomes.

Each management action funded through CFLRP will have its own project-level objectives that are designed to contribute to achieving desired conditions at larger scales. Project-scale scoring should reflect how well the results of an individual management activity met the objectives for that project. Individual projects may not meet every desired condition of the CFLRP project. Project-scale scoring is conducted by the multi-party monitoring group following completed management activities.

An individual activity might not need to lead to a fully restored acre, but if it sets the landscape up for the next treatment it may still get a good rating. For example if a successful thinning doesn't restore a fire regime, but it sets up landscape for subsequent burns that might, it could still receive a "Green" rating. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 75% or more of our CFLRP project areas.
- **Yellow** = Expected progress is being made towards desired conditions across 26% - 74% of our CFLRP project areas.
- **Red** = Expected progress is being made towards desired conditions across 25% or less of our CFLRP project areas.

Ecological Indicator	Green, Yellow, or Red score and % of the CFLRP project areas resulting in measurable progress as defined above	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Watershed Condition		

Please briefly describe how you calculated your score.

Scoring for National Reporting

Landscape-scale scoring

Few (if any) CFLRP-funded Landscapes propose to meet every proposed desired condition on every acre or achieve landscape-scale objectives through the mechanical treatment of every acre within their landscape boundary. Rather, multiple projects with multiple objectives (fire risk reduction, wildlife habitat improvement, stream restoration, etc.) should facilitate meeting these broader objectives. Scoring at the landscape-scale reflects the degree to which individual Landscapes are moving towards Desired Conditions at broader spatial extent. Landscape-scale scoring is conducted by the multi - party monitoring group at each Landscape.

"Expected progress" will be defined using 10-year benchmarks for FY 2010 projects and 8-year benchmarks for FY 2012 projects for each desired condition based on a percentage of the lifetime outcome specified for the landscape in each proposal. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across ____ % of our CFLRP landscape area.
- **Yellow** = Expected progress is being made towards desired conditions across ____ % of our CFLRP landscape area.
- **Red** = Expected progress is being made towards desired conditions across ____ % of our CFLRP landscape area.

Ecological Indicator	Green, Yellow, or Red score and % of the landscape across which progress is being made towards desired conditions	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Watershed Condition		

Please briefly describe how you decided on the percentage thresholds used above for the scoring categories and how you calculated your score.

2019 CFLRP Ecological Indicator Progress Report

Project Name: Missouri Pine-Oak Woodland Restoration State: Missouri

FISH & WILDLIFE HABITAT

Narrative - *Note: All boxes in this template will scroll, so you have as much space as you need.*

☑ If wildlife habitat is not part of your CFLRP proposal and landscape restoration strategy, please let us know by checking this box.

☐ If fish habitat is not part of your CFLRP proposal and landscape restoration strategy, please let us know by checking this box.

1. Did you make any changes to your desired condition(s) for fish & wildlife habitat as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☑

2. Did you make any changes to your monitoring methodologies for fish & wildlife habitat as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☑

3. Did you use any new or updated baseline data for evaluating your fish & wildlife habitat progress for the purposes of this report? Please briefly describe: **Yes** ☐ **No** ☐

?

4. Did your projects experience any unanticipated developments that positively or negatively affected expected progress towards your desired conditions for fish and wildlife habitat? (e.g. wildfire in the project area, litigation outcome, change in collaborative participation, etc.)

No

5. What were the most difficult barriers or challenges you experienced in progressing towards your desired conditions for fish and wildlife habitat? If you adapted to address these challenges please provide a brief description of how.

Achieving the desired prescribed fire effects (severity) to achieve the desired vegetative conditions.

6. Did you include the effects of treatments on areas adjacent to the active treatment area? Yes ☐ No ☑
If yes, please briefly describe your methodology for including these adjacent acres, and describe any work conducted across land ownership in support of fish & wildlife habitat.

Desired Conditions

*In this report, the term "**desired conditions**" refers to landscape and resource conditions (as defined collaboratively by stakeholders and land managers) that you are seeking to achieve and maintain for your CFLRP landscape over the next 10+ years. Desired conditions are outcome-driven not output-driven, and should link to your project's CFLRP proposal while being measurable. (Note: The term "desired condition" is used somewhat differently in the Forest Service's Land Management Planning Process. In that context, it is not time bound, and often represents long-term social, economic and ecological goals, while the term "objective" is used to represent specific, measurable and time-bound benchmarks to be achieved while working toward desired conditions in a forest plan area.) In this report, the term "**landscape**" refers to the landscape identified in your CFRLP project proposal or in subsequently-approved proposal edits. See cover page for links to guidance.*

7. Project-scale Desired Conditions Target for Fish & Wildlife Habitat:

67 % change (relative to the desired condition) occurs across 69 % of the project areas by 09/30/2019

100 % change (relative to the desired condition) occurs across 69 % of the project areas by 10/30/2025 *(OPTIONAL. Use if separate, additional target is needed for aquatic habitat)*

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

Improve canopy openness, reduce basal area and increase herbaceous ground cover in savanna, open and closed woodlands communities on 55% (88,000 acres, increase to matched planned restored pine, pine-oak and oak woodland communities acres) of the treated landscape. The total prescribed fire footprint to date is approximately 59,620 acres of the planned 75,466 acres, with canopy closed and basal area reduced on

Example: 50 miles of inaccessible salmon spawning habitat is made accessible by removing one dam.
Example: Stands have a basal area of 50-80 square feet/acre, which is ideal for red-cockaded woodpecker.
Example: Stands between 5,000-8,000 ft elevation are dominated by ponderosa pine, with 5-10 trees per group, and openings 0.25- 1 acre.

8. Landscape-scale Desired Conditions Target for Fish & Wildlife Habitat:

91 % change (relative to the desired condition) occurs across 70 % of the landscape area by 09/30/2019

100 % change (relative to the desired condition) occurs across 70 % of the landscape area by 10/30/2025 *(OPTIONAL. Use if separate, additional target is needed for aquatic habitat)*

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

Improve canopy openness, reduce basal area and increase herbaceous ground cover in savanna, open and closed woodlands communities on 55% (88,000 acres, increase to matched planned restored pine, pine-oak and oak woodland communities acres) of the treated landscape. he Missouri Pine-Oak Woodland Restoration landscape is 345,710 acres. Forest Service is 126,388 acres and State, TNC and the Pioneer Forest

Example: Slash pine is replaced by longleaf pine ecosystem across 5,000 acres of our CFLRP landscape.
Example: Coniferous forests across the CFLRP landscape have an average canopy cover at or above 50%.
Example: All identified inventoried aquatic organism passages at road/stream crossings that were found to be a barrier (10) are accessible for identified aquatic species at all life stages.

Habitat

9. Please select the categories of the <u>broader goals</u> related to fish & wildlife <u>habitat</u> that you are trying to achieve through your quantifiable desired condition(s):

- ☑ Open forest habitat (e.g. wider tree spacing, less mid-story vegetation)
- ☑ Grass/forb/shrub abundance and/or diversity (e.g. native or desired)
- ☐ Wildlife security (e.g. reduced disturbance and/or mortality to fish or wildlife)
- ☑ Rare or sensitive ecosystem protection and/or restoration (e.g. longleaf, bluestem, riparian, meadow, aspen or wetland habitat)
- ☑ Horizontal Complexity (e.g. "mosaic"/diversity of habitat types, patch sizes, and/or patterns)
- ☑ Vertical complexity (e.g. number of canopy layers)
- ☑ Forest structures (e.g. snags, downed wood, den trees)
- ☐ Mast-producing plant abundance and/or diversity (e.g. acorns, nuts, fruits, or berries eaten by wildlife)
- ☑ Sustainable flow of habitat age-classes through time (e.g. planning the proportion of early-, mid-, and late-seral stands)
- ☑ Habitat connectivity/availability (e.g. increased access to or availability of desired habitat)
- ☐ Aquatic habitat connectivity (e.g. culverts are passable to all aquatic organisms, no dams, stream diversions)
- ☐ Aquatic habitat complexity (e.g. downed wood, pools, riffles, etc)
- ☐ Aquatic sedimentation levels (e.g. suspended sediment or fine sediment in spawning gravels)
- ☐ Other. Please describe:

10. Please state the <u>evaluation metric(s)</u> you are using to monitor progress towards your desired conditions for fish & wildlife <u>habitat</u> for this report. Note: This evaluation metric is something you are measuring or counting to monitor habitat change. It has a unit of measurement attached to it.

Examples of habitat evaluation metrcs: basal area in square feet per acre (for tree density), number of trees per acre (for tree density), quadratic mean diameter in inches (for tree sizes), litter and duff depths in centimeters (for fire hazard), percent canopy cover (for opennesss), percent ground cover (for forage), seedling survival per acre per year (for reforestation), number of woody debris pieces in a specific size class per stream mile (for fish habitat), grass dry weight clippings used to calculate grass pounds per acre (for forage abundance)

Populations

11. Please select the categories of <u>broader goals</u> related to fish & wildlife <u>populations</u> that you are trying to achieve through your quantifiable desired condition(s). Then <u>list the specific species of interest</u> related to each category you select.

- ☐ Maintain abundance/density:
- ☑ Increase abundance/density: Bachman's sparrow, Blue-gray gnatcatcher, Chuck-Will's-widow, Field sparrow, Great Crested flycatcher , Pine w
- ☐ Decrease abundance/density:
- ☑ Maintain native species diversity:
- ☑ Increase native species diversity:
- ☑ Translocation/reintroduction: Translocation of over 100 Brown headed Nuthatch is schedule for release within the MoPWR in 2020 and
- ☐ Optimal sustained yield of game species:
- ☐ Ecosystem function/food webs:
- ☑ Spatial extent of population:
- ☐ Other. Please describe:

12. If relevant for your CFLRP project, please state the <u>evaluation metric(s)</u> you are using to monitor progress towards your desired conditions for fish & wildlife <u>populations</u>. Note: This evaluation metric is something you are measuring or counting to monitor population change. It has a unit of measurement attached to it.

The Missouri Pine-Oak Woodland Restoration Project implemented bird monitoring to 1) determine changes in abundance in response to restoration activities in the cooperative forest landscape restoration projects (CFLR) and 2) determine relationships between bird abundance and vegetation structure and composition in the Mark Twain National Forest. Objective 1 will require bird surveys spaced over the duration of the project. However, initial results from objective 2 will be available after 3 years based on the current variation in structure and management that has already taken place.
Please refer to 2013 – 2017 annual reports for details.
Melissa Roach, a University of Missouri graduate student has been monitoring bird response and has found pine- savanna and woodland

Examples of population evaluation metrics: number of wildlife encounter events per unit area via point counts or remote cameras (for wildlife usage), number of pellet groups along transects used to calculate animal density per unit area (for mammal usage), presence/absence of a plant community-associated wildlife species in the project area, presence of aquatic species as indicated by eDNA

☐ Please check this box if you are not evaluating fish & wildlife <u>populations</u>.

Data and Methodology

13. Select the <u>type(s) of monitoring</u> you used to assess Project-scale (P) and Landscape-scale (L) progress towards fish & wildlife habitat desired conditions for this report. Select all that apply.

P	L	
☑	☑	**Baseline Data Collection** (i.e. was data collected prior to treatment to be used for later comparison?)
☑	☑	**Accomplishment Reporting** (i.e. was progress tracked using acres and miles reported?)
☐	☐	**Implementation Monitoring** (i.e. were the treatments implemented as prescribed?)
☐	☐	**Effectiveness Monitoring Pilot Study** (i.e. was a trial run conducted to assess considerations of crafting an effectiveness monitoring plan?)
☑	☑	**Effectiveness Monitoring** (i.e. were treatments effective at meeting the stated objectives?)
☐	☐	**Ecological Impacts Monitoring** (i.e. were there any unforeseen ecological consequences that could compromise treatment success?)
☐	☐	**Other.** Please describe:

14. Select the <u>methodologies</u> used to assess Project-scale (P) and Landscape-scale (L) progress towards fish & wildlife habitat desired conditions for this report. Select all that apply and provide a brief description for each:

P	L	
☐	☐	Common Stand Exams (USFS procedures):
☑	☑	Understory vegetation plots or transects:
☐	☐	Fish or Wildlife occupancy/use surveys:
☐	☐	Stream surveys:
☐	☐	Remote motion-capture cameras:
☐	☐	Ground-based photo points or photo plots:
☐	☐	Aerial surveys, aerial photography, or remote sensing:
☐	☐	Treatments implemented (e.g. acres or miles accomplished):
☑	☑	Modeling (include type and whether ground-truthed):
☐	☐	GIS analysis:
☐	☐	Other:

15. Where is the the data that is being used for monitoring Project-scale (P) and Landscape-scale (L) progress toward fish & wildlife habitat desired conditions being stored? Select the <u>database</u> categories that apply and provide a description of the specific <u>datasets</u> being used. Include <u>links</u> if available:

P	L	
☐	☐	GIS database:
☐	☐	County database:
☑	☑	State database:
☐	☐	Tribal database:
☐	☐	Citizen Science database:
☐	☐	FSVeg:
☐	☐	NRIS:
☑	☑	Other USFS database of record: *please select performance measure from the table below*
☐	☐	Other:

Performance Measure Shorthand	Description	Database	P	L
BIO-NRG	Green tons from small diameter and low value trees removed from NFS lands and made available for bio-energy production	TIM	☐	☐
FOR-VEG-EST	Acres of forest vegetation established	FACTS	☐	☐
FOR-VEG-IMP	Acres of forestland vegetation improved	FACTS	☐	☐
FP-FUELS-NON-WUI	Acres of hazardous fuels treated outside the wildland/urban interface (WUI) to reduce the risk of catastrophic wildand fire	FACTS	☐	☐
FP-FUELS-WUI	Acres wildland/urban interface (WUI) high-priority hazardous fuels treated to reduce the risk of catastrophic wildland fire	FACTS	☐	☐
HBT-ENH-LAK	Acres of lake habitat restored or enhanced	WIT	☐	☐
HBT-ENH-STRM	Miles of stream habitat restored or enhanced	WIT	☐	☐
HBT-ENH-TERR	Acres of terrestrial habitat restored or enhanced	WIT	☐	☐
INVPLT-NXWD-FED-AC	Highest priority acres treated annually for noxious weeds and invasive plants on NFS lands	FACTS	☐	☐
INVSPE-TERR-FED-AC	Highest priority acres treated for invasive terrestrial & aquatic species on NFS lands	FACTS	☐	☐
RD-DECOM-NON-SYS	Miles of road decommissioned (non-system)	WIT	☐	☐
RD-DECOM-SYS	Miles of road decommissioned (system)	ROADS	☐	☐
RD-HC-IMP	Miles of high clearance system roads improved	ROADS	☐	☐

Performance Measure Shorthand	Description	Database	P	L
RD-HC-MAIN	Miles of high clearance system roads receiving maintenance	ROADS	☐	☐
RD-PC-IMP	Miles of road reconstruction and capital improvement	ROADS	☐	☐
RD-PC-MAIN	Miles of system roads receiving maintenance	ROADS	☐	☐
RG-VEG-IMP	Acres of rangeland vegetation improved	FACTS	☐	☐
S&W-RSRC-IMP	Acres of water or soil resources protected, maintained or improved to achieve desired watershed conditions	WIT	☐	☐
SP-NATIVE-FED-AC	Number of priority acres treated annually for native pests on Federal lands	FAD	☐	☐
STRM-CROS-MITG-STD	Number of stream crossings constructed or reconstructed to provide for aquatic organism passage	WIT	☐	☐
TL-IMP-STD	Miles of system trail improved	TRAILS	☐	☐
TL-MAINT-STD	Miles of system trail maintained	TRAILS	☐	☐
TMBR-SALES-TRT-AC	Acres of forestlands treated using timber sales	FACTS	☐	☐
TMBR-TRT	Acres of forestlands treated to achieve healthier conditions	FACTS	☐	☐
Other:			☐	☐
Other:			☐	☐

16. Please describe why the datasets or performance measures you selected in Question 15 above are appropriate for assessing progress towards your fish & wildlife habitat desired condition(s).

Project-scale scoring

From the beginning, CFLRP intended to shift towards desired conditions at the landscape-scale. As the disturbances and processes of interest occur at a landscape-scale, we need a landscape-scale assessment. It's a challenge to look at the impacts at that scale, given the scale itself as well as time delays (e.g. it takes more time to shift outcomes at landscape-scale than project-scale). While landscape-scale is the focus, project-scale assessments allow projects to bring in their monitoring data and look at treatment outcomes.

Each management action funded through CFLRP will have its own project-level objectives that are designed to contribute to achieving desired conditions at larger scales. Project-scale scoring should reflect how well the results of an individual management activity met the objectives for that project. Individual projects may not meet every desired condition of the CFLRP project. Project-scale scoring is conducted by the multi-party monitoring group following completed management activities.

An individual activity might not need to lead to a fully restored acre, but if it sets the landscape up for the next treatment it may still get a good rating. For example if a successful thinning doesn't restore a fire regime, but it sets up landscape for subsequent burns that might, it could still receive a "Green" rating. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 75% or more of our CFLRP project areas.
- **Yellow** = Expected progress is being made towards desired conditions across 26% - 74% of our CFLRP project areas.
- **Red** = Expected progress is being made towards desired conditions across 25% or less of our CFLRP project areas.

Ecological Indicator	Green, Yellow, or Red score and % of the CFLRP project areas resulting in measurable progress as defined above	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Fish and Wildlife Habitat	Yellow, 67%	Yes

Please briefly describe how you calculated your score.

Improve canopy openness, reduce basal area and increase herbaceous ground cover in savanna, open and closed woodlands communities on 55% (88,000 acres, increase to matched planned restored pine, pine-oak and oak woodland communities acres) of the treated landscape. The total prescribed fire footprint to date is approximately 59,620 acres of the planned 75,466 acres, with canopy closed and basal area reduced on 21,597 acres of these acres. Seventy-nine percent

Scoring for National Reporting

Landscape-scale scoring

Few (if any) CFLRP-funded Landscapes propose to meet every proposed desired condition on every acre or achieve landscape-scale objectives through the mechanical treatment of every acre within their landscape boundary. Rather, multiple projects with multiple objectives (fire risk reduction, wildlife habitat improvement, stream restoration, etc.) should facilitate meeting these broader objectives. Scoring at the landscape-scale reflects the degree to which individual Landscapes are moving towards Desired Conditions at broader spatial extent. Landscape-scale scoring is conducted by the multi -party monitoring group at each Landscape.

"Expected progress" will be defined using 10-year benchmarks for FY 2010 projects and 8-year benchmarks for FY 2012 projects for each desired condition based on a percentage of the lifetime outcome specified for the landscape in each proposal. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 91 % of our CFLRP landscape area.
- **Yellow** = Expected progress is being made towards desired conditions across ___ % of our CFLRP landscape area.
- **Red** = Expected progress is being made towards desired conditions across ___ % of our CFLRP landscape area.

Ecological Indicator	Green, Yellow, or Red score and % of the landscape across which progress is being made towards desired conditions	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Fish and Wildlife Habitat	Green, 91%	Yes

Please briefly describe how you decided on the percentage thresholds used above for the scoring categories and how you calculated your score.

Improve canopy openness, reduce basal area and increase herbaceous ground cover in savanna, open and closed woodlands communities on 55% (88,000 acres, increase to matched planned restored pine, pine-oak and oak woodland communities acres) of the treated landscape. he Missouri Pine-Oak Woodland Restoration landscape is 345,710 acres. Forest Service is 126,388 acres and State, TNC and the Pioneer Forest equal to 150,335 acres within the CFLRP landscape. The MoPWR partners had identified up to approximately 115,860 acres of restoration activities, mainly prescribed fire but some mechanical on MDC, TNC and Pioneer Forest. To date approximately 21,000 acres is under active fire management on non-Forest Service lands (private land prescribed fire occurs but

2019 CFLRP Ecological Indicator Progress Report

Project Name: Missouri Pine-Oak Woodland Restoration State: Missouri

INVASIVE SPECIES

Narrative - *Note: All boxes in this template will scroll, so you have as much space as you need*

☐ If invasive species is not part of your CFLRP proposal and landscape restoration strategy, please let us know by checking this box.

1. Did you make any changes to your desired condition(s) for invasive species as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☑

From 2014: Desired Condition: Control (eradicate, reduce and contain) 80% of the current mapped and inventoried non-native and invasive plant infested acres.
In 2014 there were 535 distinct populations of invasive plants have been mapped, representing 16 invasive species totaling 704 acres of infestation. From 2012 to 2014, 467 acres have been treated with herbicide application (includes 78 acres of re-treatments).
By 2018, 1,636.97 acres have inventoried (an additional 932.97 acres from 2014 inventory).

2. Did you make any changes to your monitoring methodologies for invasive species as compared to the 2014 Ecological Indicator Report? Please briefly describe: **Yes** ☐ **No** ☑

3. Did you use any new or updated baseline data for evaluating your invasive species progress for the purposes of this report? Please briefly describe: **Yes** ☐ **No** ☐

(Would we include expanded inventories, up to date 2019?)

4. Did your projects experience any unanticipated developments that positively or negatively affected expected progress towards your desired conditions for invasive species? (e.g. wildfire in the project area, litigation outcome, change in collaborative participation, etc.)

No.

5. What were the most difficult barriers or challenges you experienced in progressing towards your desired conditions for invasive species? If you adapted to address these challenges please provide a brief description of how.

Desired Conditions

*In this report, the term "**desired conditions**" refers to landscape and resource conditions (as defined collaboratively by stakeholders and land managers) that you are seeking to achieve and maintain for your CFLRP landscape over the next 10+ years. Desired conditions are outcome-driven not output-driven, and should link to your project's CFLRP proposal while being measurable. (Note: The term "desired condition" is used somewhat differently in the Forest Service's Land Management Planning Process. In that context, it is not time bound, and often represents long-term social, economic and ecological goals, while the term "objective" is used to represent specific, measurable and time-bound benchmarks to be achieved while working toward desired conditions in a forest plan area.) In this report, the term "**landscape**" refers to the landscape identified in your CFRLP project proposal or in subsequently-approved proposal edits. See cover page for links to guidance.*

6. Project-scale Desired Conditions Target for Invasive Species

66 % change (relative to the desired condition) occurs across 47 % of the project areas by 09/30/2019

100 % change (relative to the desired condition) occurs across 47 % of the project areas by 09/30/2021

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

Desired Condition: Control (eradicate, reduce and contain) 80% of the current mapped and inventoried non-native and invasive plant infested acres. There has been 5,193 acres of treatments (this includes more than one treatment on infested acres of primary chemical, mechanical and or cultural treatments). For the purpose of this exercise, the project area is represented by the gross inventoried acres which equal to 3,447

Example: Cogongrass is reduced to less than 25% cover.
Example: Using the prevention protocols on all projects, no new invasive species infestations are established.

7. Landscape-scale Desired Conditions Target for Invasive Species:

66 % change (relative to the desired condition) occurs across 3 % of the landscape area by 09/30/2019

100 % change (relative to the desired condition) occurs across 3 % of the landscape area by 09/30/2021

Please include 1-5 *quantifiable* desired condition statements upon which the above target is based:

Invasive inventory is not available for any other public or private lands within the landscape area at this time. At least one treatment have occurred on 2,276 acres (does not include re treatments) of the 3,447 gross acres of inventoried populations representing a 66% change (2276/3447). The landscape is defined by the 3,447 acres of the 126,388 acres of NFS lands with the CFLRP area.

Example: The increase in coverage of Leafy Spurge and Rush Skeletonweed is prevented on 500 acres of sensitive botanical habitat within our CFLRP landscape.
Example: All known populations of Yellow Star Thistle are contained along 100 miles of FS roads and trails within our CFLRP landscape.
Example: The presence of feral swine is surveyed and mapped on 500 acres within our CFLRP landscape.

8. Please select the categories of the broader goals related to invasive species that you are trying to achieve through your quantifiable desired condition(s):

- ☑ Inventory and Mapping
- ☐ Risk Assessment
- ☑ Prevention
- ☐ Maintenance at current levels
- ☑ Containment below thresholds
- ☑ Reduction
- ☑ Eradication
- ☐ Increased resilience. Recognizing *invasive species are not constrained to disturbed areas*, please describe your definition of resilience in an invasive species context:
- ☐ Other. Please describe:

9. For each invasive species you have addressed within your CFRLP landscape, please list the action(s)[1] you have taken to work towards your invasive species desired conditions, the acres and/or miles you have accomplished, and the efficacy of each action*:*
(All of the following data is reported in FACTS.)

Target Invasive Species	Action Taken	Land Ownership	Acres	Efficacy (%)
Sericea lespedeza	Herbicide Application	FS	2,176	TBD
Spotted knapweed	Herbicide Application	FS	159	100
Japanese stiltgrass	Herbicide Application	FS	335	100
Beefsteak	Herbicide Application	FS	1,479	TBD
Honeysuckles	Herbicide Application	FS	324	80
Kudzu	Fire, Mechanical, Herbicide Application	FS	189	100
Callery Pear	Herbicide Application	FS	60	TBD
Tree of Heaven	Herbicide Application	FS	4.1	100

[1] Actions taken to address an invasive species might include inventory & mapping, hand removal, mechanical removal, release of a biological control agent (an organism that kills the target species), ground-based herbicide application, aerial herbicide application, tarping, grazing, preventative weed wash stations, trapping invasive animals, etc.

10. Please briefly describe the specific negative impacts each of your target invasive species causes that you are trying to avoid. These impacts can be environmental, economic, cultural, or human/animal health-related.

> Invasive plant species negatively impact native biodiversity in all of our natural communities. Woodlands and forests infested with invasives can lose timber productivity, negatively impacting the timber industry, and timber-dependent rural communities. When spread to private lands, invasive plants impact agricultural economics by reducing quality forage, and costing landowners in management practices. Invasives negatively effect the cultural tradition of hunting wildlife species such as turkey, quail, and deer, when natural food sources are out-competed by weeds

Data and Methodology

11. Select the methodologies used to assess Project-scale (P) and Landscape-scale (L) progress towards invasive species desired conditions for this report. Select all that apply and provide a brief description of each:

P	L	
☐	☐	Aerial surveys/inventories/mapping:
☑	☑	Ground surveys/inventories/mapping:
☐	☐	Environmental sampling (wood, soil, water, infected tissue, etc.):
☑	☑	Observations of individuals:
☐	☐	Observations of damage:
☐	☐	Observation of tracks, scat, nests, etc.:
☐	☐	Trap samples:
☐	☐	eDNA:
☐	☐	Other:

12. Where is the the data that is being used for monitoring Project-scale (P) and Landscape-scale (L) progress toward invasive species desired conditions being stored? Select the databases categories that apply and provide a description of the specific datasets being used. Include links if available:

P	L	
☑	☑	GIS database:
☐	☐	County database:
☐	☐	State database:
☐	☐	Tribal database:
☐	☐	Citizen Science database:
☐	☐	Forest Inventory and Analysis (FIA) database:
☐	☑	USFS database of record (FACTS - *select performance measures*):

☑ INVPLT-NXWD-FED-AC Highest priority acres treated for noxious weeds and invasive pests ☐ INVSPE-TERR-FED-AC Highest priority acres treated for invasive terrestrial & aquatic species

P	L	
☐	☐	Other:

Project-scale scoring

From the beginning, CFLRP intended to shift towards desired conditions at the landscape-scale. As the disturbances and processes of interest occur at a landscape-scale, we need a landscape-scale assessment. It's a challenge to look at the impacts at that scale, given the scale itself as well as time delays (e.g. it takes more time to shift outcomes at landscape-scale than project-scale). While landscape-scale is the focus, project-scale assessments allow projects to bring in their monitoring data and look at treatment outcomes.

Each management action funded through CFLRP will have its own project-level objectives that are designed to contribute to achieving desired conditions at larger scales. Project-scale scoring should reflect how well the results of an individual management activity met the objectives for that project. Individual projects may not meet every desired condition of the CFLRP project. Project-scale scoring is conducted by the multi-party monitoring group following completed management activities.

An individual activity might not need to lead to a fully restored acre, but if it sets the landscape up for the next treatment it may still get a good rating. For example if a successful thinning doesn't restore a fire regime, but it sets up landscape for subsequent burns that might, it could still receive a "Green" rating. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across 75% or more of our CFLRP project areas.
- **Yellow** = Expected progress is being made towards desired conditions across 26% - 74% of our CFLRP project areas.
- **Red** = Expected progress is being made towards desired conditions across 25% or less of our CFLRP project areas.

Ecological Indicator	Green, Yellow, or Red score and % of the CFLRP project areas resulting in measurable progress as defined above	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Invasive Species	66% Yellow over 47% of the project area.	Yes

Please briefly describe how you calculated your score.

Desired Condition: Control (eradicate, reduce and contain) 80% of the current mapped and inventoried non-native and invasive plant infested acres. There has been 5,193 acres of treatments (this includes more than one treatment on infested acres of primary chemical, mechanical and or cultural treatments). For the purpose of this exercise, the project area is represented by the gross inventoried acres which equal to 3,447 gross inventoried acres, which contains 1,637

Scoring for National Reporting

Landscape-scale scoring

Few (if any) CFLRP-funded Landscapes propose to meet every proposed desired condition on every acre or achieve landscape-scale objectives through the mechanical treatment of every acre within their landscape boundary. Rather, multiple projects with multiple objectives (fire risk reduction, wildlife habitat improvement, stream restoration, etc.) should facilitate meeting these broader objectives. Scoring at the landscape-scale reflects the degree to which individual Landscapes are moving towards Desired Conditions at broader spatial extent. Landscape-scale scoring is conducted by the multi -party monitoring group at each Landscape.

"Expected progress" will be defined using 10-year benchmarks for FY 2010 projects and 8-year benchmarks for FY 2012 projects for each desired condition based on a percentage of the lifetime outcome specified for the landscape in each proposal. There may be many reasons for not scoring a "Green," including ecological and sociological considerations beyond the scope of the CFLRP project as well as recognition of unanticipated barriers or challenges. Note that scoring a "Yellow" or "Red" does not necessarily mean that work was not accomplished.

If you need to summarize scores across different desired condition targets, please refer to Guidance Document for additional instruction.

- **Green** = Expected progress is being made towards desired conditions across [ ] % of our CFLRP landscape area.
- **Yellow** = Expected progress is being made towards desired conditions across [ ] % of our CFLRP landscape area.
- **Red** = Expected progress is being made towards desired conditions across [ ] % of our CFLRP landscape area.

Ecological Indicator	Green, Yellow, or Red score and % of the landscape across which progress is being made towards desired conditions	Are you achieving your CFLRP objectives? Yes or No? If "no", briefly describe why in the box below and use the narrative section as needed.
Invasive Species	66% Yellow on 3% of the Landscape	Yes

Please briefly describe how you decided on the percentage thresholds used above for the scoring categories and how you calculated your score.

Invasive inventory is not available for any other public or private lands within the landscape area at this time. At least one treatment have occurred on 2,276 acres (does not include re treatments) of the 3,447 gross acres of inventoried populations representing a 66% change (2276/3447). The landscape is defined by the 3,447 acres of the 126,388 acres of NFS lands with the CFLRP area.

Monitoring References and Resources

1. Briefly describe any key lessons learned about integration across these 4 ecological sub-indicators.
For example, if you planned fuels reduction treatments (Fire Regime) strategically around a Priority Watershed (Watershed Condition).

Missouri Pine-oak Woodland Restoration Project contain four priority watersheds, State designated Conservation Opportunity Area and portion of Missouri Department of Conservation Priority Geography.

2. Briefly describe the roles of the parties involved in setting the desired conditions, and collecting, assessing, and sharing the data used in this report:

Central Hardwood Joint Ventures, The Nature Conservancy, NatureCite, Missouri Department of Conservation, Missouri State University, University of Missouri, Columbia, Forest Service Northern Research Station.

3. Please acknowledge the people who assisted with completing this 2019 CFLRP Ecological Indicator Report:

Bennie Terrell, Erin Yeoman, Brian Davidson

4. Please provide links to your past CFLRP monitoring reports developed by the USFS, partners, etc.:

https://www.fs.fed.us/restoration/CFLRP/results.shtml

Examples: Uncompahgre CFLRP Monitoring of Forest Spatial Patterns; Four Forest Restoration Initiative Bird Survey Report 2015

5. Please provide links to your CFLRP monitoring plans and any approved revisions (or include as an attachment):

https://oewri.missouristate.edu/big-barren-creek-watershed.htm

Examples: Colorado Front Range Multi-Party Monitoring Plan; Dinkey Landscape Ecological Monitoring Plan

6. Please provide links to technical reports or other literature utilized in determining and assessing the desired conditions used in this report:

Examples: Historical Forest Attributes of the Western Blue Mountains of Oregon; Restoring Ponderosa Pine Forests of the Colorado Front Range

Pineknot Floristic Quality Assessment Report

(18-CS-11090500-033)

SUBMITTED TO

U.S.D.A. Forest Service - Region 9 Mark Twain Nation Forest

BY

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Summary

This report is in accordance with the cost share cooperation agreement (18-CS-11090500-013) between NatureCITE (cooperator) and the USDA Forest Service – Region 9 Mark Twain National Forest. The report has been prepared from the Pineknot FACTS dataset regarding data analyses and interpretations of Floristic Quality Assessment (FQA) metrics at the site-level and for each treatment regime (No Treatment, Burn Only, Thin Only, Thin and Burn).

***Description of the report*:** Floristic Quality Assessments were conducted at the Pineknot site based on Heumann et al. (2002) sample design. The objectives of the report are to: (1) update all vascular plants and C-values from the Mark Twain Nation Forest Pineknot Site FACTS dataset according to the Missouri flora ecological checklist (Ladd and Thomas 2015), and (2) use the updated Pineknot dataset to quantify the independent and interactive effects of prescribe burning and logging on floristic quality in native shortleaf pine and mixed pine-oak woodland plant communities in southern Missouri.

***Methods*:** Prior to FQA analysis, the original dataset was updated to the current nomenclature and C-values of the Missouri Ecological Checklist (Ladd and Thomas 2015). Assessments were conducted separately at the site-level and treatment regime levels. All FQA results were generated in R computer software program developed by NatureCITE.

***Key results and conclusion*:** The combined plot data for Pineknot Site (site-level) and the Burn Only and Thin and Burn treatments had a statistically significant increase in richness from 2000 to 2014. Mean C generally declined after 2005 at the site-level and for all treatments except for a slight increase in 2015 for Thin and Burn, though none of these changes were statistically significant. Plot-by-plot comparisons will be needed to better understand the behavior of floristic quality across the site.

Introduction

Floristic Quality Assessment (FQA) has become a widely adopted and frequently used method to estimate an areas conservation value (floristic quality) based on the effects of anthropogenic disturbances and plant species composition (Mack, 2007; Matthews et al., 2009; Mabry et al., 2018). A large part of FQA popularity among conservation practitioners and ecologist is because of its ease of use, flexibility, and accuracy (Spyreas, 2014). An area's floristic quality is based on two metrics calculated by a regional species list; Mean Coefficient of Conservatism (Mean C) and Floristic Quality Index (FQI). Mean C is calculated from the combined Coefficient of Conservatism of each vascular plant species in a given area. Weedy species have low numbers (0-3) and species that are sensitive to ecological community degradation are given high numbers (7-10). Floristic Quality Index (FQI) is the product of the Mean C and the square root of the number of species present (richness).

FQA can be a powerful tool to measure a sites conservation value and its habitat degradation (Ladd and Thomas, 2015; Mabry et al., 2018; Spyreas, 2014; Swink and Wilhelm, 1994). Comparisons of FQA metrics are often complex to interpret where developing habitats at different age structures and successional stages may be taking place at a site in a given point in time (Sypreas, 2014). Additional variables such as landscape size, management regimes, treatment designs, and multiple community types can also exhibit variability in FQA scoring, resulting in confounding analysis of post-disturbance landscapes.

Another challenge with FQA is choosing which metrics can accurately measure a sites conservation value (Mabry et al., 2018; Taft et al., 2006). FQI has conclusively been shown to have very limited usefulness in predicting a site's floristic quality and biological integrity (Bried et al. 2013; Cohen et al. 2004; Fennessy and Roehrs 1997). FQI is heavily weighted by species richness, as it is directly associated in the calculation, making FQI scoring vulnerable to differences in richness. In other words, if a site is highly degraded and species rich, FQI can be artificially higher than an undisturbed natural site with few species. Furthermore, sample area (spatial scale) is largely affected by FQI (Francis et al., 2000; Rooney and Rogers, 2002; Spyreas, 2016). When comparing FQI values at two or more sites of different sizes that may otherwise have non-overlapping habitat characters and plant communities, FQI scores may not accurately represent the site's biological integrity. Because of these area-richness pitfalls, FQI values are not ideal nor the best option of use for ecological and conservation studies (Spyreas, 2014). Mean C, because it lacks these traits, is a much better indicator.

Some attempts have been made to create alternative metrics to eliminate the richness bias in FQI as well as provide insight into non-native richness. One of these widely adopted metrics is adjusted FQAI (I'), hereafter termed Adjusted FQI (Miller and Wardrop, 2006). However, Spyreas (2014) noted that Adjusted FQI performed nearly identical to Mean C and was highly correlated with one another, therefore suggesting this metric was purely redundant, and that non-standard FQA metrics require additional calculations and data manipulations that do not significantly improve the performance from standard FQA metrics. Even some studies have shown that Adjusted FQI are not as reliable in predicting floristic quality than Mean C (Forrest, 2010).

Mean C is a better predictor of floristic quality than FQI (Bried et al. 2013; Cohen et al. 2004; Fennessy and Roehrs, 1997). Because Mean C is independent of richness and spatial scale, non-subjective site comparisons can accurately be predicted and are self-reliant. Regardless of these supported assumptions, it is important to know the research methods, sample area, and sample intensity before incorporating and interpreting FQA metrics (FQI and/or Mean C) (Spyreas, 2014). Despite all the challenges researchers face in terms of assessing an areas floristic quality, quantifying plant community dynamics in post-disturbance landscapes is much more useful to management and restoration than any individual's qualitative assumptions (Sutter, 1996; Seastedt et al., 2008). Much of the achievements and influential management decisions in conservation and restoration management comes from our ability to document and monitor the changes of landscape over periods of time.

Here, we attempt to assess some of these FQA challenges when it comes to restoration efforts in shortleaf pine and mixed pine-oak woodland plant communities in southern Missouri Ozarks. Due to severe timber harvest activity and successive agricultural and/or grazing in the early 1900's, these plant communities have become highly degraded and fragmented. In many cases, shortleaf pine has become a subordinate overstory tree in a dominant matrix of mixed hardwoods (Peterson and Reich, 2001).

The loss of pineland systems in southern Missouri led The Nature Conservancy (TNC) and USDA Forest Service to development restoration campaigns and monitoring efforts of suitable pineland restoration areas (Heumann et al., 2002). The J-Pineknot (Pineknot Site hereafter) was selected out of five potential pineland restoration sites on the Mark Twain National Forest (MTNF)(Heumann et al., 2002). The project was designed to monitor plant community response to prescribed burning and logging activity implemented by the Forest Service, and to evaluate the effectiveness of management progress by utilizing Floristic Quality Assessment (FQA) variables at the site. The goal of this report is to update the nomenclature and C-values from the Pineknot Site FACTS dataset to the current Missouri flora ecological checklist (Ladd and Thomas, 2015), and use the updated dataset to infer independent and interactive effects of prescribe burning and logging on floristic quality in native shortleaf pine and mixed pine-oak woodland plant communities.

Methods

Five field seasons (2000, 2001, 2005, 2010, and 2014) of plant species sampling based on Heumann et al. (2002) plot design were conducted at the Pineknot Site. Each sampling year researchers completed vegetation sampling on the same 100 plots established by TNC in 2000. These data were compiled for FQA analysis.

Updated Species Assignments

In order to analyze the data from across the period of data collection, the data had to be converted to one consistent botanical nomenclature. The Ecological Checklist of the Missouri Flora (Ladd and Thomas, 2015) offers the most useful source. During the nomenclatural conversion of the 415 species that occurred in plots, ninety-four of the names were updated to the current nomenclature (Ladd and Thomas, 2015) (e.g. *Desmodium nudiflorum = Hylodesmum nudiflorum)*. Some data fields had "null values" in place of the scientific names but had acronym information. These individual values were either omitted completely because the acronym was entered incorrectly and could not be translated or were replaced with the correct name and included in the final analysis. Genus names without a specific epithet, though very rare, were omitted because they were not useful for FQA analysis (e.g. *Carex* sp.), except for blackberries and dewberries identified as "*Rubus* sp.". These were given a C-value of 2 and included in the FQA analysis. Given *Rubus*' ruderal behavior and that only two standard taxa were available in the dataset (*R. ablatus* [CoC = 2]; *R. flagellaris* [CoC = 3]), this was viewed as meaningful presence/absence data for FQA analysis.

Treatment Classification and FQA Data Analysis

For each sample year (2000, 2001, 2005, 2010, 2014), FQA metrics were generated at the site-level by combining data from all 100 study plots. Treatment plots were identified from the MTNF's "Treatment Regime.xlt" document and then were grouped into one of four treatments: No Treatment, Burn Only, Thin Only, and Thin and Burn. Within the managed treatments several plots received different combinations of management activity within each respective treatment type. These unique treatments were identified but not analyzed (Table 2). FQA analysis follows calculations and rationales developed by Taft et al. (1997), Swink and Wilhelm (1994), and Miller and Wardrop (2006). FQA calculations were conducted using base functions in R version 3.4.3 (R Core Team, 2017), and all generated FQA output files were saved in .csv format. Linear Regression models of native Mean C, richness, Floristic Quality Index (FQI), and Adjusted FQI were created with ggplot function of the 'ggplot2' package (Wickham, 2016). Linear regression analyses of FQA metrics across spatial scales for each treatment were assessed in Microsoft Excel (2018). Correlations between FQI and richness were also assessed.

Table 1. FQA output variables used for each measure year at the site-level and treatment regime level.

Conservatism-Based Metrics	Species Richness	Physiognomy Metrics
Total C	Native Species	Percent Trees
Native C	Non-Native Species	Percent Forbs
Total FQI = Total C(√NT)	Richness	Percent Grasses
Native FQI = Native C(√NT)		Percent Sedges
Adjusted FQI = $(\bar{C}/10 * \sqrt{N}/\sqrt{S}) * 100$		Percent Shrubs
Percent C-value – 0		Percent Vines
Percent C-value 1 – 3		Percent Ferns
Percent C-value 4 – 6		
Percent C-value 7 – 10		

Results

Updated Species Assignments & Treatment Classification

Of the 79,727 unique lines of data in the original FACTS dataset from 2000 through 2014, 76,770 values remained after nomenclature changes were updated and other irrelevant and erroneous data were omitted. A list of the updated and omitted plant species names can be viewed in Appendix A. The dataset consists of 415 plant species recorded from 2000 to 2014 at Pineknot Site (Appendix B). Of the 100 monitoring plots, 5 plots were identified as "No Treatment" (control), 7 plots "Thin Only", 34 plots "Burn Only", and 54 plots "Thin and Burn" (Table 2). The five No Treatment plots served as controls for comparison against the three management treatments. However, the three management treatments had multiple plots that received variable management activity (burning and/or logging) in different years, in different months of the year, and presumably of different intensities within their respective treatment regime (see supplementary data file "FQA_Management_Activity _Sheet_by_Plot.xlt"; Appendix F). These are labeled "Nested Unique Treatments" in Table 2. There is also a high degree of variation in plot condition (structure and composition) between plots within treatments due to widely differing histories that cannot be accounted for and that no doubt influence the FQA results. It should be noted that four plots grouped and analyzed in the Burn Only treatment did not receive any management activity until after 2014. These four plots should have probably been treated as controls and grouped into the No Treatment; however, they were lumped into the Burn Only treatment as specified in the "Treatment Regime.xlt" provided by the Forest Service. Plots were sampled in either "savannas", open woodlands, or closed woodlands. Furthermore, the scale of sampling area differed for each treatment regime because of differences in the number of plots (more plots = more area) (Table 2), thus the results of FQI or richness will be askew when comparing treatments to each other.

Table 2. Treatment regime data classification summary.

Treatment Regime	Number of Plots	Plot Identity	Number of 'Nested Unique Treatments'	Habitat	Total Sample Area
No Treatment	5	36, 89, 90, 91, 98	1	"Savanna" (n=3) Open Woodland (n=2)	62.5 m²
Thin Only	7	7, 8, 10, 11, 93, 94, 99	6	"Savanna" (n=4) Open Woodland (n=2) Closed Woodland (n=1)	87.5 m²
Burn Only	34	1, 2, 5, 13, 16, 17, 18, 19, 24, 27, 30, 33, 34, 37, 38, 41, 42, 43, 45, 50, 53, 54, 55, 61, 63, 70, 72, 75, 77, 80, 86, 87, 88, 97	11	"Savanna" (n=1) Open Woodland (n=29) Closed Woodland (n=4)	425 m²
Thin and Burn	54	3, 4, 6, 9, 12, 14, 15, 20, 21, 22, 23, 25, 26, 28, 29, 31, 32, 35, 39, 40, 44, 46-49,51, 52, 56-60, 62, 64, 65-69, 71,73, 74, 76, 78, 79, 81-85, 92, 95,96, 100	21	"Savanna" (n=2) Open Woodland (n=44) Closed Woodland (n=8)	675 m²

FQA Analysis

Pineknot Site (Site-Level: with all plots combined irrespective of treatment)**:** Linear regression for the site (n = 100) showed a significant increase in overall richness ($p<0.003$; $r^2= 0.96$) from 2000 to 2014 (Fig. 1). Native species richness increased from 206 species in 2000 to 308 species in 2014, and non-native richness increased from 7 in 2000 to 17 in 2014 (Appendix C). Similarly, yearly totals of the number of plants corresponding to all C-value range classes (0, 1-3, 4-6, 7-10) increased, but the proportion of most matrix flora species (CoC = 4-6) declined (data not shown). Total Mean C (4.402) and native Mean C (4.465) were at the highest value in 2005 but declined thereafter reaching a low of 4.126 and 4.354, respectively, in 2014 (Fig. 1; Appendix C). Two metrics designed to estimate floristic quality, native FQI and Adjusted FQI showed different results where native FQI ($p<0.02$; $r^2= 0.86$) increased and Adjusted FQI ($p<0.26$; $r^2= 0.38$) decreased (Fig. 1). It is important to remember that native FQI resembles richness because it is calculated from richness, and that Adjusted FQI resembles Mean C because it is heavily weighted by Mean C. In essence, FQI and Adjusted FQI are redundant and potentially misleading derivations of richness and Mean C.

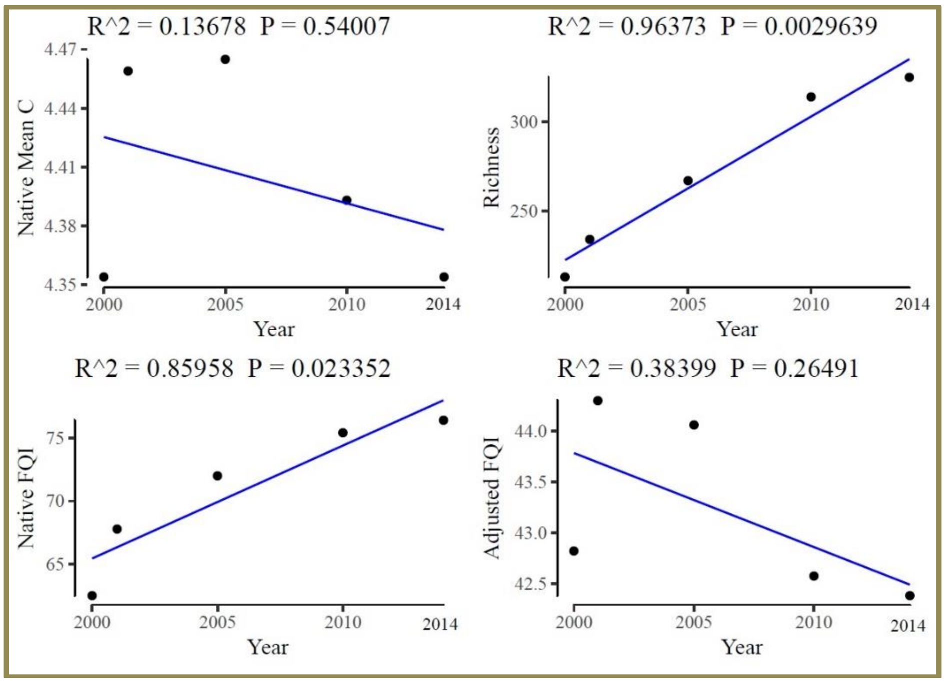

Figure 1. FQA linear regression models of Pineknot Site. Results of native Mean C, richness, native FQI, and Adjusted FQI for 2000, 2001, 2005, 2010, and 2014 (n = 100 plots). It is important to remember that Native FQI resembles richness because it is calculated from richness, and that Adjusted FQI is like Mean C because it is heavily weighted by Mean C. In essence, FQI and Adjusted FQI are redundant and potentially misleading.

***Treatments (comparing Burn Only, Thin Only, Thin and Burn, and No Treatment)*:** The FQA metrics for No Treatment varied and linear regressions show that richness, native Mean C, and native FQI were not significant or linearly correlated between years (Fig. 2; Fig. 3; Fig. 4).The Thin Only treatment showed no significant change over time in native Mean C ($p<0.95$; $r^2=0.001$) and there was only a slight (non-significant) increase in richness ($p<0.15$; $r^2=0.55$) (Fig. 2; Fig. 3). The Burn Only treatment increased in richness from 164 plant species in 2000 to 246 species by 2014 ($p<0.01$; $r^2= 0.88$). The native Mean C of the Burn Only treatment increased in 2000 (4.429) and again in 2001 (4.503) but gradually declined by 2014 (4.253)(Fig. 2; Fig. 3; Appendix D). This combined change in Mean C was not statistically meaningful. In the Thin and Burn treatment, richness and native FQI increased significantly (richness: $p<0.002$; $r^2=0.97$; native FQI: $p<0.001$; $r^2=0.98$) (Fig. 3 and Fig. 4). While not statistically meaningful, native

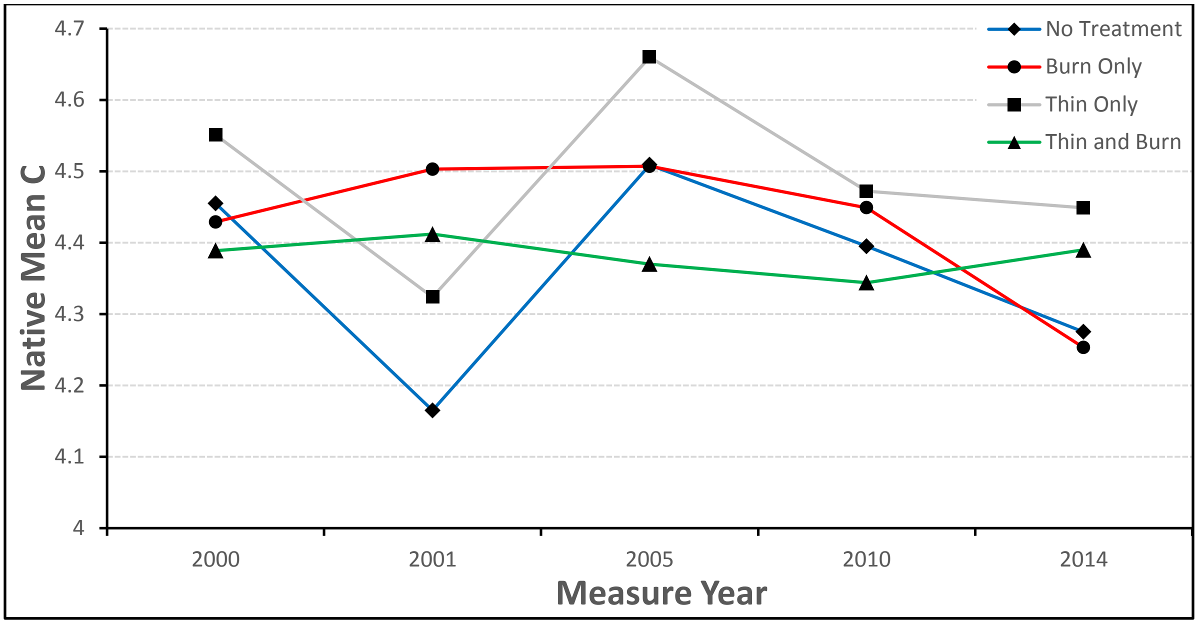

Figure 2. Change over time in native Mean C for each treatment regime. None of these changes were statistically meaningful: ***No Treatment*** (n=5 plots), $p<0.89$, $r^2=0.007$; ***Thin Only*** (n=7 plots), $p<0.95$, $r^2=0.001$; ***Burn Only*** (n=34 plots), $p<0.17$, $r^2=0.52$; and ***Thin and Burn*** (n=54 plots), $p<0.46$, $r^2=0.19$. It is important to note that because there are 1/8th to 1/10th the number of No Treatment and Thin Only plots as there are other treatments, this per treatment graph is significantly different than the combined data in Fig 1.

Mean C appears to have slightly declined after 2001 but rebounded slightly in 2014 ($p<0.47$; $r^2=0.20$) (Fig. 2). The Thin and Burn treatment had the highest increase of change in the number of non-native species (n=10) and native species (n=84) from 2000 to 2014, followed by Burn Only that gained 8 non-native species and 74 natives by 2014 (Appendix D).

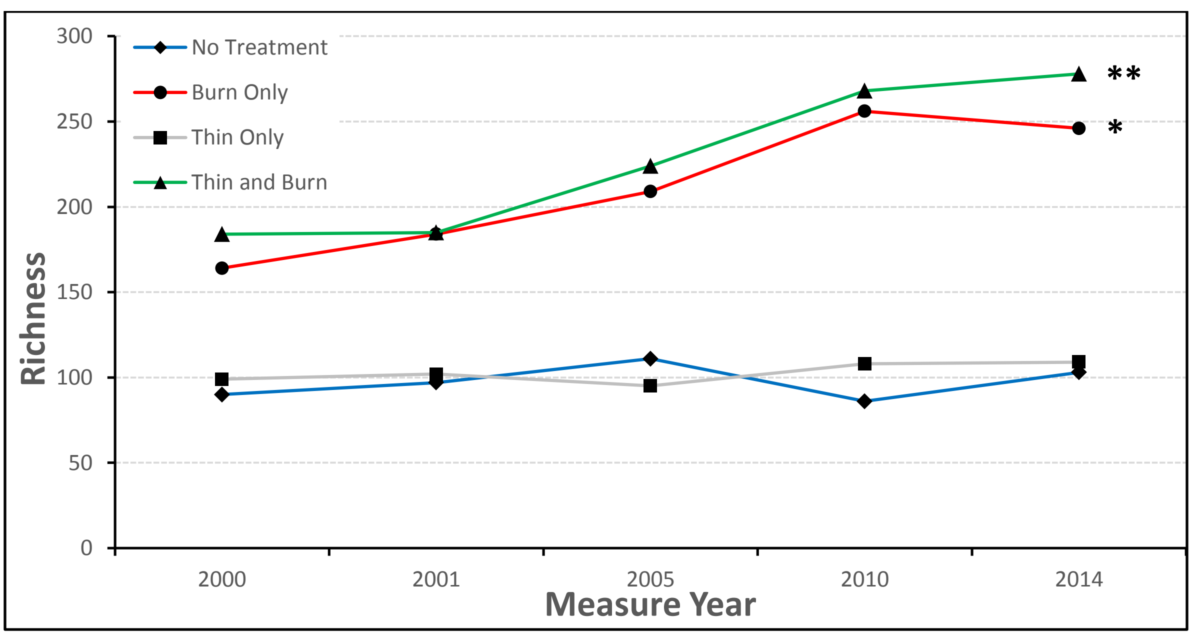

Figure 3. Change over time in richness for each treatment regime. P-values are *, **, or *** for P<0.05, 0.01, and 0.001, respectively (***No Treatment*** [n=5 plots], p<0.83, r^2=0.02; ***Thin Only*** [n=7 plots], p<0.15, r^2=0.55; ***Burn Only*** [n=34 plots], p<0.02, r^2=0.88; and ***Thin and Burn*** [n=54 plots], p<0.002, r^2=0.97). It is important to note that the initial low values for No Treatment and Thin Only plots are potentially the result of there being much fewer (1/8th to 1/10th the area of Burn Only and Thin and Burn) of these plots and thus less sampled area (richness is heavily area dependent).

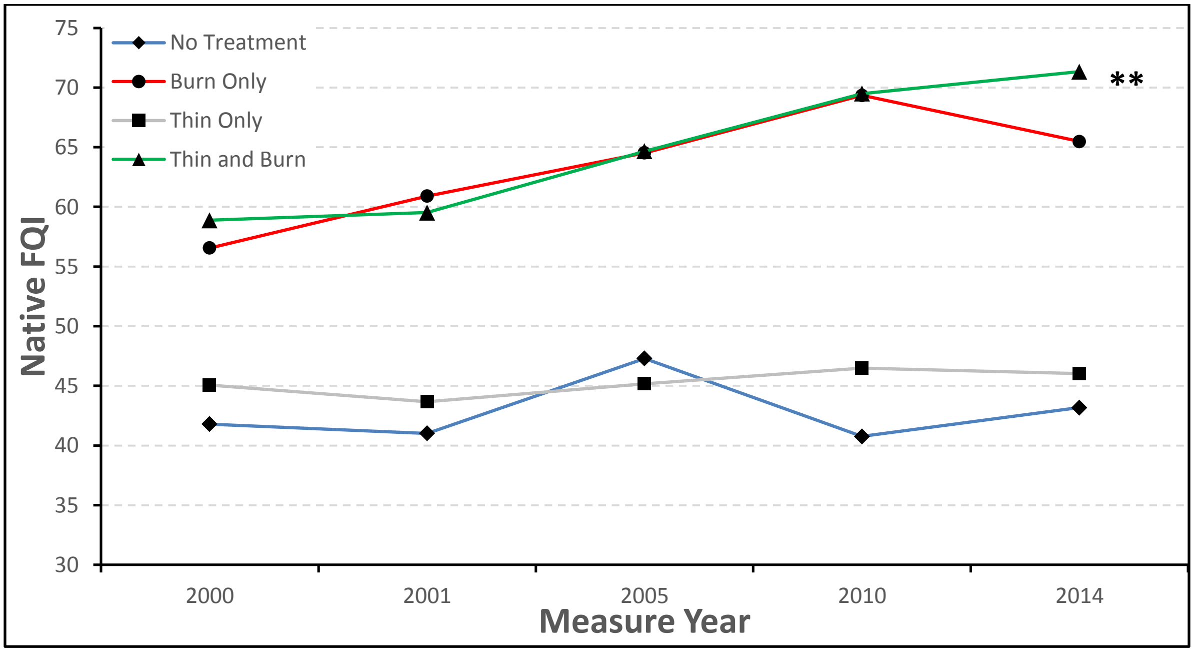

Figure 4. Change over time in native FQI for each treatment regime. P-values are *, **, or *** for P<0.05, 0.01, and 0.001, respectively (***No Treatment*** [n=5 plots], p<0.89, r^2=0.007; ***Thin Only*** [n=7 plots], p<0.11, r^2=0.62; ***Burn Only*** [n=34 plots], p<0.10, r^2=0.64; and ***Thin and Burn*** [n=54 plots], p<0.001, r^2=0.98). It is important to note that the initial low values for No Treatment and Thin Only plots are potentially the result of there being much fewer (1/8th to 1/10th the area of Burn Only and Thin and Burn) of these plots and thus less sampled area (richness is heavily area dependent).

C-value range classes (0, 1-3, 4-6, 7-10) for each treatment regime were assessed (Table 3). C-value range 4-6 had the highest number of plants observed out of all range classes for all treatments. The number of plants in all C-value range classes increased for each year in all treatments. The proportion of 1-3 and 4-6 C-value species increased the least in all treatments. The largest proportional increases were observed in the 0 and 7-10 ranges for Burn Only and Thin and Burn. In essence, the No Treatment and Thin Only plots did not have significant increases in richness, while the Burn Only and Thin and Burn treatments increased significantly in richness, however, the 0 and 7-10 categories increased more than the 1-3 and 4-6 categories.

Table 3. Total, percent, and percent difference of yearly C-value range classes for each treatment regime. Red numbers indicate annual percent losses.

Measure Year	Treatment	# CoC 0	% CoC 0	Annual % Gain/Loss 0	# CoC 1-3	% CoC 1-3	Annual % Gain/Loss 1-3	# CoC 4-6	% CoC 4-6	Annual % Gain/Loss 4-6	# CoC 7-10	% CoC 7-10	Annual % Gain/Loss 7-10
2000	Burn Only	2	1.2	0.0	45	27.4	0.0	100	61.0	0.0	17	10.4	0.0
2001	Burn Only	3	1.6	-0.6	45	24.5	-3.0	113	61.4	0.4	23	12.5	2.1
2005	Burn Only	7	3.3	0.0	51	24.4	-3.0	124	59.3	-1.6	27	12.9	2.6
2010	Burn Only	21	8.2	2.9	60	23.4	-4.0	142	55.5	-5.5	33	12.9	2.5
2014	Burn Only	18	7.3	4.1	66	26.8	-0.6	135	54.9	-6.1	27	11.0	0.6
2000	Thin and Burn	9	4.9	0.0	49	26.6	0.0	104	56.5	0.0	22	12.0	0.0
2001	Thin and Burn	8	4.3	-0.6	46	24.9	-1.8	109	58.9	2.4	22	11.9	-0.1
2005	Thin and Burn	11	4.9	0.0	64	28.6	1.9	119	53.1	-3.4	30	13.4	1.4
2010	Thin and Burn	21	7.8	2.9	70	26.1	-0.5	144	53.7	-2.8	33	12.3	0.4
2014	Thin and Burn	25	9.0	4.1	71	25.5	-1.1	142	51.1	-5.4	40	14.4	2.4
2000	Thin Only	1	1.0	0.0	21	21.2	0.0	67	67.7	0.0	10	10.1	0.0
2001	Thin Only	1	1.0	0.0	26	25.5	4.3	66	64.7	-3.0	9	8.8	-1.3
2005	Thin Only	1	1.1	0.0	19	20.0	-1.2	64	67.4	-0.3	11	11.6	1.5
2010	Thin Only	1	0.9	-0.1	24	22.2	1.0	72	66.7	-1.0	11	10.2	0.1
2014	Thin Only	4	3.7	2.7	22	20.2	-1.0	73	67.0	-0.7	10	9.2	-0.9
2000	No Treatment	2	2.2	0.0	21	23.3	0.0	59	65.6	0.0	8	8.9	0.0
2001	No Treatment	1	1.0	-1.2	28	28.9	5.5	62	63.9	-1.6	6	6.2	-2.7
2005	No Treatment	1	0.9	-2.2	25	22.5	-0.8	76	68.5	2.791	9	8.1	-0.36
2010	No Treatment	1	1.2	-3.4	18	20.9	-2.4	62	72.1	-0.18	5	5.8	-1.63
2014	No Treatment	2	1.9	-0.3	29	28.2	4.8	65	63.1	-2.4	7	6.8	-2.1

Physiognomy

Changes in physiognomy variables at the site and treatment levels were not found to be significant. They are reported in Appendix C and D.

Discussion

A relevant interpretation of the FQA analysis of the Pineknot site is complicated. On the surface, the overall increase in species richness at the site level (Fig 1) is encouraging, but intriguing patterns emerge upon deeper investigation. And, while the graphs of Mean C (Figs 1 and 2) do show fluctuations, they do not demonstrate a statistically significant change at the site or treatment levels. In order to adequately address the dynamics involved with these issues at these levels, richness and Mean C are addressed in context, separately, below. In order to do that, certain characteristics of the experimental design must be addressed first.

Experimental Design

In general, experimentation strives to assess the changes of one or few carefully controlled variables over time. It must be scaled to the variables and questions being addressed both spatially and temporally (Block et al., 2001). The plots of the Pineknot site exhibit considerable variation in initial conditions and in management histories that a lumping of plots into broad categories tends to ignore. For example, 21 of the 54 plots grouped in the Thin and Burn treatment received burning and thinning prescriptions in different years and sometimes at different seasons of the year; which is to say that each plot is experiencing different successional states in time compared to the other 33 plots. This type of variability is referred to as "nested unique treatments" in Table 2. It is also very likely that some of the plots differed substantially in terms of general ecological condition at the start of monitoring as well, though we have no way of knowing without a deeper investigation into plot specific dynamics. Nested unique treatments are also occurring for the other two management treatments as well where most Burn Only plots did not receive management activity until the spring of 2007, and out of the seven Thin Only plots, five experienced thinning prior to 1992 and two were thinned in 2007. More thorough and accurate comparisons likely occur at the plot level rather than the, somewhat, artificial treatment level. In short, while the Pineknot monitoring was well designed for a plot by plot analysis, it was not well designed, spatially or temporally, to accurately address floristic quality assessment as it relates to the four broadly defined treatment regimes. Attempting to address it at that broad scale reduces the clarity and significance of the results.

The experimental design also makes comparison of richness and FQI between treatments tenuous because the treatments have differing numbers of plots and thus consist of different quantities of area. Since richness and FQI are area sensitive, the results are relative. For example, the 50 quadrats of all 100 plots equal 1250 square meters (roughly a 35 x 35 meter area). The No Treatment plots represent 5 plots which is 5% of the area (62.5 square meter) compared to the Thin and Burn plots which total 54 in number, which is 54% of the area (675 square meters). Comparing the treatments or plots with themselves over time is not problematic, however.

Richness

Richness increased for the Pineknot Site (combined plots) as well as the Burn Only and Thin and Burn treatments. No Treatment and Thin Only treatments did not increase in richness. As mentioned in the introduction, increases in richness are not always desirable. It is necessary to investigate the qualities as well as the quantity of the species that are recruiting at a site in order to determine whether the resulting increase in richness is positive, negative, or neutral. The C-value range classes 0, 1-3, 4-6, and 7-10 all showed increases at the site scale (Table 3). At the treatment scale, Burn Only and Thin and Burn treatments saw meaningful increases (the No Treatment and Thin Only treatments did not increase or decrease significantly). These results were expected. However, the rates of increasing richness in the C-value range classes differed from each other in that the number of 0 and 7-10 species increased more, proportionally, than the number of 1-3 and 4-6 species. This would be easy to ignore but at the plot level (following the changes in each plot over time) this phenomenon is more exaggerated for some plots and non-existent in others with very few plots expressing a condition in between. When the plots are grouped by treatment, the net result is watered down by averaging and the dynamics responsible for the phenomenon, assuming it isn't just chaos, are obscured. The plot level variability likely derives from subordinate features of management (as discussed in the "Experimental Design" section above) that we are not investigating here. If this subordinate variation was investigated it would likely provide significant insight into FQA dynamics that we do not currently understand.

For reasons addressed in the second paragraph of the "Experimental Design" section above, richness is not comparable between treatments. Comparison of treatments and plots to themselves over time is not problematic, however.

Mean C (Floristic Quality)

At its inception, the hypothesized result of management of the Pineknot site was that floristic quality (Mean C) would increase with increased vascular plant species richness (Heumann et al., 2002). While richness has significantly increased in the Burn Only and Thin and Burn treatments, none of the treatments demonstrated significant increases or decreases in Mean C from 2000 to 2014 (however, as shown in Fig. 1, there was an overall increase from 2000 to 2005 followed by a precipitous decline). When we briefly analyze Mean C at the plot level, instead of the treatment level, we find that Mean C is consistently declining in about 60 percent of the treatment plots and stable or improving in about 40 percent. When the plots are combined into the somewhat artificial treatments, these differences are cancelled out and we are left with the impression that nothing changed, when it may have actually changed in two diverging fashions. As explained with richness, and as discussed in the first paragraph of the "Experimental Design" section, these results are probably better interpreted at the plot level than the treatment level and further analysis to this end would be worthwhile. It is possible that factors inherent at the plot level such as different starting conditions and the variability in season burned, fire intensity, fire frequency, time since thinning and degree of thinning are larger drivers of change than are captured in the four broad treatment categories.

Conclusions

The achievement of desired restoration goals entails high floristic quality and richness that plateau to a stable equilibrium which relates to some sort of climax community or historical remnant landscape. Quantifying the restoration success at the Pineknot Site based on each treatment regime is problematic. There are likely multiple variables at play at the plot level that need to be elucidated in order to best describe the relevant dynamics. An analysis of dominant physiognomy classes or dominant species might better describe correlations in floristic quality and management inputs. For example, shrub dominance in some systems have shown to lower species diversity and cause major changes in plant community structure (Boscutti et al., 2018; Michelle and Knapp, 2003). A study by Hajny et al. (2011) found that *Rhus glabra* populations favor low intensity spring burning in tallgrass prairies. If some ruderal shrub species (*Rhus* spp. and *Rubus* spp.) positively respond to seasonality and intensity of fire at Pineknot Site, inferences could potentially be made about plant community assemblages that relate to the site's floristic quality. Similar observations of other species could be made about responses to light availability before and after subsequent timber harvest activity.

Analyzing these data has been a valuable exercise in clarifying the properties of FQA measures in terms of the use of FQI, richness, and Mean C. These data have also proved valuable in understanding a broad perspective of landscape restoration management efforts in southern

Missouri Ozarks. By addressing the concerns above, carrying out additional data collection, and conducting a more thorough analysis beyond the scope of this report we may gain a better understanding of the behavior of floristic quality as it pertains to prescribed burning and thinning in pineland systems of southern Missouri.

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Appendix A. List of updated and omitted scientific plant names from the original dataset according to Ladd & Thomas (2015).

Original Dataset Plant Names	Updated Plant Names
Acalypha gracilens	*Acalypha monococca*
Acer rubrum	*Acer rubrum var. rubrum*
Agrostis perennans	*Agrostis perennans var. perennans*
Antennaria plantaginifolia	*Antennaria parlinii*
Antennaria plantaginifolia	*Antennaria parlinii*
Aristida dichotoma	*Aristida dichotoma var. dichotoma*
Aristolochia serpentaria	*Aristolochia serpentaria var. serpentaria*
AUPEP (acronym)	*Aureolaria pectinata*
Aureolaria flava	*Aureolaria flava var. calycosa*
Baptisia bracteata	*Baptisia bracteata var. leucophaea*
Brickellia eupatorioides	*Brickellia eupatorioides var. texana*
Carex albicans	*Carex albicans var. albicans*
Carex diandra	*Carex digitalis*
Carex microdonta	Omit
Carex muehlenbergii	*Carex muehlenbergii var. muehlenbergii*
Carex nigromarginata	*Carex nigromarginata var. nigromarginata*
Carex sp.	Omit
Carex tenera	*Carya texana*
Carya alba	*Carya tomentosa*
Ceanothus	*Ceanothus americanus*
Celtis tenuifolia	*Celtis pumila*
CHINI2 (acronym)	*Chamaecrista nictitans*
Cirsium sp.	*Cirsium altissimum*
Conyza canadensis	*Conyza canadensis var. canadensis*
Cornus alternifolia	Omit
Cornus sp.	*Cornus florida*
Crataegus engelmannii	*Crataegus berberifolia*
Crataegus sp.	Omit
Croton capitatus	*Croton capitatus var. capitatus*
Croton glandulosus	*Croton glandulosus var. septentrionalis*
Croton willdenowii	*Croton willdenowii*
Delphinium sp.	Omit
Desmanthus leptolobus	*Desmodium laevigatum*
Desmodium glutinosum	*Hylodesmum glutinosim*
Desmodium humifusum	*Desmodium x humifusum*
Desmodium nudiflorum	*Hylodesmum nudiflorum*
Dianthus deltoides	*Dichanthelium depauperatum*
Dichanthelium acuminatum	*Dichanthelium lanuginosum*
Dichanthelium boreale	*Dichanthelium bicknellii*

Dichanthelium commutatum	*Dichanthelium ashei*
Dichanthelium dichotomum	*Dichanthelium dichotomum var. barbulatum*
Dichanthelium linearifolium	*Dichanthelium linearifolium var. linearifolium*
Dichanthelium oligosanthes	*Dichanthelium oligosanthes var. scribnerianum*
DIGIT2 (acronym)	Omit
Distichlis spicata	*Dichanthelium sphaerocarpon*
Elodea canadensis	*Elymus glabriflorus*
Elymus virginicus	*Elymus glabriflorus*
Erechtites hieraciifolia	*Erechtites hieracifolius*
ERODI (acronym)	Omit
Frangula caroliniana	*Rhamnus caroliniana*
Galactia volubilis	*Galactia regularis*
GALO3 (acronym)	*Gaura longifolia*
Helianthus strumosus	*Helianthus hirsutus*
Heliopsis helianthoides	*Heliopsis helianthoides var. helianthoides*
Houstonia longifolia	*Houstonia longifolia var. tenuifolia*
Juncus tenuis	*Juncus tenuis var. tenuis*
Leersia virginica	*Leersia virginica var. virginica*
Linum medium	*Linum medium var. texanum*
Luzula bulbosa	*Luzula campestris var. multiflora*
MARAR (acronym)	*Maianthemum racemosum*
Melilotus officinalis	*Melilotus officinale*
Mimosa microphylla	*Mimosa quadrivalvis var. nuttallii*
Mimosa nuttallii	*Mimosa quadrivalvis var. nuttallii*
Monotropa hypopithys	*Monotropa hypopitys*
Obolaria virginica	Omit
Palafoxia callosa	Omit
Paspalum setaceum	*Paspalum setaceum var. ciliatifolium*
Phegopteris hexagonoptera	*Phegoteris hexagonoptera*
Phlox pilosa	*Phlox pilosa subsp. pilosa*
Physocarpus opulifolius	*Physocarpus opulifolius var. intermedius*
Physostegia angustifolia	*Physostegia virginiana subsp. praemorsa*
Physostegia virginiana	*Physostegia virginiana subsp. praemorsa*
Polygonum hydropiper	*Persicaria hydropiper*
Polygonum scandens	*Fallopia scandens*
Prunella vulgaris	*Prunella vulgaris var. lanceolata*
Quercus ellipsoidalis	*Quercus coccinea*
Ranunculus hispidus	*Ranunculus hispidus var. hispidus*
Rhus aromatica	*Rhus aromatica var. aromatica*
Rhus copallinum	*Rhus copallinum var. latifolia*
Rosa carolina	*Rosa carolina subsp. carolina*
RUBUS	*Rubus. sp.*
Rubus armeniacus	*Rubus serissimus*

Rubus flagellaris	*Rubus enslenii*
Rubus pensilvanicus	*Rubus ablatus*
RUFR4 (acronym)	*Rubus ablatus*
Salix alba	*Sassafras albidum*
Salvia azurea	*Salvia azurea var. grandiflora*
Schedonorus phoenix	*Festuca arundinacea*
Schoenoplectus etuberculatus	Omit
Scutellaria parvula	*Scutellaria parvula var. parvula*
SEPUP2 (acronym)	*Setaria glauca*
Setaria viridis	*Setaria viridis var. viridis*
Sideroxylon lanuginosum	*Sideroxylon lanuginosum subsp. oblongifolium*
Silphium integrifolium	*Silphium integrifolium var. integrifolium*
Smilax tamnoides	*Smilax hispida*
Solanum rostratum	Omit
Solidago altissima	*Solidago altissima var. altissima*
Solidago nemoralis	*Solidago nemoralis var. nemoralis*
Sphenopholis intermedia	*Sphenopholis obtusata var. major*
Sphenopholis obtusata	*Sphenopholis obtusata var. major*
Sporobolus compositus	*Sporobolus compositus var. compositrus*
Strophostyles helvola	*Strophostyles helvola var. helvola*
SYLAL7 (acronym)	*Symphyotrichum lateriflorum*
Symphyotrichum pilosum	*Symphyotrichum pilosum var. pilosum*
Teucrium canadense	*Teucrium canadense var. canadense*
Thaspium trifoliatum	*Thaspium trifoliatum var. flavum*
Triadenum walteri	Omit
Tridens flavus	*Tridens flavus var. flavus*
TRIFO (acronym)	Omit
Viola tricolor	*Viola palmata*
Viola triloba	*Viola palmata*
Vulpia octoflora	*Vulpia octoflora var. glauca*

Appendix B. List of all species encountered in the Pineknot floristic quality survey from 2000 - 2014, including Acronym, Nativity, CoC, Physiognomy traits, and life form. Nomenclature and CoC follows Ladd & Thomas (2015).

Scientific Name	Acronym	Native/Non-Native	CoC	Physiognomy	Duration
Acalypha monococca	ACAMON	native	3	forb	annual
Acalypha virginica	ACAVIR	native	2	forb	annual
Acer rubrum var. rubrum	ACERUR	native	5	tree	perennial
Actaea racemosa	ACTRAC	native	7	forb	perennial
Agalinis gattingeri	AGAGAT	native	7	forb	annual
Agalinis tenuifolia	AGATEN	native	4	forb	annual
Ageratina altissima	AGEALT	native	2	forb	perennial
Agrimonia pubescens	AGRPUB	native	4	forb	perennial
Agrimonia rostellata	AGRROS	native	4	forb	perennial
Agrostis gigantea	AGRGIG	non-native	0	grass	perennial
Agrostis hyemalis	AGRHYE	native	3	grass	perennial
Agrostis perennans var. perennans	AGRPEP	native	3	grass	perennial
Ambrosia artemisiifolia	AMBART	native	0	forb	annual
Ambrosia bidentata	AMBBID	native	0	forb	annual
Amelanchier arborea	AMEARB	native	6	tree	perennial
Amorpha canescens	AMOCAN	native	8	shrub	perennial
Amphicarpaea bracteata	AMPBRA	native	4	forb	annual
Andropogon gerardii	ANDGER	native	5	grass	perennial
Andropogon virginicus	ANDVIR	native	2	grass	perennial
Anemone virginiana	ANEVIR	native	4	forb	perennial
Antennaria parlinii	ANTPAR	native	5	forb	perennial
Apocynum cannabinum	APOCAN	native	3	forb	perennial
Arenaria serpyllifolia	ARESER	non-native	0	forb	annual
Aristida dichotoma var. dichotoma	ARIDID	native	3	grass	annual
Aristida purpurascens	ARIPUR	native	5	grass	perennial
Aristolochia serpentaria var. serpentaria	ARISES	native	6	forb	perennial
Arnoglossum atriplicifolium	ARNATR	native	4	forb	perennial
Asclepias quadrifolia	ASCQUA	native	6	forb	perennial
Asclepias verticillata	ASCVER	native	2	forb	perennial
Asimina triloba	ASITRI	native	5	tree	perennial
Asplenium platyneuron	ASPPLA	native	4	fern	perennial
Aureolaria flava var. calycosa	AURFLC	native	8	forb	perennial
Aureolaria pectinata	AURPEC	native	7	forb	annual
Baptisia bracteata var. leucophaea	BAPBRA	native	7	forb	perennial
Berchemia scandens	BERSCA	native	6	vine	perennial
Bidens bipinnata	BIDBIP	non-native	0	forb	annual
Bidens frondosa	BIDFRO	native	2	forb	annual

Boehmeria cylindrica	BOECYL	native	4	forb	perennial
Botrychium dissectum	BOTDIS	native	5	fern	perennial
Botrychium virginianum	BOTVIR	native	4	fern	perennial
Brachyelytrum erectum	BRAERE	native	5	grass	perennial
Brickellia eupatorioides var. texana	BRIEUT	native	7	forb	perennial
Bromus pubescens	BROPUB	native	5	grass	perennial
Cardamine pensylvanica	CARPEN	native	6	forb	biennial
Carduus nutans	CARNUT	non-native	0	forb	biennial
Carex albicans var. albicans	CXALBB	native	6	sedge	perennial
Carex amphibola	CXAMPH	native	3	sedge	perennial
Carex blanda	CXBLAN	native	2	sedge	perennial
Carex cephalophora	CXCEPH	native	5	sedge	perennial
Carex digitalis	CXDIGI	native	7	sedge	perennial
Carex festucacea	CXFEST	native	5	sedge	perennial
Carex glaucodea	CXGLAU	native	4	sedge	perennial
Carex hirsutella	CXHIRS	native	4	sedge	perennial
Carex intumescens	CXINTU	native	7	sedge	perennial
Carex meadii	CXMEAD	native	6	sedge	perennial
Carex muehlenbergii var. muehlenbergii	CXMUHM	native	5	sedge	perennial
Carex nigromarginata var. nigromarginata	CXNIGN	native	7	sedge	perennial
Carex retroflexa	CXRETR	native	4	sedge	perennial
Carex umbellata	CXUMBE	native	6	sedge	perennial
Carya glabra	CARGLA	native	6	tree	perennial
Carya ovalis	CAROVL	native	6	tree	perennial
Carya texana	CARTEX	native	5	tree	perennial
Carya tomentosa	CARTOM	native	5	tree	perennial
Ceanothus americanus	CEAAME	native	7	shrub	perennial
Celtis occidentalis	CELOCC	native	3	tree	perennial
Celtis pumila	CELPUM	native	6	tree	perennial
Cercis canadensis	CERCAN	native	3	tree	perennial
Chamaecrista fasciculata	CHAFAS	native	2	forb	annual
Chamaecrista nictitans	CHANIC	native	2	forb	annual
Chasmanthium latifolium	CHALAT	native	4	grass	perennial
Cinna arundinacea	CINARU	native	7	grass	perennial
Cirsium altissimum	CIRALT	native	4	forb	perennial
Cirsium carolinianum	CIRCAR	native	8	forb	biennial
Cirsium discolor	CIRDIS	native	3	forb	perennial
Clitoria mariana	CLIMAR	native	7	forb	perennial
Comandra umbellata	COMUMB	native	7	forb	perennial
Commelina erecta	COMERE	native	4	forb	perennial
Conoclinium coelestinum	CONCOE	native	3	forb	perennial
Conyza canadensis var. canadensis	CONCAC	native	0	forb	annual
Coreopsis lanceolata	CORLAN	native	5	forb	perennial

Coreopsis palmata	CORPAL	native	7	forb	perennial
Coreopsis tripteris	CORTRI	native	6	forb	perennial
Cornus drummondii	CORDRU	native	2	shrub	perennial
Cornus florida	CORFLO	native	5	tree	perennial
Corydalis flavula	CORFLA	native	3	forb	biennial
Corylus americana	CORYAM	native	4	shrub	perennial
Crataegus berberifolia	CRABER	native	4	tree	perennial
Crataegus crus-galli	CRACRU	native	3	tree	perennial
Crataegus uniflora	CRAUNI	native	7	tree	perennial
Crotalaria sagittalis	CROSAG	native	5	forb	annual
Croton capitatus var. capitatus	CROCAC	native	0	forb	annual
Croton glandulosus var. septentrionalis	CROGLA	native	1	forb	annual
Croton monanthogynus	CROMON	native	2	forb	annual
Croton willdenowii	CROWIL	native	4	forb	annual
Cunila origanoides	CUNORI	native	6	forb	perennial
Cuphea viscosissima	CUPVIS	native	4	forb	annual
Cyperus strigosus	CYPSTR	native	1	sedge	perennial
Dalea candida	DALCAN	native	8	forb	perennial
Danthonia spicata	DANSPI	native	3	grass	perennial
Daucus carota	DAUCAR	non-native	0	forb	biennial
Desmodium ciliare	DESCIL	native	5	forb	perennial
Desmodium cuspidatum	DESCUS	native	5	forb	perennial
Desmodium glabellum	DESGLA	native	3	forb	perennial
Desmodium x humifusum	DESHUM	native	8	forb	perennial
Desmodium laevigatum	DESLAE	native	7	forb	perennial
Desmodium marilandicum	DESMAR	native	5	forb	perennial
Desmodium nuttallii	DESNUT	native	7	forb	perennial
Desmodium obtusum	DESOBT	native	6	forb	perennial
Desmodium paniculatum	DESPAN	native	3	forb	perennial
Desmodium rotundifolium	DESROT	native	6	forb	perennial
Dianthus armeria	DIAARM	non-native	0	forb	annual
Dichanthelium ashei	DICASH	native	7	grass	perennial
Dichanthelium bicknellii	DICBIC	native	6	grass	perennial
Dichanthelium boscii	DICBOS	native	5	grass	perennial
Dichanthelium clandestinum	DICCLA	native	4	grass	perennial
Dichanthelium depauperatum	DICDEP	native	4	grass	perennial
Dichanthelium dichotomum var. barbulatum	DICDIB	native	6	grass	perennial
Dichanthelium lanuginosum	DICLAN	native	2	grass	perennial
Dichanthelium laxiflorum	DICLAX	native	6	grass	perennial
Dichanthelium linearifolium var. linearifolium	DICLIL	native	5	grass	perennial
Dichanthelium oligosanthes var. scribnerianum	DICOLS	native	4	grass	perennial
Dichanthelium ravenelii	DICRAV	native	7	grass	perennial

Dichanthelium sphaerocarpon	DICSPH	native	5	grass	perennial
Dichanthelium villosissimum	DICVIL	native	6	grass	perennial
Digitaria cognata	DIGCOG	native	3	grass	perennial
Digitaria ischaemum	DIGISC	non-native	0	grass	annual
Digitaria sanguinalis	DIGSAN	non-native	0	grass	annual
Diodia teres	DIODTE	native	2	forb	annual
Diodia virginiana	DIODVI	native	5	forb	perennial
Dioscorea quaternata	DIOQUA	native	5	forb	perennial
Dioscorea villosa	DIOVIL	native	5	forb	perennial
Diospyros virginiana	DIOSVI	native	3	tree	perennial
Echinacea purpurea	ECHPUR	native	5	forb	perennial
Elephantopus carolinianus	ELECAR	native	3	forb	perennial
Elymus glabriflorus	ELYGLR	native	4	grass	perennial
Elymus villosus	ELYVIL	native	4	grass	perennial
Eragrostis capillaris	ERACAP	native	3	grass	annual
Eragrostis frankii	ERAFRA	native	3	grass	annual
Eragrostis spectabilis	ERASPE	native	3	grass	perennial
Erechtites hieracifolius	EREHIE	native	1	forb	annual
Erigeron annuus	ERIGAN	native	1	forb	annual
Erigeron pulchellus	ERIPUL	native	6	forb	biennial
Erigeron strigosus	ERISTG	native	3	forb	annual
Eryngium yuccifolium	ERYYUC	native	8	forb	perennial
Euonymus alatus	EUOALA	non-native	0	shrub	perennial
Eupatorium serotinum	EUPSER	native	1	forb	perennial
Euphorbia corollata	EPHCOR	native	3	forb	perennial
Euphorbia dentata	EPHDEN	native	0	forb	annual
Fallopia scandens	FALSCA	native	3	forb	perennial
Festuca arundinacea	FESARU	non-native	0	grass	perennial
Festuca subverticillata	FESSUB	native	4	grass	perennial
Fragaria virginiana	FRAVIR	native	3	forb	perennial
Fraxinus americana	FRAAME	native	4	tree	perennial
Galactia regularis	GALREG	native	6	forb	perennial
Galium aparine	GALAPA	native	0	forb	annual
Galium arkansanum	GALARK	native	6	forb	perennial
Galium circaezans	GALCIR	native	4	forb	perennial
Galium concinnum	GALCON	native	4	forb	perennial
Galium obtusum	GALOBT	native	5	forb	perennial
Galium pilosum	GALPIL	native	6	forb	perennial
Galium triflorum	GALTRI	native	4	forb	perennial
Gamochaeta purpurea	GAMPUR	native	3	forb	annual
Gaura longiflora	GAULON	native	1	forb	biennial
Geranium maculatum	GERMAC	native	5	forb	perennial
Geum canadense	GEUCAN	native	2	forb	perennial

Gillenia stipulata	GILSTI	native	5	forb	perennial
Glandularia canadensis	GLACAN	native	5	forb	perennial
Gymnopogon ambiguus	GYMAMB	native	8	grass	perennial
Hedeoma hispida	HEDHIS	native	3	forb	annual
Hedeoma pulegioides	HEDPUL	native	4	forb	annual
Helianthus hirsutus	HELHIR	native	4	forb	perennial
Heliopsis helianthoides var. helianthoides	HELHEH	native	5	forb	perennial
Heliotropium indicum	HELIND	non-native	0	forb	annual
Heuchera americana	HEUAME	native	7	forb	perennial
Hieracium gronovii	HIEGRO	native	4	forb	perennial
Houstonia longifolia var. tenuifolia	HOULOT	native	5	forb	perennial
Hylodesmum glutinosim	HYLGLU	native	3	forb	perennial
Hylodesmum nudiflorum	HYLNUD	native	4	forb	perennial
Hypericum drummondii	HYPDRU	native	4	forb	annual
Hypericum hypericoides	HYPHYP	native	8	forb	perennial
Hypericum prolificum	HYPPRO	native	4	shrub	perennial
Hypericum punctatum	HYPPUN	native	3	forb	perennial
Ilex decidua	ILEDEC	native	5	shrub	perennial
Ionactis linariifolius	IONLIN	native	9	forb	perennial
Ipomoea pandurata	IPOPAN	native	2	forb	perennial
Juglans nigra	JUGNIG	native	4	tree	perennial
Juncus tenuis var. tenuis	JUNTET	native	0	forb	perennial
Juniperus virginiana	JUNVIR	native	2	tree	perennial
Krigia biflora	KRIBIF	native	5	forb	perennial
Krigia dandelion	KRIDAN	native	6	forb	perennial
Kummerowia stipulacea	KUMSTI	non-native	0	forb	annual
Kummerowia striata	KUMSTR	non-native	0	forb	annual
Lactuca canadensis	LACCAN	native	3	forb	biennial
Lactuca floridana	LACFLO	native	3	forb	biennial
Lactuca hirsuta	LACHIR	native	4	forb	annual
Lechea mucronata	LECMUC	native	5	forb	perennial
Lechea tenuifolia	LECTEN	native	4	forb	perennial
Leersia oryzoides	LEEORY	native	3	grass	perennial
Leersia virginica var. virginica	LEEVIV	native	4	grass	perennial
Lespedeza cuneata	LESCUN	non-native	0	forb	perennial
Lespedeza frutescens	LESFRU	native	5	forb	perennial
Lespedeza hirta	LESHIR	native	7	forb	perennial
Lespedeza procumbens	LESPRO	native	4	forb	perennial
Lespedeza repens	LESREP	native	4	forb	perennial
Lespedeza violacea	LESVIO	native	6	forb	perennial
Lespedeza virginica	LESVIR	native	5	forb	perennial
Leucanthemum vulgare	LEUVUL	non-native	0	forb	perennial
Liatris aspera	LIAASP	native	6	forb	perennial

Liatris cylindracea	LIACYL	native	7	forb	perennial
Liatris squarrulosa	LIASQL	native	8	forb	perennial
Ligusticum canadense	LIGCAN	native	8	forb	perennial
Lilium michiganense	LILMIC	native	7	forb	perennial
Lindera benzoin	LINBEN	native	5	shrub	perennial
Linum medium var. texanum	LINMED	native	5	forb	perennial
Liparis liliifolia	LIPLIL	native	7	forb	perennial
Lithospermum canescens	LITCAN	native	6	forb	perennial
Lobelia inflata	LOBINF	native	3	forb	annual
Lobelia spicata	LOBSPI	native	5	forb	perennial
Lonicera flava	LONFLA	native	7	vine	perennial
Lonicera japonica	LONJAP	non-native	0	vine	perennial
Ludwigia alternifolia	LUDALT	native	4	forb	perennial
Luzula campestris var. multiflora	LUZCAU	native	4	forb	perennial
Lysimachia lanceolata	LYSLAN	native	4	forb	perennial
Maianthemum racemosum	MAIRAC	native	4	forb	perennial
Malaxis unifolia	MALUNI	native	9	forb	perennial
Malus ioensis	MALIOE	native	3	tree	perennial
Matelea decipiens	MATDEC	native	5	forb	perennial
Melilotus officinale	MELOFF	non-native	0	forb	biennial
Menispermum canadense	MENICA	native	4	vine	perennial
Mimosa quadrivalvis var. nuttallii	MIMQUA	native	6	forb	perennial
Monarda bradburiana	MONBRA	native	5	forb	perennial
Monarda fistulosa	MONFIS	native	4	forb	perennial
Monotropa hypopitys	MONHYP	native	8	forb	perennial
Morus rubra	MORRUB	native	4	tree	perennial
Muhlenbergia schreberi	MUHSCH	native	0	grass	perennial
Muhlenbergia sobolifera	MUHSOB	native	4	grass	perennial
Muhlenbergia sylvatica	MUHSYL	native	5	grass	perennial
Muhlenbergia tenuiflora	MUHTEN	native	6	grass	perennial
Nyssa sylvatica	NYSSYL	native	5	tree	perennial
Orbexilum pedunculatum	ORBPED	native	6	forb	perennial
Oxalis dillenii	OXADIL	native	0	forb	perennial
Oxalis stricta	OXASTR	native	0	forb	perennial
Oxalis violacea	OXAVIO	native	5	forb	perennial
Packera obovata	PACOBO	native	4	forb	perennial
Panax quinquefolius	PANQUI	native	8	forb	perennial
Panicum anceps	PANANC	native	3	grass	perennial
Panicum virgatum	PANVIR	native	4	grass	perennial
Parietaria pensylvanica	PARPEN	native	3	forb	annual
Paronychia canadensis	PARCAN	native	4	forb	annual
Paronychia fastigiata	PARFAS	native	4	forb	annual
Parthenium integrifolium	PARINT	native	6	forb	perennial

Parthenocissus quinquefolia	PARQUI	native	3	vine	perennial
Paspalum setaceum var. ciliatifolium	PASSCI	native	3	grass	perennial
Passiflora incarnata	PASINC	native	2	forb	perennial
Passiflora lutea	PASLUT	native	4	forb	perennial
Penstemon pallidus	PENPAL	native	5	forb	perennial
Perilla frutescens	PERFRU	non-native	0	forb	annual
Persicaria hydropiper	PERHYR	native	3	forb	annual
Phegopteris hexagonoptera	PHEHEX	native	8	fern	perennial
Phlox divaricata	PHLDIV	native	4	forb	perennial
Phlox pilosa subsp. pilosa	PHLPIP	native	6	forb	perennial
Phryma leptostachya	PHRLEP	native	2	forb	perennial
Physalis heterophylla	PHSAHE	native	3	forb	perennial
Physalis virginiana	PHSAVI	native	3	forb	perennial
Physocarpus opulifolius var. intermedius	PHYOPU	native	5	shrub	perennial
Physostegia virginiana subsp. praemorsa	PHYVIP	native	7	forb	perennial
Phytolacca americana	PHYAME	native	2	forb	perennial
Pilea pumila	PILPUM	native	4	forb	annual
Pinus echinata	PINECH	native	5	tree	perennial
Plantago lanceolata	PLALAN	non-native	0	forb	annual
Plantago rugelii	PLARUG	native	0	forb	annual
Plantago virginica	PLAVIG	native	1	forb	annual
Platanthera lacera	PLALAC	native	6	forb	perennial
Platanus occidentalis	PLAOCC	native	3	tree	perennial
Poa pratensis	POAPRA	non-native	0	grass	perennial
Poa sylvestris	POASYL	native	5	grass	perennial
Polystichum acrostichoides	POLACR	native	5	fern	perennial
Potentilla canadensis	POTCAN	native	8	forb	perennial
Potentilla simplex	POTSIM	native	3	forb	perennial
Prenanthes altissima	PREALT	native	5	forb	perennial
Prenanthes aspera	PREASP	native	7	forb	perennial
Prunella vulgaris var. lanceolata	PRUVUA	native	1	forb	perennial
Prunus americana	PRUAME	native	4	tree	perennial
Prunus munsoniana	PRUMUN	native	5	tree	perennial
Prunus serotina	PRUSER	native	2	tree	perennial
Pseudognaphalium obtusifolium	PSEOBT	native	2	forb	annual
Ptelea trifoliata	PTETRI	native	5	shrub	perennial
Pteridium aquilinum	PTEAQU	native	4	fern	perennial
Pycnanthemum tenuifolium	PYCTEN	native	4	forb	perennial
Pycnanthemum virginianum	PYCVIR	native	6	forb	perennial
Quercus alba	QUEALB	native	4	tree	perennial
Quercus coccinea	QUECOC	native	5	tree	perennial
Quercus falcata	QUEFAL	native	6	tree	perennial
Quercus macrocarpa	QUEMAC	native	4	tree	perennial

Quercus marilandica	QUEMAR	native	4	tree	perennial
Quercus muehlenbergii	QUEMUE	native	5	tree	perennial
Quercus rubra	QUERUB	native	5	tree	perennial
Quercus stellata	QUESTE	native	4	tree	perennial
Quercus velutina	QUEVEL	native	4	tree	perennial
Ranunculus hispidus var. hispidus	RANHIH	native	6	forb	perennial
Ranunculus recurvatus	RANREC	native	5	forb	perennial
Rhamnus caroliniana	RHACAR	native	6	shrub	perennial
Rhus aromatica var. aromatica	RHUARA	native	4	shrub	perennial
Rhus copallinum var. latifolia	RHUCOP	native	2	shrub	perennial
Rhus glabra	RHUGLA	native	1	shrub	perennial
Rosa carolina subsp. carolina	ROSCAC	native	4	shrub	perennial
Rosa multiflora	ROSMUL	non-native	0	shrub	perennial
Rosa setigera	ROSSET	native	4	shrub	perennial
Rubus ablatus	RUBABL	native	2	shrub	perennial
Rubus allegheniensis	RUBALL	native	4	shrub	perennial
Rubus enslenii	RUBENS	native	5	shrub	perennial
Rubus serissimus	RUBSER	non-native	0	shrub	perennial
Rubus sp.	RUBUS	native	2	shrub	perennial
Rudbeckia hirta	RUDHIR	native	1	forb	perennial
Ruellia humilis	RUEHUM	native	3	forb	perennial
Ruellia pedunculata	RUEPED	native	5	forb	perennial
Sabatia angularis	SABANG	native	4	forb	biennial
Salix nigra	SALNIG	native	2	tree	perennial
Salvia azurea var. grandiflora	SALAZU	native	4	forb	perennial
Salvia lyrata	SALLYR	native	3	forb	perennial
Sanicula canadensis	SANICA	native	3	forb	biennial
Sanicula odorata	SANODO	native	2	forb	perennial
Sassafras albidum	SASALB	native	2	tree	perennial
Schizachyrium scoparium	SCHSCO	native	5	grass	perennial
Scleria ciliata	SCLCIL	native	8	sedge	perennial
Scleria oligantha	SCLOLI	native	8	sedge	perennial
Scleria pauciflora	SCLPAU	native	6	sedge	perennial
Scleria triglomerata	SCLTRI	native	6	sedge	perennial
Scutellaria elliptica	SCUELL	native	7	forb	perennial
Scutellaria incana	SCUINC	native	5	forb	perennial
Scutellaria parvula var. parvula	SCUPAP	native	4	forb	perennial
Senna marilandica	SENMAR	native	4	forb	perennial
Setaria glauca	SETGLA	non-native	0	grass	annual
Setaria viridis var. viridis	SETVIV	non-native	0	grass	annual
Sideroxylon lanuginosum subsp. oblongifolium	SIDLAN	native	5	tree	perennial
Silene stellata	SILSTE	native	5	forb	perennial

Silene virginica	SILVIR	native	7	forb	perennial
Silphium asteriscus	SILAST	native	7	forb	perennial
Silphium integrifolium var. integrifolium	SILINI	native	4	forb	perennial
Sisyrinchium angustifolium	SISANG	native	5	forb	perennial
Sisyrinchium campestre	SISCAM	native	5	forb	perennial
Smilax bona-nox	SMIBON	native	3	vine	perennial
Smilax ecirrhata	SMIECI	native	5	forb	perennial
Smilax glauca	SMIGLA	native	4	vine	perennial
Smilax hispida	SMIHIS	native	3	vine	perennial
Smilax pulverulenta	SMIPUL	native	6	forb	perennial
Solanum carolinense	SOLCAR	native	0	forb	perennial
Solidago altissima var. altissima	SOLALA	native	1	forb	perennial
Solidago buckleyi	SOLBUC	native	8	forb	perennial
Solidago hispida	SOLHIS	native	6	forb	perennial
Solidago juncea	SOLJUN	native	4	forb	perennial
Solidago nemoralis var. nemoralis	SOLNEN	native	2	forb	perennial
Solidago odora	SOLODO	native	8	forb	perennial
Solidago petiolaris	SOLPET	native	8	forb	perennial
Solidago radula	SOLRAD	native	6	forb	perennial
Solidago ulmifolia	SOLULM	native	4	forb	perennial
Sorghastrum nutans	SORNUT	native	4	grass	perennial
Sphenopholis nitida	SPHNIT	native	7	grass	perennial
Sphenopholis obtusata var. major	SPHOBM	native	6	grass	perennial
Sporobolus clandestinus	SPOCLA	native	5	grass	perennial
Sporobolus compositus var. compositrus	SPOCOC	native	3	grass	perennial
Sporobolus vaginiflorus	SPOVAG	native	0	grass	annual
Strophostyles helvola var. helvola	STRHEH	native	2	forb	annual
Strophostyles umbellata	STRUMB	native	3	forb	perennial
Stylosanthes biflora	STYBIF	native	5	forb	perennial
Symphoricarpos orbiculatus	SYMORB	native	1	shrub	perennial
Symphyotrichum anomalum	SYMANO	native	6	forb	perennial
Symphyotrichum lateriflorum	SYMLAT	native	3	forb	perennial
Symphyotrichum oolentangiense	SYMOOL	native	7	forb	perennial
Symphyotrichum patens	SYMPAT	native	5	forb	perennial
Symphyotrichum pilosum var. pilosum	SYMPIP	native	0	forb	perennial
Symphyotrichum turbinellum	SYMTUR	native	6	forb	perennial
Symphyotrichum urophyllum	SYMURO	native	4	forb	perennial
Taenidia integerrima	TAEINT	native	6	forb	perennial
Tephrosia virginiana	TEPVIR	native	5	forb	perennial
Teucrium canadense var. canadense	TEUCAC	native	2	forb	perennial
Thalictrum revolutum	THAREV	native	5	forb	perennial
Thalictrum thalictroides	THATHA	native	5	forb	perennial
Thaspium trifoliatum var. flavum	THATRF	native	6	forb	perennial

Toxicodendron pubescens	TOXPUB	native	7	vine	perennial
Toxicodendron radicans	TOXRAD	native	1	vine	perennial
Tradescantia longipes	TRALON	native	8	forb	perennial
Tragia betonicifolia	TRABET	native	4	forb	perennial
Trichophorum planifolium	TRIPLA	native	9	sedge	perennial
Trichostema brachiatum	TRIBRA	native	4	forb	annual
Trichostema dichotomum	TRIDIC	native	6	forb	annual
Tridens flavus var. flavus	TRIFLF	native	1	grass	perennial
Trifolium campestre	TRICAM	non-native	0	forb	annual
Trifolium repens	TRIREP	non-native	0	forb	perennial
Triodanis perfoliata	TRIPFL	native	2	forb	annual
Triticum aestivum	TRIAES	non-native	0	grass	annual
Ulmus alata	ULMALA	native	4	tree	perennial
Ulmus americana	ULMAME	native	4	tree	perennial
Ulmus rubra	ULMRUB	native	5	tree	perennial
Uvularia grandiflora	UVUGRA	native	6	forb	perennial
Vaccinium arboreum	VACARB	native	6	shrub	perennial
Vaccinium pallidum	VACPAL	native	4	shrub	perennial
Vaccinium stamineum	VACSTA	native	6	shrub	perennial
Verbascum thapsus	VERTHA	non-native	0	forb	biennial
Verbena stricta	VERSTR	native	2	forb	perennial
Verbena urticifolia	VERURT	native	2	forb	perennial
Verbesina helianthoides	VERHEL	native	5	forb	perennial
Verbesina virginica	VERBVI	native	5	forb	perennial
Vernonia arkansana	VERARK	native	7	forb	perennial
Vernonia baldwinii	VERBAL	native	2	forb	perennial
Veronica arvensis	VERARV	non-native	0	forb	annual
Viburnum rufidulum	VIBRUF	native	4	shrub	perennial
Vicia caroliniana	VICCAR	native	6	forb	perennial
Viola palmata	VIOPAT	native	5	forb	perennial
Viola pedata	VIOPEA	native	5	forb	perennial
Viola sagittata	VIOSAG	native	6	forb	perennial
Viola sororia	VIOSOR	native	2	forb	perennial
Vitis aestivalis	VITAES	native	5	vine	perennial
Vitis vulpina	VITVUL	native	5	vine	perennial
Vulpia octoflora var. glauca	VULOCG	native	2	grass	annual

Appendix C. Site-level FQA results for each measure year (2000, 2001, 2005, 2010, 2014).

Measure Year	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% trees	% forbs	% grasses	% sedges	% shrubs	% vines	% ferns
2000	4.211	4.354	206	7	213	61.461	62.497	42.822	6.103	26.761	55.869	11.268	9.9	60.1	13.6	4.2	7	2.8	2.3
2001	4.402	4.459	231	3	234	67.333	67.769	44.302	3.846	24.786	58.547	12.821	11.5	56.4	13.7	4.7	7.7	3.4	2.6
2005	4.348	4.465	260	7	267	71.052	72.002	44.065	4.869	26.217	55.056	13.858	9	61.8	12.7	4.5	6.7	3	2.2
2010	4.127	4.393	295	19	314	73.138	75.456	42.582	9.236	24.522	53.822	12.42	11.1	58.6	13.4	5.1	6.7	3.2	1.9
2014	4.126	4.354	308	17	325	74.385	76.411	42.385	9.231	25.231	51.692	13.846	8.9	62.2	13.5	4.6	5.5	3.4	1.8

Appendix D. Treatment Regime FQA results for each measure year (2000, 2001, 2005, 2010, 2014).

Measure Year	Treatment	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value = 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% Trees	% forbs	% Grasses	% Sedges	% Shrubs	% Vines	% Ferns
2000	No Treatment	4.356	4.455	88	2	90	41.32	41.787	44.048	2.222	23.333	65.556	8.889	14.4	47.8	13.3	4.4	11.1	5.6	3.3
2001	No Treatment	4.165	4.165	97	0	97	41.02	41.02	41.649	1.031	28.866	63.918	6.186	16.5	45.4	12.4	5.2	11.3	6.2	3.1
2005	No Treatment	4.468	4.509	110	1	111	47.078	47.292	44.887	0.901	22.523	68.468	8.108	13.5	48.6	14.4	6.3	9	5.4	2.7
2010	No Treatment	4.395	4.395	86	0	86	40.761	40.761	43.953	1.163	20.93	72.093	5.814	18.6	44.2	12.8	8.1	9.3	4.7	2.3
2014	No Treatment	4.233	4.275	102	1	103	42.96	43.17	42.537	1.942	28.155	63.107	6.796	16.5	51.5	9.7	6.8	8.7	5.8	1
2000	Burn Only	4.402	4.429	163	1	164	56.379	56.551	44.159	1.22	27.439	60.976	10.366	11	59.1	11.6	5.5	7.3	3.7	1.8
2001	Burn Only	4.478	4.503	183	1	184	60.746	60.912	44.905	1.63	24.457	61.413	12.5	10.9	53.8	15.2	5.4	8.2	4.3	2.2
2005	Burn Only	4.421	4.507	205	4	209	63.914	64.535	44.64	3.349	24.402	59.33	12.919	9.6	58.9	14.4	4.3	8.1	2.9	1.9
2010	Burn Only	4.223	4.449	243	13	256	67.562	69.346	43.341	8.203	23.438	55.469	12.891	10.9	58.2	13.3	5.1	7	3.9	1.6
2014	Burn Only	4.098	4.253	237	9	246	64.268	65.477	41.746	7.317	26.829	54.878	10.976	9.3	59.8	13.4	4.9	6.9	3.7	2
2000	Thin and Burn	4.293	4.389	180	4	184	58.24	58.883	43.409	4.891	26.63	56.522	11.957	10.9	58.7	14.1	3.8	7.6	3.3	1.6
2001	Thin and Burn	4.341	4.412	182	3	185	59.038	59.522	43.762	4.324	24.865	58.919	11.892	11.9	56.8	12.4	4.9	7.6	4.3	2.2
2005	Thin and Burn	4.272	4.37	219	5	224	63.942	64.668	43.208	4.911	28.571	53.125	13.393	10.7	60.3	12.1	4.5	6.7	3.6	2.2
2010	Thin and Burn	4.149	4.344	256	12	268	67.926	69.5	42.454	7.836	26.119	53.731	12.313	11.2	57.8	14.9	4.9	6.7	3	1.5
2014	Thin and Burn	4.169	4.39	264	14	278	69.512	71.332	42.782	8.993	25.54	51.079	14.388	8.6	61.5	14	5	6.1	3.2	1.4
2000	Thin Only	4.505	4.551	98	1	99	44.825	45.053	45.28	1.01	21.212	67.677	10.101	15.2	48.5	11.1	6.1	10.1	5.1	4
2001	Thin Only	4.324	4.324	102	0	102	43.666	43.666	43.235	0.98	25.49	64.706	8.824	14.7	45.1	11.8	7.8	12.7	4.9	2.9
2005	Thin Only	4.611	4.66	94	1	95	44.938	45.176	46.35	1.053	20	67.368	11.579	16.8	44.2	11.6	5.3	11.6	5.3	5.3
2010	Thin Only	4.472	4.472	108	0	108	46.477	46.477	44.722	0.926	22.222	66.667	10.185	19.4	38.9	13.9	6.5	11.1	6.5	3.7
2014	Thin Only	4.367	4.449	107	2	109	45.593	46.017	44.076	3.67	20.183	66.972	9.174	14.7	49.5	10.1	5.5	10.1	6.4	3.7

Appendix E. FQA results for individual plot by each measure year (2000, 2001, 2005, 2010, 2014).

Measure Year	Plot ID	Treatment	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value = 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% Trees	% forbs	% Grasses	% Sedges	% Shrubs	% Vines	% Ferns
2000	Plot01	Rx Fire	4.571	4.571	49	49	0	32	32	45.714	0	22.449	69.388	8.163	22.4	51	6.1	4.1	10.2	4.1	2
2001	Plot01	Rx Fire	4.682	4.682	44	44	0	31.056	31.056	46.818	0	18.182	70.455	11.364	22.7	50	9.1	6.8	4.5	4.5	2.3
2005	Plot01	Rx Fire	4.6	4.6	65	65	0	37.086	37.086	46	1.538	24.615	56.923	16.923	15.4	50.8	18.5	3.1	9.2	3.1	0
2010	Plot01	Rx Fire	4.698	4.698	53	53	0	34.203	34.203	46.981	1.887	18.868	67.925	11.321	20.8	45.3	15.1	3.8	11.3	1.9	1.9
2014	Plot01	Rx Fire	4.333	4.491	57	55	2	32.716	33.305	44.114	5.263	24.561	57.895	12.281	14	56.1	14	3.5	7	3.5	1.8
2000	Plot02	Rx Fire	4.559	4.559	34	34	0	26.582	26.582	45.588	0	23.529	61.765	14.706	17.6	47.1	8.8	2.9	14.7	8.8	0
2001	Plot02	Rx Fire	4.325	4.325	40	40	0	27.354	27.354	43.25	0	27.5	67.5	5	25	47.5	2.5	2.5	12.5	7.5	2.5
2005	Plot02	Rx Fire	3.984	4.119	61	59	2	31.113	31.636	40.506	6.557	26.23	57.377	9.836	14.8	54.1	8.2	4.9	11.5	4.9	1.6
2010	Plot02	Rx Fire	4.414	4.414	70	70	0	36.933	36.933	44.143	1.429	25.714	62.857	10	18.6	44.3	11.4	5.7	12.9	7.1	0
2014	Plot02	Rx Fire	4.328	4.328	58	58	0	32.958	32.958	43.276	1.724	27.586	60.345	10.345	17.2	48.3	10.3	6.9	10.3	6.9	0
2000	Plot03	Thin and Burn	4.456	4.536	57	56	1	33.643	33.942	44.958	1.754	24.561	63.158	10.526	21.1	50.9	5.3	8.8	7	5.3	1.8
2001	Plot03	Thin and Burn	4.185	4.264	54	53	1	30.755	31.043	42.245	1.852	29.63	61.111	7.407	18.5	55.6	5.6	3.7	9.3	7.4	0
2005	Plot03	Thin and Burn	4.141	4.141	64	64	0	33.125	33.125	41.406	1.562	31.25	57.812	9.375	17.2	50	7.8	7.8	10.9	4.7	1.6
2010	Plot03	Thin and Burn	4.324	4.366	102	101	1	43.666	43.881	43.449	2.941	23.529	64.706	8.824	13.7	50	12.7	6.9	10.8	4.9	1
2014	Plot03	Thin and Burn	4.154	4.2	91	90	1	39.625	39.845	41.769	3.297	27.473	61.538	7.692	12.1	57.1	11	6.6	8.8	3.3	1.1
2000	Plot04	Thin and Burn	5.158	5.158	38	38	0	31.795	31.795	51.579	0	5.263	78.947	15.789	28.9	36.8	18.4	2.6	5.3	7.9	0
2001	Plot04	Thin and Burn	4.867	4.867	30	30	0	26.656	26.656	48.667	0	10	80	10	20	30	16.7	6.7	16.7	6.7	3.3
2005	Plot04	Thin and Burn	4.625	4.625	40	40	0	29.251	29.251	46.25	0	20	65	15	17.5	50	10	2.5	7.5	10	2.5
2010	Plot04	Thin and Burn	4.603	4.603	58	58	0	35.059	35.059	46.034	0	18.966	70.69	10.345	17.2	44.8	13.8	6.9	10.3	5.2	1.7
2014	Plot04	Thin and Burn	4.531	4.531	64	64	0	36.25	36.25	45.312	1.562	23.438	59.375	15.625	15.6	53.1	9.4	7.8	6.2	6.2	1.6
2000	Plot05	Rx Fire	4.725	4.725	40	40	0	29.884	29.884	47.25	0	15	77.5	7.5	25	40	10	5	12.5	5	2.5
2001	Plot05	Rx Fire	4.939	4.939	33	33	0	28.375	28.375	49.394	0	12.121	72.727	15.152	27.3	36.4	9.1	3	15.2	6.1	3
2005	Plot05	Rx Fire	4.769	4.769	39	39	0	29.784	29.784	47.692	0	12.821	76.923	10.256	28.2	38.5	12.8	2.6	10.3	5.1	2.6
2010	Plot05	Rx Fire	4.78	4.78	59	59	0	36.713	36.713	47.797	0	16.949	71.186	11.864	20.3	44.1	11.9	5.1	11.9	5.1	1.7
2014	Plot05	Rx Fire	4.759	4.759	54	54	0	34.973	34.973	47.593	1.852	14.815	70.37	12.963	16.7	46.3	9.3	7.4	13	5.6	1.9
2000	Plot06	Thin and Burn	4.588	4.588	34	34	0	26.754	26.8	45.882	0	14.706	76.471	8.824	29.4	41.2	8.8	2.9	11.8	5.9	0
2001	Plot06	Thin and	5.148	5.148	27	27	0	26.751	26.8	51.481	0	7.407	77.778	14.815	22.2	48.1	18.5	3.7	7.4	0	0

		Burn																			
2005	Plot06	Thin and Burn	4.674	4.674	43	43	0	30.652	30.7	46.744	0	16.279	69.767	13.953	16.3	44.2	16.3	4.7	9.3	9.3	0
2010	Plot06	Thin and Burn	4.745	4.745	55	55	0	35.193	35.2	47.455	0	18.182	67.273	14.545	20	36.4	18.2	3.6	12.7	7.3	1.8
2014	Plot06	Thin and Burn	4.493	4.561	67	66	1	36.773	37.1	45.264	1.493	23.881	61.194	13.433	14.9	49.3	11.9	7.5	9	6	1.5
2001	Plot07	Thin Only	3.879	3.879	33	33	0	22.282	22.282	38.788	0	33.333	63.636	3.03	27.3	33.3	6.1	3	15.2	12.1	3
2005	Plot07	Thin Only	4.583	4.583	36	36	0	27.5	27.5	45.833	0	13.889	80.556	5.556	30.6	27.8	11.1	8.3	8.3	11.1	2.8
2010	Plot07	Thin Only	4.44	4.44	50	50	0	31.396	31.396	44.4	0	20	74	6	28	22	16	6	16	10	2
2014	Plot07	Thin Only	4.614	4.614	44	44	0	30.603	30.603	46.136	0	13.636	81.818	4.545	27.3	38.6	9.1	4.5	11.4	6.8	2.3
2000	Plot08	Thin Only	4.255	4.255	51	51	0	30.386	30.386	42.549	0	23.529	72.549	3.922	13.7	49	11.8	3.9	9.8	9.8	2
2001	Plot08	Thin Only	4.28	4.28	50	50	0	30.264	30.264	42.8	0	22	74	4	16	50	12	8	8	6	0
2005	Plot08	Thin Only	4.208	4.208	53	53	0	30.631	30.631	42.075	0	30.189	66.038	3.774	20.8	43.4	13.2	3.8	7.5	9.4	1.9
2010	Plot08	Thin Only	4.284	4.284	74	74	0	36.851	36.851	42.838	1.351	25.676	64.865	8.108	16.2	41.9	14.9	8.1	9.5	6.8	2.7
2014	Plot08	Thin Only	3.969	4.032	64	63	1	31.75	32.001	40.001	4.688	28.125	65.625	1.562	12.5	53.1	9.4	6.2	12.5	6.2	0
2000	Plot09	Thin and Burn	4.545	4.545	22	22	0	21.32	21.32	45.455	0	18.182	77.273	4.545	36.4	31.8	13.6	0	9.1	9.1	0
2001	Plot09	Thin and Burn	4.522	4.522	23	23	0	21.685	21.685	45.217	0	13.043	82.609	4.348	30.4	39.1	13	0	8.7	8.7	0
2005	Plot09	Thin and Burn	4.381	4.381	42	42	0	28.392	28.392	43.81	0	26.19	64.286	9.524	26.2	33.3	14.3	4.8	9.5	11.9	0
2010	Plot09	Thin and Burn	4.568	4.568	37	37	0	27.783	27.783	45.676	0	16.216	78.378	5.405	32.4	16.2	18.9	5.4	13.5	10.8	2.7
2014	Plot09	Thin and Burn	4.829	4.829	41	41	0	30.922	30.922	48.293	0	12.195	75.61	12.195	24.4	31.7	14.6	9.8	9.8	7.3	2.4
2000	Plot010	Thin Only	4.5	4.5	20	20	0	20.125	20.125	45	0	20	70	10	25	30	0	10	10	15	10
2001	Plot010	Thin Only	4.478	4.478	23	23	0	21.477	21.477	44.783	0	26.087	60.87	13.043	34.8	26.1	0	8.7	8.7	8.7	13
2005	Plot010	Thin Only	4.708	4.708	24	24	0	23.066	23.066	47.083	0	12.5	75	12.5	37.5	29.2	0	8.3	0	12.5	12.5
2010	Plot010	Thin Only	4.8	4.8	30	30	0	26.291	26.291	48	0	16.667	70	13.333	36.7	20	6.7	10	6.7	13.3	6.7
2014	Plot010	Thin Only	4.793	4.793	29	29	0	25.812	25.812	47.931	0	13.793	72.414	13.793	24.1	34.5	6.9	10.3	6.9	10.3	6.9
2000	Plot011	Thin Only	4.925	4.925	40	40	0	31.148	31.148	49.25	0	12.5	72.5	15	25	45	10	2.5	10	5	2.5
2001	Plot011	Thin Only	4.278	4.278	36	36	0	25.667	25.667	42.778	2.778	25	61.111	11.111	25	44.4	0	2.8	16.7	8.3	2.8
2005	Plot011	Thin Only	4.6	4.6	35	35	0	27.214	27.214	46	0	22.857	62.857	14.286	28.6	37.1	2.9	5.7	17.1	5.7	2.9
2010	Plot011	Thin Only	4.55	4.55	40	40	0	28.777	28.777	45.5	0	20	70	10	30	27.5	10	5	15	10	2.5
2014	Plot011	Thin Only	4.654	4.654	26	26	0	23.73	23.73	46.538	0	19.231	61.538	19.231	19.2	38.5	11.5	3.8	19.2	3.8	3.8
2000	Plot012	Thin and Burn	4	4.108	38	37	1	24.658	24.989	40.537	2.632	36.842	52.632	7.895	18.4	34.2	15.8	5.3	13.2	10.5	2.6
2001	Plot012	Thin and Burn	4.216	4.216	37	37	0	25.646	25.646	42.162	0	32.432	56.757	10.811	24.3	35.1	8.1	8.1	10.8	10.8	2.7
2005	Plot012	Thin and Burn	3.831	3.875	89	88	1	36.146	36.351	38.532	4.494	39.326	47.191	8.989	12.4	56.2	10.1	4.5	6.7	7.9	2.2
2010	Plot012	Thin and Burn	3.857	4	84	81	3	35.351	36	39.279	5.952	35.714	50	8.333	16.7	47.6	15.5	7.1	7.1	3.6	2.4
2014	Plot012	Thin and	3.838	3.838	74	74	0	33.014	33.014	38.378	4.054	41.892	43.243	10.811	14.9	58.1	9.5	4.1	6.8	5.4	1.4

		Burn																			
2000	Plot013	Rx Fire	4.452	4.452	31	31	0	24.786	24.786	44.516	0	22.581	67.742	9.677	25.8	38.7	6.5	3.2	16.1	9.7	0
2001	Plot013	Rx Fire	4.364	4.364	33	33	0	25.067	25.067	43.636	0	18.182	78.788	3.03	30.3	33.3	6.1	6.1	12.1	12.1	0
2005	Plot013	Rx Fire	4.522	4.522	46	46	0	30.668	30.668	45.217	0	23.913	65.217	10.87	17.4	43.5	10.9	4.3	17.4	6.5	0
2010	Plot013	Rx Fire	4.31	4.31	58	58	0	32.827	32.827	43.103	1.724	25.862	62.069	10.345	19	50	10.3	5.2	12.1	3.4	0
2014	Plot013	Rx Fire	4.29	4.29	69	69	0	35.634	35.634	42.899	1.449	28.986	60.87	8.696	15.9	52.2	14.5	5.8	8.7	2.9	0
2000	Plot014	Thin and Burn	4.767	4.767	30	30	0	26.108	26.108	47.667	0	13.333	76.667	10	23.3	43.3	0	6.7	13.3	6.7	6.7
2001	Plot014	Thin and Burn	4.742	4.742	31	31	0	26.402	26.402	47.419	0	12.903	80.645	6.452	19.4	48.4	6.5	3.2	9.7	6.5	6.5
2005	Plot014	Thin and Burn	4.704	4.704	27	27	0	24.441	24.441	47.037	0	11.111	77.778	11.111	22.2	33.3	3.7	7.4	3.7	14.8	14.8
2010	Plot014	Thin and Burn	4.733	4.733	30	30	0	25.926	25.926	47.333	0	13.333	76.667	10	30	33.3	3.3	3.3	13.3	10	6.7
2014	Plot014	Thin and Burn	4.538	4.538	39	39	0	28.343	28.343	45.385	0	20.513	69.231	10.256	28.2	35.9	7.7	5.1	10.3	7.7	5.1
2000	Plot015	Thin and Burn	4.843	4.843	51	51	0	34.587	34.587	48.431	0	15.686	72.549	11.765	17.6	45.1	13.7	5.9	11.8	5.9	0
2001	Plot015	Thin and Burn	4.46	4.46	50	50	0	31.537	31.537	44.6	2	24	66	8	18	54	14	4	4	6	0
2005	Plot015	Thin and Burn	4.857	4.857	63	63	0	38.552	38.552	48.571	0	19.048	68.254	12.698	12.7	50.8	17.5	4.8	11.1	3.2	0
2010	Plot015	Thin and Burn	4.431	4.431	72	72	0	37.595	37.595	44.306	2.778	23.611	63.889	9.722	15.3	50	15.3	5.6	9.7	4.2	0
2014	Plot015	Thin and Burn	4.699	4.699	73	73	0	40.145	40.145	46.986	2.74	20.548	60.274	16.438	11	57.5	16.4	4.1	6.8	4.1	0
2000	Plot016	Rx Fire	4.719	4.719	32	32	0	26.693	26.693	47.188	0	12.5	78.125	9.375	34.4	31.2	9.4	6.2	3.1	12.5	3.1
2001	Plot016	Rx Fire	4.643	4.643	28	28	0	24.568	24.568	46.429	0	17.857	75	7.143	35.7	21.4	10.7	7.1	14.3	7.1	3.6
2005	Plot016	Rx Fire	4.656	4.656	32	32	0	26.34	26.34	46.562	3.125	15.625	68.75	12.5	25	31.2	12.5	3.1	9.4	15.6	3.1
2010	Plot016	Rx Fire	4.667	4.667	36	36	0	28	28	46.667	0	13.889	80.556	5.556	36.1	30.6	8.3	5.6	8.3	8.3	2.8
2014	Plot016	Rx Fire	4.548	4.548	31	31	0	25.324	25.324	45.484	0	19.355	70.968	9.677	29	32.3	9.7	3.2	6.5	16.1	3.2
2000	Plot017	Rx Fire	4.521	4.521	73	73	0	38.624	38.624	45.205	0	23.288	64.384	12.329	9.6	58.9	13.7	4.1	6.8	5.5	1.4
2001	Plot017	Rx Fire	4.486	4.486	70	70	0	37.53	37.53	44.857	1.429	21.429	68.571	8.571	12.9	51.4	17.1	4.3	10	2.9	1.4
2005	Plot017	Rx Fire	4.301	4.301	83	83	0	39.186	39.186	43.012	2.41	27.711	61.446	8.434	8.4	61.4	13.3	4.8	6	4.8	1.2
2010	Plot017	Rx Fire	4.378	4.427	90	89	1	41.531	41.764	44.023	3.333	27.778	57.778	11.111	13.3	55.6	14.4	5.6	7.8	2.2	1.1
2014	Plot017	Rx Fire	4.483	4.483	87	87	0	41.812	41.812	44.828	1.149	26.437	59.77	12.644	12.6	54	14.9	4.6	10.3	2.3	1.1
2000	Plot018	Rx Fire	4.909	4.909	44	44	0	32.563	32.563	49.091	0	11.364	75	13.636	25	43.2	13.6	4.5	6.8	4.5	2.3
2001	Plot018	Rx Fire	5.103	5.103	29	29	0	27.483	27.483	51.034	0	10.345	75.862	13.793	24.1	48.3	13.8	3.4	10.3	0	0
2005	Plot018	Rx Fire	5	5	31	31	0	27.839	27.839	50	0	6.452	80.645	12.903	16.1	48.4	19.4	3.2	6.5	3.2	3.2
2010	Plot018	Rx Fire	4.818	4.818	55	55	0	35.733	35.733	48.182	0	14.545	74.545	10.909	16.4	47.3	14.5	5.5	10.9	3.6	1.8
2014	Plot018	Rx Fire	4.772	4.772	57	57	0	36.027	36.027	47.719	0	19.298	64.912	15.789	15.8	52.6	12.3	3.5	8.8	5.3	1.8
2000	Plot019	Rx Fire	4.955	4.955	22	22	0	23.239	23.239	49.545	0	13.636	72.727	13.636	31.8	18.2	22.7	9.1	9.1	4.5	4.5
2001	Plot019	Rx Fire	4.722	4.722	18	18	0	20.035	20.035	47.222	0	11.111	77.778	11.111	44.4	27.8	11.1	5.6	5.6	0	5.6
2005	Plot019	Rx Fire	4.56	4.56	25	25	0	22.8	22.8	45.6	0	20	68	12	36	20	16	4	8	12	4

2010	Plot019	Rx Fire	4.812	4.812	32	32	0	27.224	27.224	48.125	0	15.625	71.875	12.5	34.4	25	12.5	3.1	12.5	9.4	3.1
2014	Plot019	Rx Fire	4.609	4.609	23	23	0	22.103	22.103	46.087	0	13.043	78.261	8.696	43.5	17.4	13	8.7	8.7	4.3	4.3
2000	Plot020	Thin and Burn	4.9	4.9	30	30	0	26.838	26.838	49	0	13.333	73.333	13.333	20	46.7	6.7	6.7	6.7	10	3.3
2001	Plot020	Thin and Burn	4.607	4.607	28	28	0	24.379	24.379	46.071	0	17.857	71.429	10.714	32.1	35.7	7.1	3.6	7.1	10.7	3.6
2005	Plot020	Thin and Burn	4.531	4.531	32	32	0	25.633	25.633	45.312	0	15.625	78.125	6.25	18.8	28.1	18.8	9.4	6.2	15.6	3.1
2010	Plot020	Thin and Burn	4.714	4.714	56	56	0	35.278	35.278	47.143	0	17.857	69.643	12.5	16.1	42.9	14.3	7.1	10.7	7.1	1.8
2014	Plot020	Thin and Burn	4.681	4.681	47	47	0	32.09	32.09	46.809	0	14.894	78.723	6.383	14.9	44.7	17	6.4	10.6	6.4	0
2000	Plot021	Thin and Burn	4.46	4.46	50	50	0	31.537	31.537	44.6	0	20	72	8	16	46	16	2	16	4	0
2001	Plot021	Thin and Burn	4.473	4.473	55	55	0	33.171	33.171	44.727	0	25.455	63.636	10.909	18.2	47.3	10.9	1.8	16.4	5.5	0
2005	Plot021	Thin and Burn	4.619	4.619	42	42	0	29.935	29.935	46.19	0	19.048	71.429	9.524	21.4	40.5	14.3	4.8	11.9	4.8	2.4
2010	Plot021	Thin and Burn	4.408	4.408	71	71	0	37.146	37.146	44.085	2.817	25.352	60.563	11.268	15.5	50.7	15.5	8.5	5.6	2.8	1.4
2014	Plot021	Thin and Burn	4.282	4.282	71	71	0	36.078	36.078	42.817	4.225	28.169	57.746	9.859	11.3	57.7	16.9	4.2	4.2	4.2	1.4
2000	Plot022	Thin and Burn	4.28	4.28	50	50	0	30.264	30.264	42.8	0	32	58	10	16	52	12	4	8	8	0
2001	Plot022	Thin and Burn	4.467	4.467	60	60	0	34.599	34.599	44.667	0	23.333	65	11.667	16.7	48.3	13.3	5	11.7	5	0
2005	Plot022	Thin and Burn	4.037	4.086	82	81	1	36.553	36.778	40.614	4.878	30.488	57.317	7.317	7.3	61	12.2	4.9	8.5	6.1	0
2010	Plot022	Thin and Burn	4.721	4.721	68	68	0	38.927	38.927	47.206	1.471	20.588	63.235	14.706	17.6	48.5	14.7	2.9	10.3	4.4	1.5
2014	Plot022	Thin and Burn	4.092	4.147	76	75	1	35.674	35.911	41.193	7.895	25	57.895	9.211	9.2	60.5	13.2	3.9	7.9	5.3	0
2000	Plot023	Thin and Burn	4.727	4.727	33	33	0	27.156	27.156	47.273	0	12.121	78.788	9.091	27.3	39.4	9.1	3	9.1	12.1	0
2001	Plot023	Thin and Burn	4.808	4.808	26	26	0	24.515	24.515	48.077	0	11.538	76.923	11.538	26.9	26.9	7.7	11.5	7.7	15.4	3.8
2005	Plot023	Thin and Burn	4.588	4.588	34	34	0	26.754	26.754	45.882	0	17.647	70.588	11.765	17.6	41.2	17.6	8.8	8.8	5.9	0
2010	Plot023	Thin and Burn	4.756	4.756	45	45	0	31.901	31.901	47.556	0	17.778	68.889	13.333	22.2	48.9	15.6	2.2	6.7	4.4	0
2014	Plot023	Thin and Burn	4.926	4.926	54	54	0	36.198	36.198	49.259	0	12.963	72.222	14.815	16.7	55.6	9.3	5.6	9.3	3.7	0
2000	Plot024	Rx Fire	4.656	4.656	32	32	0	26.34	26.34	46.562	0	15.625	71.875	12.5	28.1	40.6	3.1	6.2	6.2	12.5	3.1
2001	Plot024	Rx Fire	4.765	4.765	34	34	0	27.783	27.783	47.647	0	11.765	79.412	8.824	32.4	38.2	0	2.9	14.7	8.8	2.9
2005	Plot024	Rx Fire	4.533	4.533	30	30	0	24.83	24.83	45.333	0	23.333	60	16.667	20	40	10	3.3	16.7	6.7	3.3
2010	Plot024	Rx Fire	4.365	4.365	74	74	0	37.548	37.548	43.649	1.351	25.676	62.162	10.811	17.6	39.2	14.9	6.8	13.5	5.4	2.7

2014	Plot024	Rx Fire	4.188	4.188	64	64	0	33.5	33.5	41.875	3.125	25	64.062	7.812	17.2	45.3	7.8	7.8	14.1	4.7	3.1
2000	Plot025	Thin and Burn	4.477	4.477	44	44	0	29.699	29.699	44.773	0	22.727	70.455	6.818	18.2	40.9	11.4	6.8	13.6	9.1	0
2001	Plot025	Thin and Burn	4.69	4.69	42	42	0	30.398	30.398	46.905	0	16.667	76.19	7.143	21.4	42.9	9.5	4.8	14.3	7.1	0
2005	Plot025	Thin and Burn	4.64	4.64	50	50	0	32.81	32.81	46.4	0	18	74	8	24	44	6	4	16	6	0
2010	Plot025	Thin and Burn	4.342	4.382	111	110	1	45.749	45.957	43.62	3.604	27.027	57.658	11.712	10.8	55	20.7	3.6	7.2	2.7	0
2014	Plot025	Thin and Burn	4.506	4.558	87	86	1	42.027	42.27	45.319	2.299	21.839	66.667	9.195	10.3	60.9	13.8	3.4	5.7	4.6	1.1
2000	Plot026	Thin and Burn	4.533	4.533	30	30	0	24.83	24.83	45.333	0	16.667	76.667	6.667	26.7	30	6.7	10	10	13.3	3.3
2001	Plot026	Thin and Burn	4.429	4.429	49	49	0	31	31	44.286	2.041	22.449	65.306	10.204	20.4	46.9	14.3	2	6.1	8.2	2
2005	Plot026	Thin and Burn	4.517	4.596	58	57	1	34.402	34.703	45.567	1.724	20.69	67.241	10.345	17.2	55.2	12.1	1.7	5.2	6.9	1.7
2010	Plot026	Thin and Burn	4.433	4.433	97	97	0	43.66	43.66	44.33	4.124	24.742	58.763	12.371	13.4	54.6	16.5	4.1	6.2	4.1	1
2014	Plot026	Thin and Burn	4.415	4.415	94	94	0	42.804	42.804	44.149	2.128	25.532	60.638	11.702	10.6	55.3	17	5.3	7.4	3.2	1.1
2000	Plot027	Rx Fire	4.615	4.615	65	65	0	37.21	37.21	46.154	0	23.077	67.692	9.231	13.8	46.2	13.8	9.2	9.2	4.6	3.1
2001	Plot027	Rx Fire	4.391	4.391	69	69	0	36.477	36.477	43.913	1.449	28.986	59.42	10.145	8.7	50.7	18.8	4.3	10.1	4.3	2.9
2005	Plot027	Rx Fire	4.383	4.438	81	80	1	39.444	39.69	44.1	1.235	25.926	64.198	8.642	12.3	54.3	14.8	4.9	7.4	3.7	2.5
2010	Plot027	Rx Fire	4.422	4.422	102	102	0	44.656	44.656	44.216	3.922	22.549	62.745	10.784	12.7	53.9	14.7	3.9	9.8	2.9	2
2014	Plot027	Rx Fire	4.462	4.462	104	104	0	45.499	45.499	44.615	2.885	23.077	60.577	13.462	10.6	61.5	13.5	5.8	4.8	1.9	1.9
2000	Plot028	Thin and Burn	4.639	4.639	36	36	0	27.833	27.833	46.389	0	16.667	75	8.333	25	38.9	11.1	2.8	13.9	8.3	0
2001	Plot028	Thin and Burn	4.794	4.794	34	34	0	27.954	27.954	47.941	0	8.824	88.235	2.941	20.6	38.2	2.9	8.8	17.6	11.8	0
2005	Plot028	Thin and Burn	4.417	4.417	36	36	0	26.5	26.5	44.167	0	16.667	80.556	2.778	22.2	41.7	11.1	5.6	13.9	5.6	0
2010	Plot028	Thin and Burn	4.523	4.523	65	65	0	36.466	36.466	45.231	1.538	21.538	67.692	9.231	15.4	52.3	12.3	3.1	10.8	6.2	0
2014	Plot028	Thin and Burn	4.203	4.203	64	64	0	33.625	33.625	42.031	3.125	25	64.062	7.812	15.6	54.7	9.4	4.7	10.9	4.7	0
2000	Plot029	Thin and Burn	4.259	4.259	27	27	0	22.132	22.132	42.593	3.704	22.222	70.37	3.704	29.6	29.6	7.4	3.7	14.8	14.8	0
2001	Plot029	Thin and Burn	4.759	4.759	29	29	0	25.626	25.626	47.586	0	17.241	68.966	13.793	27.6	24.1	10.3	3.4	27.6	6.9	0
2005	Plot029	Thin and Burn	4.515	4.515	33	33	0	25.938	25.938	45.152	0	18.182	78.788	3.03	27.3	33.3	9.1	3	15.2	12.1	0
2010	Plot029	Thin and Burn	4.109	4.109	55	55	0	30.474	30.474	41.091	3.636	21.818	70.909	3.636	23.6	34.5	18.2	3.6	14.5	5.5	0
2014	Plot029	Thin and Burn	4.246	4.309	69	68	1	35.273	35.531	42.775	2.899	28.986	57.971	10.145	14.5	43.5	17.4	7.2	11.6	5.8	0

2000	Plot030	Rx Fire	4.634	4.634	41	41	0	29.673	29.673	46.341	0	19.512	70.732	9.756	19.5	46.3	22	4.9	4.9	2.4	0
2001	Plot030	Rx Fire	4.793	4.793	29	29	0	25.812	25.812	47.931	0	13.793	75.862	10.345	27.6	41.4	13.8	3.4	10.3	3.4	0
2005	Plot030	Rx Fire	4.773	4.773	44	44	0	31.659	31.659	47.727	0	13.636	79.545	6.818	27.3	43.2	13.6	4.5	6.8	2.3	2.3
2010	Plot030	Rx Fire	4.143	4.143	56	56	0	31.002	31.002	41.429	0	30.357	66.071	3.571	21.4	28.6	21.4	8.9	12.5	5.4	1.8
2014	Plot030	Rx Fire	4.229	4.229	48	48	0	29.301	29.301	42.292	2.083	31.25	60.417	6.25	16.7	43.8	18.8	6.2	8.3	6.2	0
2000	Plot031	Thin and Burn	4.086	4.206	35	34	1	24.171	24.524	41.454	2.9	22.857	68.571	5.714	22.9	40	2.9	5.7	14.3	11.4	2.9
2001	Plot031	Thin and Burn	4.103	4.103	39	39	0	25.621	25.621	41.026	2.6	25.641	64.103	7.692	23.1	38.5	7.7	7.7	10.3	10.3	2.6
2005	Plot031	Thin and Burn	4.452	4.452	31	31	0	24.786	24.786	44.516	0	25.806	58.065	16.129	29	22.6	3.2	12.9	9.7	16.1	6.5
2010	Plot031	Thin and Burn	3.865	4.102	52	49	3	27.874	28.714	39.82	11.5	23.077	55.769	9.615	17.3	34.6	11.5	7.7	15.4	9.6	3.8
2014	Plot031	Thin and Burn	3.882	4.062	68	65	3	32.015	32.745	39.709	7.4	26.471	60.294	5.882	13.2	42.6	19.1	7.4	8.8	5.9	2.9
2000	Plot032	Thin and Burn	4.633	4.633	30	30	0	25.378	25.378	46.333	0	16.667	73.333	10	30	36.7	6.7	3.3	6.7	13.3	3.3
2001	Plot032	Thin and Burn	4.613	4.613	31	31	0	25.684	25.684	46.129	0	19.355	67.742	12.903	32.3	35.5	9.7	6.5	3.2	9.7	3.2
2005	Plot032	Thin and Burn	4.909	4.909	44	44	0	32.563	32.563	49.091	0	11.364	75	13.636	29.5	36.4	13.6	4.5	4.5	9.1	2.3
2010	Plot032	Thin and Burn	3.818	3.962	55	53	2	28.316	28.846	38.896	7.273	25.455	63.636	3.636	27.3	36.4	9.1	7.3	12.7	5.5	1.8
2014	Plot032	Thin and Burn	4.532	4.532	47	47	0	31.069	31.069	45.319	0	21.277	65.957	12.766	23.4	40.4	8.5	6.4	10.6	8.5	2.1
2000	Plot033	Rx Fire	4.543	4.543	35	35	0	26.876	26.876	45.429	0	17.143	77.143	5.714	31.4	34.3	5.7	5.7	8.6	8.6	5.7
2001	Plot033	Rx Fire	4.848	4.848	33	33	0	27.852	27.852	48.485	0	18.182	63.636	18.182	21.2	39.4	15.2	6.1	6.1	9.1	3
2005	Plot033	Rx Fire	4.455	4.455	33	33	0	25.589	25.589	44.545	0	21.212	69.697	9.091	30.3	36.4	6.1	3	12.1	9.1	3
2010	Plot033	Rx Fire	4.854	4.854	41	41	0	31.079	31.079	48.537	0	9.756	80.488	9.756	26.8	39	4.9	4.9	14.6	7.3	2.4
2014	Plot033	Rx Fire	4.528	4.528	36	36	0	27.167	27.167	45.278	2.778	16.667	66.667	13.889	25	44.4	8.3	2.8	8.3	8.3	2.8
2000	Plot034	Rx Fire	4.714	4.714	28	28	0	24.946	24.946	47.143	0	10.714	75	14.286	35.7	28.6	7.1	7.1	10.7	7.1	3.6
2001	Plot034	Rx Fire	4.577	4.577	26	26	0	23.338	23.338	45.769	0	11.538	84.615	3.846	34.6	26.9	7.7	3.8	15.4	7.7	3.8
2005	Plot034	Rx Fire	4.6	4.6	30	30	0	25.195	25.195	46	0	16.667	73.333	10	30	30	10	3.3	13.3	10	3.3
2010	Plot034	Rx Fire	4.676	4.676	34	34	0	27.268	27.268	46.765	0	14.706	73.529	11.765	29.4	26.5	11.8	2.9	14.7	11.8	2.9
2014	Plot034	Rx Fire	4.562	4.562	48	48	0	31.61	31.61	45.625	2.083	16.667	66.667	14.583	20.8	39.6	10.4	2.1	14.6	8.3	4.2
2000	Plot035	Thin and Burn	4.455	4.455	22	22	0	20.894	20.894	44.545	0	18.182	68.182	13.636	31.8	31.8	9.1	9.1	9.1	9.1	0
2001	Plot035	Thin and Burn	4.526	4.526	19	19	0	19.73	19.73	45.263	0	15.789	73.684	10.526	42.1	31.6	0	10.5	10.5	5.3	0
2005	Plot035	Thin and Burn	4.44	4.44	25	25	0	22.2	22.2	44.4	0	20	68	12	28	28	12	8	12	12	0
2010	Plot035	Thin and Burn	3.423	3.708	52	48	4	24.684	25.692	35.629	19.231	23.077	51.923	5.769	13.5	46.2	21.2	7.7	5.8	3.8	1.9
2014	Plot035	Thin and Burn	3.491	3.84	55	50	5	25.889	27.153	36.613	16.364	30.909	43.636	9.091	16.4	50.9	18.2	7.3	5.5	1.8	0

2000	Plot036	No Treatment	4.217	4.311	46	45	1	28.604	28.92	42.64	2.174	23.913	65.217	8.696	17.4	45.7	15.2	4.3	10.9	6.5	0
2001	Plot036	No Treatment	3.52	3.52	25	25	0	17.6	17.6	35.2	4	36	56	4	36	28	12	4	12	4	4
2005	Plot036	No Treatment	4.273	4.372	44	43	1	28.342	28.67	43.221	2.273	27.273	61.364	9.091	18.2	38.6	18.2	6.8	11.4	4.5	2.3
2010	Plot036	No Treatment	4.318	4.318	44	44	0	28.644	28.644	43.182	0	25	70.455	4.545	22.7	34.1	18.2	6.8	9.1	6.8	2.3
2014	Plot036	No Treatment	4.326	4.326	46	46	0	29.341	29.341	43.261	0	23.913	69.565	6.522	21.7	37	13	8.7	10.9	6.5	2.2
2000	Plot037	Rx Fire	4.852	4.852	27	27	0	25.211	25.211	48.519	0	18.519	62.963	18.519	25.9	48.1	3.7	3.7	14.8	3.7	0
2001	Plot037	Rx Fire	4.261	4.261	23	23	0	20.434	20.434	42.609	0	21.739	69.565	8.696	26.1	30.4	13	4.3	13	13	0
2005	Plot037	Rx Fire	4.488	4.488	41	41	0	28.736	28.736	44.878	0	24.39	68.293	7.317	17.1	51.2	9.8	4.9	12.2	4.9	0
2010	Plot037	Rx Fire	4.873	4.873	55	55	0	36.137	36.137	48.727	0	16.364	69.091	14.545	20	50.9	9.1	3.6	12.7	3.6	0
2014	Plot037	Rx Fire	4.4	4.4	50	50	0	31.113	31.113	44	2	24	60	14	18	54	6	2	16	4	0
2000	Plot038	Rx Fire	4.436	4.436	39	39	0	27.702	27.702	44.359	0	25.641	66.667	7.692	17.9	43.6	12.8	7.7	12.8	5.1	0
2001	Plot038	Rx Fire	5.071	5.071	42	42	0	32.867	32.867	50.714	0	9.524	71.429	19.048	19	50	11.9	2.4	9.5	4.8	2.4
2005	Plot038	Rx Fire	4.298	4.298	57	57	0	32.451	32.451	42.982	0	24.561	70.175	5.263	19.3	42.1	10.5	8.8	10.5	7	1.8
2010	Plot038	Rx Fire	4.788	4.788	66	66	0	38.897	38.897	47.879	0	16.667	71.212	12.121	19.7	45.5	9.1	9.1	9.1	6.1	1.5
2014	Plot038	Rx Fire	4.485	4.485	68	68	0	36.987	36.987	44.853	0	25	64.706	10.294	14.7	52.9	8.8	7.4	7.4	7.4	1.5
2000	Plot039	Thin and Burn	4.69	4.69	29	29	0	25.255	25.255	46.897	0	17.241	68.966	13.793	20.7	51.7	6.9	6.9	6.9	6.9	0
2001	Plot039	Thin and Burn	4.85	4.85	40	40	0	30.674	30.674	48.5	0	15	70	15	22.5	42.5	10	2.5	10	7.5	5
2005	Plot039	Thin and Burn	4.535	4.535	43	43	0	29.737	29.737	45.349	0	18.605	69.767	11.628	16.3	48.8	9.3	4.7	9.3	7	4.7
2010	Plot039	Thin and Burn	4.536	4.603	69	68	1	37.681	37.957	45.695	2.899	18.841	66.667	11.594	15.9	49.3	11.6	4.3	7.2	5.8	5.8
2014	Plot039	Thin and Burn	4.468	4.468	62	62	0	35.179	35.179	44.677	0	24.194	66.129	9.677	14.5	54.8	11.3	4.8	8.1	4.8	1.6
2000	Plot040	Thin and Burn	4.583	4.583	36	36	0	27.5	27.5	45.833	0	22.222	66.667	11.111	30.6	36.1	2.8	5.6	13.9	11.1	0
2001	Plot040	Thin and Burn	4.414	4.414	29	29	0	23.769	23.769	44.138	0	20.69	68.966	10.345	34.5	31	3.4	3.4	13.8	13.8	0
2005	Plot040	Thin and Burn	4.316	4.432	38	37	1	26.604	26.961	43.737	2.632	23.684	68.421	5.263	26.3	39.5	2.6	2.6	18.4	10.5	0
2010	Plot040	Thin and Burn	4.6	4.6	35	35	0	27.214	27.214	46	0	20	68.571	11.429	31.4	25.7	17.1	0	17.1	8.6	0
2014	Plot040	Thin and Burn	4.481	4.566	54	53	1	32.932	33.241	45.236	3.704	18.519	64.815	12.963	14.8	48.1	14.8	3.7	13	5.6	0
2000	Plot041	Rx Fire	4.643	4.643	28	28	0	24.568	24.568	46.429	0	25	64.286	10.714	35.7	28.6	7.1	7.1	7.1	10.7	3.6
2001	Plot041	Rx Fire	4.478	4.478	23	23	0	21.477	21.477	44.783	0	21.739	73.913	4.348	43.5	21.7	4.3	4.3	8.7	13	4.3
2005	Plot041	Rx Fire	4.393	4.393	28	28	0	23.245	23.245	43.929	0	25	64.286	10.714	39.3	21.4	10.7	3.6	14.3	10.7	0
2010	Plot041	Rx Fire	4.452	4.452	31	31	0	24.786	24.786	44.516	0	16.129	80.645	3.226	35.5	19.4	6.5	9.7	16.1	12.9	0
2014	Plot041	Rx Fire	4.333	4.333	33	33	0	24.893	24.893	43.333	0	21.212	72.727	6.061	30.3	42.4	6.1	0	12.1	9.1	0

2000	Plot042	Rx Fire	4.411	4.411	56	56	0	33.007	33.007	44.107	0	21.429	67.857	10.714	14.3	42.9	12.5	8.9	8.9	7.1	5.4
2001	Plot042	Rx Fire	4.468	4.468	47	47	0	30.632	30.632	44.681	0	21.277	70.213	8.511	17	42.6	10.6	6.4	12.8	6.4	4.3
2005	Plot042	Rx Fire	4.585	4.585	65	65	0	36.962	36.962	45.846	0	18.462	70.769	10.769	13.8	50.8	7.7	7.7	10.8	6.2	3.1
2010	Plot042	Rx Fire	4.12	4.171	83	82	1	37.539	37.768	41.455	3.614	28.916	59.036	8.434	12	55.4	14.5	3.6	9.6	3.6	1.2
2014	Plot042	Rx Fire	4.192	4.192	73	73	0	35.815	35.815	41.918	2.74	28.767	57.534	10.959	9.6	50.7	16.4	8.2	9.6	4.1	1.4
2000	Plot043	Rx Fire	4.769	4.769	26	26	0	24.318	24.318	47.692	0	19.231	61.538	19.231	23.1	42.3	7.7	3.8	11.5	7.7	3.8
2001	Plot043	Rx Fire	4.743	4.743	35	35	0	28.059	28.059	47.429	0	14.286	77.143	8.571	31.4	40	5.7	2.9	11.4	5.7	2.9
2005	Plot043	Rx Fire	4.694	4.694	36	36	0	28.167	28.167	46.944	0	19.444	69.444	11.111	25	38.9	11.1	2.8	11.1	8.3	2.8
2010	Plot043	Rx Fire	4.746	4.746	67	67	0	38.85	38.85	47.463	0	17.91	71.642	10.448	17.9	46.3	17.9	3	10.4	3	1.5
2014	Plot043	Rx Fire	4.765	4.765	51	51	0	34.027	34.027	47.647	0	15.686	70.588	13.725	15.7	45.1	15.7	7.8	9.8	3.9	2
2000	Plot044	Thin and Burn	4.735	4.735	49	49	0	33.143	33.143	47.347	0	18.367	71.429	10.204	18.4	44.9	12.2	6.1	10.2	8.2	0
2001	Plot044	Thin and Burn	4.881	4.881	42	42	0	31.632	31.632	48.81	0	16.667	71.429	11.905	19	42.9	11.9	7.1	9.5	9.5	0
2005	Plot044	Thin and Burn	4.871	4.871	62	62	0	38.354	38.354	48.71	0	17.742	67.742	14.516	17.7	50	14.5	8.1	4.8	4.8	0
2010	Plot044	Thin and Burn	4.54	4.54	87	87	0	42.348	42.348	45.402	2.299	22.989	62.069	12.644	14.9	51.7	13.8	4.6	10.3	4.6	0
2014	Plot044	Thin and Burn	4.697	4.697	109	109	0	49.041	49.041	46.972	1.835	21.101	60.55	16.514	9.2	61.5	11.9	4.6	9.2	2.8	0.9
2000	Plot045	Rx Fire	4.889	4.889	27	27	0	25.403	25.403	48.889	0	11.111	70.37	18.519	25.9	48.1	3.7	3.7	11.1	7.4	0
2001	Plot045	Rx Fire	4.591	4.591	22	22	0	21.533	21.533	45.909	0	13.636	77.273	9.091	31.8	36.4	4.5	13.6	9.1	4.5	0
2005	Plot045	Rx Fire	4.9	4.9	30	30	0	26.838	26.838	49	0	6.667	80	13.333	30	46.7	3.3	3.3	10	6.7	0
2010	Plot045	Rx Fire	4.6	4.6	45	45	0	30.858	30.858	46	0	24.444	62.222	13.333	20	46.7	13.3	4.4	11.1	4.4	0
2014	Plot045	Rx Fire	4.792	4.792	48	48	0	33.198	33.198	47.917	0	20.833	62.5	16.667	14.6	54.2	10.4	6.2	8.3	4.2	2.1
2000	Plot046	Thin and Burn	4.24	4.24	25	25	0	21.2	21.2	42.4	0	28	64	8	24	44	4	8	12	8	0
2001	Plot046	Thin and Burn	4.417	4.417	24	24	0	21.637	21.637	44.167	0	25	66.667	8.333	37.5	33.3	0	4.2	8.3	16.7	0
2005	Plot046	Thin and Burn	4.621	4.621	29	29	0	24.883	24.883	46.207	0	20.69	68.966	10.345	34.5	37.9	3.4	3.4	10.3	10.3	0
2010	Plot046	Thin and Burn	4.524	4.524	42	42	0	29.318	29.318	45.238	0	19.048	71.429	9.524	38.1	31	4.8	2.4	14.3	9.5	0
2014	Plot046	Thin and Burn	4.667	4.667	45	45	0	31.305	31.305	46.667	0	17.778	71.111	11.111	22.2	46.7	8.9	6.7	8.9	6.7	0
2000	Plot047	Thin and Burn	4.864	4.864	22	22	0	22.812	22.812	48.636	0	13.636	77.273	9.091	31.8	13.6	22.7	9.1	9.1	9.1	4.5
2001	Plot047	Thin and Burn	4.591	4.591	22	22	0	21.533	21.533	45.909	0	22.727	59.091	18.182	40.9	22.7	4.5	4.5	13.6	9.1	4.5
2005	Plot047	Thin and Burn	4.852	4.852	27	27	0	25.211	25.211	48.519	0	7.407	81.481	11.111	33.3	29.6	11.1	3.7	7.4	11.1	3.7
2010	Plot047	Thin and Burn	4.469	4.469	49	49	0	31.286	31.286	44.694	2.041	22.449	61.224	14.286	20.4	42.9	12.2	2	14.3	6.1	2
2014	Plot047	Thin and Burn	4.28	4.28	50	50	0	30.264	30.264	42.8	2	28	58	12	12	50	14	8	10	4	2

2000	Plot048	Thin and Burn	4.646	4.646	48	48	0	32.187	32.187	46.458	0	18.75	66.667	14.583	18.8	45.8	8.3	4.2	12.5	8.3	2.1
2001	Plot048	Thin and Burn	4.267	4.267	45	45	0	28.622	28.622	42.667	0	24.444	66.667	8.889	17.8	35.6	8.9	4.4	22.2	8.9	2.2
2005	Plot048	Thin and Burn	4.288	4.288	52	52	0	30.925	30.925	42.885	0	30.769	57.692	11.538	13.5	46.2	15.4	1.9	13.5	7.7	1.9
2010	Plot048	Thin and Burn	4.468	4.526	77	76	1	39.202	39.46	44.968	2.597	19.481	66.234	11.688	15.6	41.6	16.9	6.5	13	5.2	1.3
2014	Plot048	Thin and Burn	4.246	4.309	69	68	1	35.273	35.531	42.775	2.899	20.29	69.565	7.246	15.9	52.2	7.2	8.7	10.1	4.3	1.4
2000	Plot049	Thin and Burn	4.891	4.891	55	55	0	36.272	36.272	48.909	0	18.182	65.455	16.364	10.9	56.4	16.4	5.5	7.3	1.8	1.8
2001	Plot049	Thin and Burn	4.842	4.842	57	57	0	36.557	36.557	48.421	0	15.789	75.439	8.772	8.8	56.1	19.3	3.5	7	3.5	1.8
2005	Plot049	Thin and Burn	4.742	4.82	62	61	1	37.338	37.643	47.806	1.613	19.355	64.516	14.516	17.7	53.2	14.5	1.6	6.5	4.8	1.6
2010	Plot049	Thin and Burn	4.542	4.542	48	48	0	31.466	31.466	45.417	0	22.917	68.75	8.333	18.8	41.7	18.8	4.2	8.3	6.2	2.1
2014	Plot049	Thin and Burn	4.653	4.653	49	49	0	32.571	32.571	46.531	0	20.408	69.388	10.204	16.3	51	12.2	6.1	8.2	4.1	2
2000	Plot050	Thin and Burn	4.769	4.769	26	26	0	24.318	24.318	47.692	0	19.231	65.385	15.385	38.5	26.9	7.7	3.8	19.2	0	3.8
2001	Plot050	Thin and Burn	4.958	4.958	24	24	0	24.291	24.291	49.583	0	8.333	79.167	12.5	29.2	25	4.2	4.2	20.8	12.5	4.2
2005	Plot050	Thin and Burn	4.462	4.462	26	26	0	22.749	22.749	44.615	0	19.231	76.923	3.846	30.8	26.9	3.8	7.7	11.5	15.4	3.8
2010	Plot050	Thin and Burn	4.581	4.581	31	31	0	25.504	25.504	45.806	0	12.903	77.419	9.677	35.5	22.6	9.7	3.2	16.1	9.7	3.2
2014	Plot050	Thin and Burn	4.481	4.481	27	27	0	23.286	23.286	44.815	0	18.519	70.37	11.111	33.3	29.6	3.7	3.7	14.8	11.1	3.7
2000	Plot051	Thin and Burn	4.781	4.781	32	32	0	27.047	27.047	47.812	0	18.75	62.5	18.75	28.1	37.5	12.5	6.2	6.2	9.4	0
2001	Plot051	Thin and Burn	4.561	4.561	41	41	0	29.204	29.204	45.61	0	19.512	73.171	7.317	26.8	36.6	12.2	4.9	17.1	2.4	0
2005	Plot051	Thin and Burn	4.684	4.684	38	38	0	28.875	28.875	46.842	0	18.421	68.421	13.158	26.3	39.5	10.5	5.3	10.5	7.9	0
2010	Plot051	Thin and Burn	4.677	4.677	65	65	0	37.707	37.707	46.769	0	21.538	69.231	9.231	15.4	46.2	16.9	6.2	7.7	6.2	1.5
2014	Plot051	Thin and Burn	4.578	4.578	64	64	0	36.625	36.625	45.781	0	18.75	71.875	9.375	17.2	46.9	14.1	6.2	10.9	4.7	0
2000	Plot052	Thin and Burn	4.061	4.146	49	48	1	28.429	28.723	41.033	6.122	28.571	57.143	8.163	16.3	42.9	22.4	6.1	6.1	4.1	2
2001	Plot052	Thin and Burn	4.205	4.205	39	39	0	26.261	26.261	42.051	2.564	23.077	71.795	2.564	20.5	43.6	15.4	2.6	10.3	7.7	0
2005	Plot052	Thin and Burn	3.786	3.786	56	56	0	28.33	28.33	37.857	5.357	28.571	62.5	3.571	17.9	44.6	14.3	5.4	8.9	7.1	1.8

2010	Plot052	Thin and Burn	4.659	4.659	44	44	0	30.905	30.905	46.591	0	15.909	77.273	6.818	22.7	43.2	9.1	6.8	11.4	4.5	2.3
2014	Plot052	Thin and Burn	4.213	4.5	47	44	3	28.881	29.85	43.54	6.383	23.404	59.574	10.638	10.6	44.7	14.9	8.5	12.8	6.4	2.1
2000	Plot053	Rx Fire	4.326	4.326	46	46	0	29.341	29.341	43.261	0	28.261	60.87	10.87	23.9	30.4	15.2	8.7	13	8.7	0
2001	Plot053	Rx Fire	4.535	4.535	43	43	0	29.737	29.737	45.349	0	20.93	69.767	9.302	23.3	30.2	11.6	7	18.6	9.3	0
2005	Plot053	Rx Fire	4.614	4.614	44	44	0	30.603	30.603	46.136	0	18.182	68.182	13.636	22.7	40.9	9.1	2.3	13.6	9.1	2.3
2010	Plot053	Rx Fire	4.342	4.342	38	38	0	26.767	26.767	43.421	0	26.316	65.789	7.895	26.3	31.6	7.9	7.9	15.8	7.9	2.6
2014	Plot053	Rx Fire	4.64	4.64	25	25	0	23.2	23.2	46.4	0	24	64	12	28	32	4	8	12	16	0
2000	Plot054	Rx Fire	4.971	4.971	34	34	0	28.983	28.983	49.706	0	8.824	76.471	14.706	29.4	32.4	8.8	5.9	11.8	8.8	2.9
2001	Plot054	Rx Fire	4.667	4.667	27	27	0	24.249	24.249	46.667	0	18.519	70.37	11.111	33.3	29.6	3.7	3.7	11.1	14.8	3.7
2005	Plot054	Rx Fire	4.75	4.75	32	32	0	26.87	26.87	47.5	0	12.5	81.25	6.25	28.1	25	12.5	6.2	12.5	12.5	3.1
2010	Plot054	Rx Fire	4.738	4.738	42	42	0	30.706	30.706	47.381	0	14.286	76.19	9.524	21.4	38.1	14.3	2.4	14.3	7.1	2.4
2014	Plot054	Rx Fire	4.395	4.395	38	38	0	27.091	27.091	43.947	2.632	21.053	65.789	10.526	21.1	34.2	23.7	5.3	10.5	2.6	2.6
2000	Plot055	Rx Fire	4.391	4.591	23	22	1	21.06	21.533	44.9	4.348	13.043	78.261	4.348	34.8	34.8	0	0	17.4	13	0
2001	Plot055	Rx Fire	4.6	4.6	20	20	0	20.572	20.572	46	0	20	65	15	30	40	0	5	5	20	0
2005	Plot055	Rx Fire	4.56	4.56	25	25	0	22.8	22.8	45.6	0	16	76	8	48	20	4	4	12	12	0
2010	Plot055	Rx Fire	3.484	3.849	95	86	9	33.96	35.693	36.62	15.789	26.316	50.526	7.368	12.6	49.5	20	5.3	8.4	4.2	0
2014	Plot055	Rx Fire	3.68	3.79	103	100	3	37.344	37.9	37.344	8.738	35.922	45.631	9.709	10.7	57.3	12.6	4.9	8.7	2.9	2.9
2000	Plot056	Thin and Burn	4.7	4.7	50	50	0	33.234	33.234	47	0	24	62	14	18	48	14	4	10	6	0
2001	Plot056	Thin and Burn	4.652	4.652	46	46	0	31.553	31.553	46.522	0	17.391	73.913	8.696	19.6	50	8.7	4.3	8.7	8.7	0
2005	Plot056	Thin and Burn	4.784	4.784	51	51	0	34.167	34.167	47.843	0	17.647	70.588	11.765	17.6	54.9	7.8	3.9	9.8	5.9	0
2010	Plot056	Thin and Burn	4.159	4.207	88	87	1	39.016	39.239	41.829	4.545	27.273	60.227	7.955	11.4	56.8	15.9	3.4	6.8	4.5	1.1
2014	Plot056	Thin and Burn	4.07	4.167	86	84	2	37.741	38.188	41.179	5.814	30.233	54.651	9.302	10.5	55.8	16.3	3.5	9.3	4.7	0
2000	Plot057	Thin and Burn	4.5	4.5	34	34	0	26.239	26.239	45	0	26.471	64.706	8.824	17.6	35.3	11.8	11.8	11.8	8.8	2.9
2001	Plot057	Thin and Burn	4.345	4.345	29	29	0	23.398	23.398	43.448	0	24.138	65.517	10.345	20.7	48.3	3.4	6.9	6.9	10.3	3.4
2005	Plot057	Thin and Burn	4.641	4.641	39	39	0	28.983	28.983	46.41	0	17.949	66.667	15.385	20.5	43.6	12.8	5.1	7.7	7.7	2.6
2010	Plot057	Thin and Burn	4.622	4.622	37	37	0	28.112	28.112	46.216	0	18.919	70.27	10.811	27	35.1	10.8	5.4	16.2	2.7	2.7
2014	Plot057	Thin and Burn	4.512	4.625	41	40	1	28.892	29.251	45.682	2.439	17.073	68.293	12.195	24.4	53.7	7.3	7.3	2.4	2.4	2.4
2000	Plot058	Thin and Burn	4.629	4.629	35	35	0	27.383	27.383	46.286	0	20	74.286	5.714	28.6	45.7	0	2.9	14.3	8.6	0
2001	Plot058	Thin and Burn	4.781	4.781	32	32	0	27.047	27.047	47.812	0	15.625	78.125	6.25	28.1	40.6	6.2	3.1	12.5	9.4	0
2005	Plot058	Thin and Burn	5.071	5.071	42	42	0	32.867	32.867	50.714	0	11.905	73.81	14.286	26.2	40.5	19	2.4	4.8	7.1	0

2010	Plot058	Thin and Burn	4.812	4.812	48	48	0	33.342	33.342	48.125	2.083	14.583	68.75	14.583	18.8	50	12.5	6.2	6.2	4.2	2.1
2014	Plot058	Thin and Burn	4.792	4.792	53	53	0	34.89	34.89	47.925	0	15.094	69.811	15.094	17	54.7	11.3	5.7	5.7	5.7	0
2000	Plot059	Thin and Burn	4.098	4.2	41	40	1	26.237	26.563	41.485	7.317	24.39	58.537	9.756	22	36.6	22	2.4	9.8	7.3	0
2001	Plot059	Thin and Burn	4.167	4.268	42	41	1	27.003	27.33	42.172	4.762	26.19	57.143	11.905	21.4	40.5	11.9	9.5	9.5	7.1	0
2005	Plot059	Thin and Burn	4.56	4.653	50	49	1	32.244	32.571	46.063	2	18	68	12	18	40	16	6	14	6	0
2010	Plot059	Thin and Burn	4.544	4.544	57	57	0	34.305	34.305	45.439	0	24.561	63.158	12.281	19.3	40.4	15.8	5.3	12.3	5.3	1.8
2014	Plot059	Thin and Burn	4.793	4.793	58	58	0	36.503	36.503	47.931	0	20.69	60.345	18.966	15.5	48.3	13.8	3.4	13.8	3.4	1.7
2000	Plot060	Thin and Burn	4.519	4.519	27	27	0	23.479	23.479	45.185	0	22.222	70.37	7.407	25.9	37	0	3.7	18.5	11.1	3.7
2001	Plot060	Thin and Burn	4.586	4.586	29	29	0	24.697	24.697	45.862	0	24.138	58.621	17.241	31	37.9	3.4	3.4	10.3	13.8	0
2005	Plot060	Thin and Burn	4.697	4.697	33	33	0	26.982	26.982	46.97	0	18.182	69.697	12.121	18.2	42.4	6.1	3	18.2	9.1	3
2010	Plot060	Thin and Burn	4.674	4.674	46	46	0	31.7	31.7	46.739	0	17.391	69.565	13.043	21.7	41.3	6.5	6.5	15.2	6.5	2.2
2014	Plot060	Thin and Burn	4	4.087	47	46	1	27.423	27.719	40.432	4.255	34.043	48.936	12.766	21.3	42.6	8.5	2.1	17	8.5	0
2000	Plot061	Rx Fire	4.033	4.033	61	61	0	31.497	31.497	40.328	0	39.344	52.459	8.197	11.5	52.5	6.6	8.2	11.5	6.6	3.3
2001	Plot061	Rx Fire	3.833	3.883	78	77	1	33.855	34.074	38.581	3.846	35.897	56.41	3.846	10.3	52.6	12.8	7.7	9	3.8	3.8
2005	Plot061	Rx Fire	4.035	4.035	86	86	0	37.418	37.418	40.349	1.163	32.558	56.977	9.302	11.6	54.7	12.8	4.7	8.1	4.7	3.5
2010	Plot061	Rx Fire	3.917	4.028	109	106	3	40.899	41.474	39.725	5.505	30.275	55.963	8.257	11.9	54.1	13.8	4.6	10.1	5.5	0
2014	Plot061	Rx Fire	3.815	3.948	119	115	4	41.618	42.336	38.809	7.563	31.092	52.101	9.244	7.6	60.5	11.8	5.9	7.6	4.2	2.5
2000	Plot062	Thin and Burn	4.6	4.6	25	25	0	23	23	46	0	20	68	12	32	36	0	4	12	16	0
2001	Plot062	Thin and Burn	4.25	4.25	28	28	0	22.489	22.489	42.5	0	25	71.429	3.571	25	39.3	0	3.6	17.9	14.3	0
2005	Plot062	Thin and Burn	4.441	4.441	34	34	0	25.896	25.896	44.412	0	20.588	67.647	11.765	35.3	38.2	0	2.9	8.8	11.8	2.9
2010	Plot062	Thin and Burn	3.782	3.852	55	54	1	28.047	28.305	38.167	5.455	34.545	50.909	9.091	21.8	45.5	9.1	1.8	12.7	5.5	3.6
2014	Plot062	Thin and Burn	3.931	4	58	57	1	29.938	30.199	39.654	3.448	34.483	55.172	6.897	17.2	39.7	13.8	8.6	12.1	6.9	1.7
2000	Plot063	Rx Fire	4.559	4.559	34	34	0	26.582	26.582	45.588	0	17.647	73.529	3	29.4	35.3	2.9	5.9	17.6	8.8	0
2001	Plot063	Rx Fire	4.581	4.581	31	31	0	25.504	25.504	45.806	0	22.581	67.742	3	19.4	45.2	3.2	3.2	16.1	12.9	0
2005	Plot063	Rx Fire	4.444	4.444	36	36	0	26.667	26.667	44.444	0	22.222	72.222	3	25	41.7	5.6	2.8	16.7	5.6	2.8
2010	Plot063	Rx Fire	4.625	4.625	40	40	0	29.251	29.251	46.25	0	20	70	3	25	35	7.5	5	17.5	7.5	2.5
2014	Plot063	Rx Fire	4.44	4.44	50	50	0	31.396	31.396	44.4	0	28	60	3	22	42	10	4	12	8	2
2000	Plot064	Thin and	4.176	4.239	68	67	1	34.44	34.696	42.075	2.941	26.471	64.706	5.882	11.8	45.6	20.6	4.4	13.2	4.4	0

		Burn																			
2001	Plot064	Thin and Burn	4.196	4.273	56	55	1	31.403	31.687	42.344	1.786	26.786	64.286	7.143	19.6	37.5	19.6	5.4	12.5	3.6	1.8
2005	Plot064	Thin and Burn	3.986	4.099	73	71	2	34.059	34.535	40.421	4.11	32.877	56.164	6.849	12.3	52.1	17.8	5.5	8.2	4.1	0
2010	Plot064	Thin and Burn	4.213	4.213	89	89	0	39.75	39.75	42.135	2.247	26.966	64.045	6.742	14.6	48.3	19.1	4.5	9	3.4	1.1
2014	Plot064	Thin and Burn	4.254	4.254	67	67	0	34.818	34.818	42.537	2.985	23.881	62.687	10.448	13.4	50.7	16.4	4.5	10.4	3	1.5
2000	Plot065	Thin and Burn	4.923	4.923	26	26	0	25.103	25.103	49.231	0	11.538	73.077	15.385	34.6	26.9	0	7.7	19.2	11.5	0
2001	Plot065	Thin and Burn	4.28	4.28	25	25	0	21.4	21.4	42.8	0	20	76	4	36	24	0	4	20	16	0
2005	Plot065	Thin and Burn	4.611	4.611	36	36	0	27.667	27.667	46.111	0	13.889	77.778	8.333	27.8	41.7	8.3	2.8	13.9	5.6	0
2010	Plot065	Thin and Burn	4.27	4.27	63	63	0	33.891	33.891	42.698	1.587	25.397	66.667	6.349	22.2	41.3	14.3	7.9	7.9	4.8	1.6
2014	Plot065	Thin and Burn	4.647	4.647	51	51	0	33.187	33.187	46.471	0	21.569	64.706	13.725	17.6	45.1	13.7	5.9	11.8	3.9	2
2000	Plot066	Thin and Burn	4.722	4.722	36	36	0	28.333	28.333	47.222	0	16.667	69.444	13.889	30.6	27.8	16.7	8.3	11.1	5.6	0
2001	Plot066	Thin and Burn	4.528	4.528	36	36	0	27.167	27.167	45.278	0	16.667	72.222	11.111	27.8	25	22.2	8.3	11.1	5.6	0
2005	Plot066	Thin and Burn	4.311	4.311	45	45	0	28.92	28.92	43.111	0	26.667	62.222	11.111	20	40	17.8	6.7	13.3	2.2	0
2010	Plot066	Thin and Burn	4.364	4.364	66	66	0	35.45	35.45	43.636	1.515	27.273	59.091	12.121	18.2	37.9	21.2	9.1	9.1	4.5	0
2014	Plot066	Thin and Burn	4.633	4.633	49	49	0	32.429	32.429	46.327	0	20.408	63.265	16.327	16.3	42.9	18.4	6.1	10.2	6.1	0
2000	Plot067	Thin and Burn	4.727	4.837	44	43	1	31.357	31.72	47.819	2.273	11.364	75	11.364	27.3	50	2.3	2.3	11.4	6.8	0
2001	Plot067	Thin and Burn	4.459	4.459	37	37	0	27.126	27.126	44.595	0	16.216	78.378	5.405	24.3	32.4	10.8	2.7	16.2	10.8	2.7
2005	Plot067	Thin and Burn	4.408	4.5	49	48	1	30.857	31.177	44.538	2.041	20.408	69.388	8.163	16.3	53.1	10.2	4.1	6.1	8.2	2
2010	Plot067	Thin and Burn	4.314	4.314	70	70	0	36.096	36.096	43.143	1.429	24.286	65.714	8.571	18.6	40	15.7	5.7	11.4	5.7	2.9
2014	Plot067	Thin and Burn	4.167	4.167	66	66	0	33.85	33.85	41.667	3.03	25.758	62.121	9.091	16.7	50	13.6	6.1	7.6	4.5	1.5
2000	Plot068	Thin and Burn	4.412	4.412	34	34	0	25.725	25.725	44.118	0	17.647	73.529	8.824	20.6	26.5	11.8	8.8	17.6	11.8	2.9
2001	Plot068	Thin and Burn	4.808	4.808	26	26	0	24.515	24.515	48.077	0	11.538	76.923	11.538	23.1	34.6	11.5	3.8	11.5	11.5	3.8
2005	Plot068	Thin and Burn	4.839	4.839	31	31	0	26.941	26.941	48.387	0	12.903	74.194	12.903	22.6	38.7	12.9	6.5	9.7	6.5	3.2
2010	Plot068	Thin and	4.648	4.648	54	54	0	34.157	34.157	46.481	0	22.222	66.667	11.111	22.2	40.7	11.1	3.7	14.8	5.6	1.9

		Burn																			
2014	Plot068	Thin and Burn	4.189	4.189	37	37	0	25.482	25.482	41.892	0	24.324	70.27	5.405	24.3	29.7	10.8	10.8	13.5	8.1	2.7
2000	Plot069	Thin and Burn	4.667	4.667	36	36	0	28	28	46.667	0	19.444	66.667	13.889	19.4	41.7	11.1	5.6	11.1	8.3	2.8
2001	Plot069	Thin and Burn	4.533	4.533	30	30	0	24.83	24.83	45.333	0	16.667	73.333	10	26.7	26.7	16.7	3.3	13.3	10	3.3
2005	Plot069	Thin and Burn	4.689	4.689	45	45	0	31.454	31.454	46.889	0	17.778	68.889	13.333	15.6	51.1	8.9	4.4	11.1	6.7	2.2
2010	Plot069	Thin and Burn	4.705	4.705	61	61	0	36.747	36.747	47.049	0	22.951	62.295	14.754	14.8	42.6	18	6.6	11.5	4.9	1.6
2014	Plot069	Thin and Burn	4.481	4.481	52	52	0	32.311	32.311	44.808	0	25	63.462	11.538	15.4	46.2	15.4	5.8	11.5	3.8	1.9
2000	Plot07	Thin Only	4.156	4.156	32	32	0	23.511	23.511	41.562	0	25	71.875	3.125	28.1	34.4	6.2	3.1	12.5	12.5	3.1
2000	Plot070	Rx Fire	4.75	4.75	16	16	0	19	19	47.5	0	12.5	75	12.5	37.5	18.8	0	12.5	18.8	12.5	0
2001	Plot070	Rx Fire	4.667	4.667	12	12	0	16.166	16.166	46.667	0	8.333	91.667	0	50	16.7	0	8.3	16.7	8.3	0
2005	Plot070	Rx Fire	4.762	4.762	21	21	0	21.822	21.822	47.619	0	14.286	71.429	14.286	28.6	38.1	0	9.5	19	4.8	0
2010	Plot070	Rx Fire	4.778	4.778	27	27	0	24.826	24.826	47.778	0	11.111	77.778	11.111	33.3	29.6	7.4	7.4	18.5	3.7	0
2014	Plot070	Rx Fire	4.367	4.367	30	30	0	23.917	23.917	43.667	3.333	20	66.667	10	20	46.7	10	6.7	13.3	3.3	0
2000	Plot071	Thin and Burn	4.842	4.842	19	19	0	21.106	21.106	48.421	0	10.526	78.947	10.526	47.4	31.6	0	5.3	10.5	5.3	0
2001	Plot071	Thin and Burn	4.632	4.632	19	19	0	20.189	20.189	46.316	0	10.526	84.211	5.263	47.4	26.3	0	5.3	15.8	5.3	0
2005	Plot071	Thin and Burn	4.19	4.4	21	20	1	19.203	19.677	42.94	4.762	19.048	71.429	4.762	38.1	23.8	4.8	4.8	19	9.5	0
2010	Plot071	Thin and Burn	4.478	4.478	46	46	0	30.373	30.373	44.783	0	19.565	71.739	8.696	26.1	37	10.9	6.5	15.2	4.3	0
2014	Plot071	Thin and Burn	4.614	4.614	44	44	0	30.603	30.603	46.136	0	20.455	65.909	13.636	20.5	43.2	13.6	4.5	15.9	2.3	0
2000	Plot072	Rx Fire	4.158	4.158	19	19	0	18.124	18.124	41.579	0	26.316	63.158	10.526	47.4	10.5	5.3	5.3	15.8	15.8	0
2001	Plot072	Rx Fire	3.867	3.867	15	15	0	14.976	14.976	38.667	0	33.333	66.667	0	40	26.7	0	0	13.3	20	0
2005	Plot072	Rx Fire	4.4	4.552	30	29	1	24.1	24.512	44.752	3.333	16.667	70	10	23.3	36.7	10	3.3	16.7	10	0
2010	Plot072	Rx Fire	4.617	4.617	47	47	0	31.653	31.653	46.17	0	23.404	61.702	14.894	19.1	44.7	8.5	4.3	17	6.4	0
2014	Plot072	Rx Fire	4.135	4.135	52	52	0	29.815	29.815	41.346	1.923	30.769	55.769	11.538	17.3	48.1	9.6	5.8	13.5	5.8	0
2000	Plot073	Thin and Burn	4.469	4.469	32	32	0	25.279	25.279	44.688	0	12.5	81.25	6.25	28.1	31.2	12.5	6.2	9.4	9.4	3.1
2001	Plot073	Thin and Burn	4.724	4.724	29	29	0	25.44	25.44	47.241	0	13.793	75.862	10.345	27.6	31	10.3	3.4	20.7	6.9	0
2005	Plot073	Thin and Burn	4.757	4.889	37	36	1	28.934	29.333	48.224	2.703	8.108	72.973	16.216	24.3	40.5	13.5	2.7	10.8	5.4	2.7
2010	Plot073	Thin and Burn	4.455	4.455	77	77	0	39.088	39.088	44.545	1.299	23.377	66.234	9.091	22.1	42.9	13	5.2	10.4	5.2	1.3
2014	Plot073	Thin and Burn	4.395	4.453	76	75	1	38.312	38.567	44.239	3.947	25	56.579	14.474	9.2	59.2	11.8	2.6	10.5	5.3	1.3
2000	Plot074	Thin and	4.78	4.78	50	50	0	33.8	33.8	47.8	0	20	66	14	16	50	12	6	8	6	2

		Burn																			
2001	Plot074	Thin and Burn	4.854	4.854	41	41	0	31.079	31.079	48.537	0	14.634	70.732	14.634	24.4	51.2	9.8	2.4	7.3	4.9	0
2005	Plot074	Thin and Burn	4.625	4.625	56	56	0	34.61	34.61	46.25	0	17.857	75	7.143	14.3	51.8	14.3	7.1	5.4	5.4	1.8
2010	Plot074	Thin and Burn	4.806	4.806	72	72	0	40.776	40.776	48.056	1.389	13.889	72.222	12.5	19.4	50	11.1	5.6	8.3	4.2	1.4
2014	Plot074	Thin and Burn	4.891	4.891	55	55	0	36.272	36.272	48.909	0	10.909	74.545	14.545	18.2	49.1	10.9	3.6	10.9	5.5	1.8
2000	Plot075	Rx Fire	5	5	36	36	0	30	30	50	0	8.333	77.778	13.889	27.8	41.7	8.3	2.8	8.3	8.3	2.8
2001	Plot075	Rx Fire	4.786	4.786	28	28	0	25.324	25.324	47.857	0	10.714	78.571	10.714	32.1	32.1	7.1	3.6	10.7	10.7	3.6
2005	Plot075	Rx Fire	4.8	4.8	35	35	0	28.397	28.397	48	0	11.429	80	8.571	31.4	37.1	11.4	2.9	5.7	8.6	2.9
2010	Plot075	Rx Fire	4.878	4.878	49	49	0	34.143	34.143	48.776	0	14.286	71.429	14.286	22.4	44.9	8.2	6.1	8.2	8.2	2
2014	Plot075	Rx Fire	4.647	4.647	51	51	0	33.187	33.187	46.471	0	19.608	64.706	15.686	17.6	43.1	15.7	5.9	9.8	5.9	2
2000	Plot076	Thin and Burn	4.462	4.462	26	26	0	22.749	22.749	44.615	0	11.538	80.769	7.692	42.3	30.8	0	3.8	11.5	7.7	3.8
2001	Plot076	Thin and Burn	4.35	4.35	20	20	0	19.454	19.454	43.5	0	20	75	5	45	20	0	5	15	10	5
2005	Plot076	Thin and Burn	4.429	4.429	28	28	0	23.434	23.434	44.286	0	14.286	78.571	7.143	35.7	35.7	3.6	3.6	14.3	3.6	3.6
2010	Plot076	Thin and Burn	5	5	30	30	0	27.386	27.386	50	0	6.667	83.333	10	30	26.7	16.7	6.7	6.7	6.7	6.7
2014	Plot076	Thin and Burn	4.545	4.545	33	33	0	26.112	26.112	45.455	0	21.212	69.697	9.091	27.3	39.4	6.1	6.1	9.1	9.1	3
2000	Plot077	Rx Fire	4.559	4.559	59	59	0	35.021	35.021	45.593	0	23.729	67.797	8.475	16.9	45.8	13.6	5.1	11.9	6.8	0
2001	Plot077	Rx Fire	4.49	4.49	51	51	0	32.066	32.066	44.902	0	23.529	68.627	7.843	19.6	39.2	17.6	7.8	11.8	3.9	0
2005	Plot077	Rx Fire	4.352	4.414	71	70	1	36.672	36.933	43.831	1.408	25.352	63.38	9.859	15.5	50.7	16.9	5.6	5.6	4.2	1.4
2010	Plot077	Rx Fire	4.582	4.582	79	79	0	40.728	40.728	45.823	0	18.987	70.886	10.127	17.7	40.5	16.5	7.6	11.4	5.1	1.3
2014	Plot077	Rx Fire	4.562	4.562	89	89	0	43.036	43.036	45.618	0	21.348	69.663	8.989	14.6	52.8	13.5	6.7	6.7	4.5	1.1
2000	Plot078	Thin and Burn	4.68	4.68	50	50	0	33.093	33.093	46.8	0	20	72	8	20	42	18	4	12	2	2
2001	Plot078	Thin and Burn	4.69	4.69	42	42	0	30.398	30.398	46.905	0	19.048	71.429	9.524	16.7	47.6	14.3	2.4	11.9	4.8	2.4
2005	Plot078	Thin and Burn	4.304	4.382	56	55	1	32.205	32.496	43.425	1.786	25	66.071	7.143	10.7	53.6	14.3	3.6	10.7	5.4	1.8
2010	Plot078	Thin and Burn	4.958	4.958	71	71	0	41.775	41.775	49.577	0	12.676	71.831	15.493	15.5	49.3	14.1	5.6	11.3	2.8	1.4
2014	Plot078	Thin and Burn	4.569	4.569	65	65	0	36.838	36.838	45.692	1.538	20	66.154	12.308	15.4	49.2	16.9	3.1	10.8	3.1	1.5
2000	Plot079	Thin and Burn	4.568	4.568	44	44	0	30.302	30.302	45.682	0	18.182	75	6.818	20.5	31.8	9.1	9.1	18.2	9.1	2.3
2001	Plot079	Thin and Burn	4.465	4.465	43	43	0	29.28	29.28	44.651	0	20.93	69.767	9.302	16.3	46.5	9.3	9.3	11.6	4.7	2.3
2005	Plot079	Thin and Burn	4.654	4.654	52	52	0	33.559	33.559	46.538	0	23.077	63.462	13.462	17.3	51.9	9.6	5.8	7.7	5.8	1.9

2010	Plot079	Thin and Burn	4.857	4.857	70	70	0	40.638	40.638	48.571	0	17.143	67.143	15.714	15.7	48.6	12.9	4.3	11.4	5.7	1.4
2014	Plot079	Thin and Burn	4.439	4.439	57	57	0	33.511	33.511	44.386	0	28.07	59.649	12.281	17.5	50.9	10.5	3.5	14	1.8	1.8
2000	Plot080	Rx Fire	4.479	4.574	48	47	1	31.033	31.361	45.266	2.083	18.75	70.833	8.333	20.8	47.9	10.4	4.2	10.4	4.2	2.1
2001	Plot080	Rx Fire	4.477	4.477	44	44	0	29.699	29.699	44.773	0	22.727	68.182	9.091	22.7	40.9	9.1	2.3	15.9	6.8	2.3
2005	Plot080	Rx Fire	4.509	4.509	57	57	0	34.04	34.04	45.088	1.754	21.053	64.912	12.281	17.5	49.1	12.3	5.3	8.8	5.3	1.8
2010	Plot080	Rx Fire	4.797	4.797	59	59	0	36.843	36.843	47.966	0	18.644	66.102	15.254	18.6	42.4	15.3	3.4	13.6	5.1	1.7
2014	Plot080	Rx Fire	4.726	4.726	62	62	0	37.211	37.211	47.258	0	22.581	62.903	14.516	14.5	56.5	8.1	3.2	12.9	3.2	1.6
2000	Plot081	Thin and Burn	4.625	4.625	32	32	0	26.163	26.163	46.25	0	9.375	87.5	3.125	31.2	28.1	18.8	9.4	3.1	9.4	0
2001	Plot081	Thin and Burn	4.6	4.6	20	20	0	20.572	20.572	46	0	10	85	5	25	30	10	15	10	10	0
2005	Plot081	Thin and Burn	4.333	4.42	51	50	1	30.946	31.254	43.765	1.961	27.451	58.824	11.765	13.7	43.1	21.6	9.8	3.9	7.8	0
2010	Plot081	Thin and Burn	4.706	4.706	51	51	0	33.607	33.607	47.059	0	23.529	62.745	13.725	15.7	49	11.8	5.9	11.8	5.9	0
2014	Plot081	Thin and Burn	4.46	4.551	50	49	1	31.537	31.857	45.053	4	20	60	16	16	44	14	8	10	6	2
2000	Plot082	Thin and Burn	3.267	3.5	30	28	2	17.892	18.52	33.813	16.667	30	50	3.333	23.3	43.3	16.7	3.3	3.3	10	0
2001	Plot082	Thin and Burn	3.786	3.926	28	27	1	20.032	20.4	38.552	10.714	17.857	67.857	3.571	25	35.7	10.7	3.6	14.3	10.7	0
2005	Plot082	Thin and Burn	4.1	4.205	40	39	1	25.931	26.261	41.522	2.5	30	57.5	10	12.5	50	10	10	10	7.5	0
2010	Plot082	Thin and Burn	4.4	4.4	60	60	0	34.082	34.082	44	1.667	25	63.333	10	16.7	45	15	8.3	8.3	5	1.7
2014	Plot082	Thin and Burn	3.52	3.771	75	70	5	30.484	31.554	36.435	12	34.667	48	5.333	10.7	57.3	14.7	5.3	8	4	0
2000	Plot083	Thin and Burn	4.69	4.69	29	29	0	25.255	25.255	46.897	0	13.793	75.862	10.345	31	31	3.4	6.9	13.8	13.8	0
2001	Plot083	Thin and Burn	4.541	4.541	37	37	0	27.619	27.619	45.405	0	16.216	72.973	10.811	27	35.1	16.2	5.4	8.1	8.1	0
2005	Plot083	Thin and Burn	4.581	4.69	43	42	1	30.042	30.398	46.356	2.326	23.256	62.791	11.628	20.9	41.9	11.6	4.7	11.6	9.3	0
2010	Plot083	Thin and Burn	4.611	4.611	36	36	0	27.667	27.667	46.111	0	19.444	72.222	8.333	25	30.6	8.3	5.6	13.9	11.1	5.6
2014	Plot083	Thin and Burn	4.558	4.558	52	52	0	32.866	32.866	45.577	0	19.231	69.231	11.538	23.1	36.5	7.7	5.8	17.3	7.7	1.9
2000	Plot084	Thin and Burn	4.125	4.125	40	40	0	26.089	26.089	41.25	2.5	27.5	65	5	22.5	32.5	12.5	7.5	17.5	7.5	0
2001	Plot084	Thin and Burn	4.346	4.346	26	26	0	22.161	22.161	43.462	0	26.923	65.385	7.692	23.1	42.3	3.8	3.8	15.4	11.5	0
2005	Plot084	Thin and Burn	4.207	4.207	29	29	0	22.655	22.655	42.069	0	24.138	75.862	0	37.9	20.7	10.3	0	17.2	13.8	0
2010	Plot084	Thin and	3.985	4.045	68	67	1	32.864	33.108	40.149	4.412	27.941	61.765	5.882	19.1	36.8	17.6	4.4	16.2	5.9	0

		Burn																			
2014	Plot084	Thin and Burn	3.829	4.042	76	72	4	33.38	34.295	39.339	7.895	31.579	50	10.526	11.8	42.1	21.1	7.9	11.8	5.3	0
2000	Plot085	Thin and Burn	4.562	4.562	32	32	0	25.809	25.809	45.625	0	21.875	71.875	6.25	28.1	37.5	3.1	3.1	15.6	12.5	0
2001	Plot085	Thin and Burn	4.125	4.125	40	40	0	26.089	26.089	41.25	0	27.5	67.5	5	25	42.5	2.5	0	17.5	10	2.5
2005	Plot085	Thin and Burn	4.515	4.515	33	33	0	25.938	25.938	45.152	0	18.182	75.758	6.061	24.2	45.5	3	0	15.2	12.1	0
2010	Plot085	Thin and Burn	4.409	4.409	44	44	0	29.247	29.247	44.091	0	20.455	70.455	9.091	29.5	34.1	4.5	4.5	13.6	11.4	2.3
2014	Plot085	Thin and Burn	4.196	4.273	56	55	1	31.403	31.687	42.344	3.571	26.786	60.714	8.929	23.2	39.3	8.9	8.9	8.9	7.1	3.6
2000	Plot086	Rx Fire	4.44	4.44	50	50	0	31.396	31.396	44.4	2	28	58	12	22	50	10	6	6	6	0
2001	Plot086	Rx Fire	4.522	4.522	46	46	0	30.668	30.668	45.217	0	19.565	73.913	6.522	21.7	43.5	8.7	4.3	10.9	8.7	2.2
2005	Plot086	Rx Fire	4.66	4.755	50	49	1	32.951	33.286	47.073	2	12	78	8	18	50	6	4	14	6	2
2010	Plot086	Rx Fire	4.231	4.231	78	78	0	37.365	37.365	42.308	0	28.205	65.385	6.41	17.9	42.3	10.3	9	12.8	5.1	2.6
2014	Plot086	Rx Fire	4.524	4.597	63	62	1	35.907	36.195	45.601	1.587	17.46	69.841	11.111	19	41.3	9.5	7.9	12.7	6.3	3.2
2000	Plot087	Rx Fire	4.267	4.267	15	15	0	16.525	16.525	42.667	0	20	80	0	46.7	33.3	0	0	6.7	13.3	0
2001	Plot087	Rx Fire	4	4	14	14	0	14.967	14.967	40	0	28.571	71.429	0	28.6	50	0	0	7.1	14.3	0
2005	Plot087	Rx Fire	4.421	4.421	19	19	0	19.271	19.271	44.211	0	21.053	73.684	5.263	42.1	31.6	5.3	0	10.5	10.5	0
2010	Plot087	Rx Fire	4	4.075	54	53	1	29.394	29.67	40.376	5.556	31.481	55.556	7.407	22.2	37	14.8	7.4	11.1	7.4	0
2014	Plot087	Rx Fire	3.783	3.867	46	45	1	25.655	25.938	38.244	6.522	32.609	52.174	8.696	13	45.7	15.2	8.7	10.9	6.5	0
2000	Plot088	Rx Fire	4.423	4.423	26	26	0	22.553	22.553	44.231	0	23.077	69.231	7.692	30.8	30.8	0	3.8	15.4	15.4	3.8
2001	Plot088	Rx Fire	4.773	4.773	22	22	0	22.386	22.386	47.727	0	13.636	81.818	4.545	31.8	22.7	9.1	0	18.2	18.2	0
2005	Plot088	Rx Fire	4.677	4.677	31	31	0	26.043	26.043	46.774	0	19.355	70.968	9.677	25.8	29	12.9	3.2	12.9	12.9	3.2
2010	Plot088	Rx Fire	4.718	4.718	39	39	0	29.464	29.464	47.179	0	15.385	74.359	10.256	28.2	23.1	12.8	7.7	15.4	10.3	2.6
2014	Plot088	Rx Fire	4.625	4.625	32	32	0	26.163	26.163	46.25	0	15.625	75	9.375	28.1	25	18.8	6.2	12.5	6.2	3.1
2000	Plot089	No Treatment	4.531	4.531	32	32	0	25.633	25.633	45.312	0	21.875	68.75	9.375	28.1	25	18.8	6.2	12.5	6.2	3.1
2001	Plot089	No Treatment	4.387	4.387	31	31	0	24.426	24.426	43.871	0	22.581	70.968	6.452	35.5	16.1	12.9	3.2	19.4	9.7	3.2
2005	Plot089	No Treatment	4.707	4.707	41	41	0	30.142	30.142	47.073	0	17.073	70.732	12.195	22	34.1	17.1	2.4	9.8	12.2	2.4
2010	Plot089	No Treatment	4.727	4.727	33	33	0	27.156	27.156	47.273	0	9.091	84.848	6.061	30.3	24.2	15.2	12.1	9.1	6.1	3
2014	Plot089	No Treatment	4.423	4.423	26	26	0	22.553	22.553	44.231	0	19.231	76.923	3.846	30.8	23.1	11.5	11.5	7.7	11.5	3.8
2000	Plot090	No Treatment	4.345	4.5	29	28	1	23.398	23.812	44.217	3.448	17.241	72.414	6.897	34.5	24.1	13.8	3.4	13.8	10.3	0
2001	Plot090	No Treatment	4.222	4.222	27	27	0	21.939	21.939	42.222	0	22.222	74.074	3.704	25.9	29.6	11.1	3.7	11.1	11.1	7.4
2005	Plot090	No Treatment	4.433	4.433	30	30	0	24.282	24.282	44.333	0	20	73.333	6.667	26.7	33.3	10	3.3	10	13.3	3.3
2010	Plot090	No	4.618	4.618	34	34	0	26.925	26.925	46.176	0	17.647	70.588	11.765	29.4	20.6	17.6	8.8	5.9	11.8	5.9

		Treatment																			
2014	Plot090	No Treatment	4.548	4.548	31	31	0	25.324	25.324	45.484	0	25.806	54.839	19.355	29	25.8	12.9	9.7	9.7	12.9	0
2000	Plot091	No Treatment	4.357	4.357	28	28	0	23.056	23.056	43.571	0	17.857	82.143	0	35.7	28.6	14.3	7.1	10.7	3.6	0
2001	Plot091	No Treatment	4.667	4.667	36	36	0	28	28	46.667	0	16.667	72.222	11.111	27.8	38.9	8.3	5.6	8.3	11.1	0
2005	Plot091	No Treatment	4.475	4.475	40	40	0	28.302	28.302	44.75	0	12.5	85	2.5	32.5	35	12.5	5	7.5	7.5	0
2010	Plot091	No Treatment	4.436	4.436	39	39	0	27.702	27.702	44.359	0	17.949	79.487	2.564	28.2	38.5	10.3	7.7	7.7	7.7	0
2014	Plot091	No Treatment	4.419	4.419	31	31	0	24.606	24.606	44.194	0	19.355	77.419	3.226	25.8	35.5	9.7	12.9	6.5	9.7	0
2000	Plot092	Thin and Burn	4.324	4.324	34	34	0	25.21	25.21	43.235	0	20.588	76.471	2.941	26.5	26.5	11.8	8.8	11.8	11.8	2.9
2001	Plot092	Thin and Burn	4.222	4.222	27	27	0	21.939	21.939	42.222	0	29.63	66.667	3.704	25.9	37	7.4	3.7	11.1	11.1	3.7
2005	Plot092	Thin and Burn	4.538	4.538	52	52	0	32.727	32.727	45.385	0	21.154	67.308	11.538	17.3	40.4	19.2	3.8	11.5	5.8	1.9
2010	Plot092	Thin and Burn	4.5	4.5	56	56	0	33.675	33.675	45	0	23.214	64.286	12.5	19.6	37.5	16.1	5.4	12.5	7.1	1.8
2014	Plot092	Thin and Burn	4.442	4.442	43	43	0	29.127	29.127	44.419	0	23.256	67.442	9.302	20.9	39.5	14	7	9.3	7	2.3
2000	Plot093	Thin Only	4.356	4.455	45	44	1	29.218	29.548	44.048	2.222	20	71.111	6.667	17.8	44.4	11.1	6.7	13.3	6.7	0
2001	Plot093	Thin Only	4.103	4.103	39	39	0	25.621	25.621	41.026	0	28.205	66.667	5.128	17.9	35.9	17.9	7.7	10.3	10.3	0
2005	Plot093	Thin Only	4.604	4.604	48	48	0	31.899	31.899	46.042	0	20.833	66.667	12.5	22.9	41.7	10.4	6.2	12.5	6.2	0
2010	Plot093	Thin Only	4.295	4.295	44	44	0	28.493	28.493	42.955	0	18.182	79.545	2.273	27.3	29.5	13.6	6.8	13.6	6.8	2.3
2014	Plot093	Thin Only	4.639	4.639	36	36	0	27.833	27.833	46.389	0	16.667	75	8.333	25	30.6	13.9	5.6	11.1	11.1	2.8
2000	Plot094	Thin Only	4.75	4.75	32	32	0	26.87	26.87	47.5	0	15.625	71.875	12.5	28.1	37.5	9.4	3.1	12.5	9.4	0
2001	Plot094	Thin Only	4.852	4.852	27	27	0	25.211	25.211	48.519	0	11.111	77.778	11.111	33.3	33.3	3.7	3.7	18.5	7.4	0
2005	Plot094	Thin Only	4.233	4.379	30	29	1	23.187	23.583	43.057	3.333	20	70	6.667	33.3	23.3	10	3.3	16.7	13.3	0
2010	Plot094	Thin Only	4.531	4.531	32	32	0	25.633	25.633	45.312	0	18.75	75	6.25	37.5	25	6.2	9.4	12.5	9.4	0
2014	Plot094	Thin Only	4.233	4.233	30	30	0	23.187	23.187	42.333	0	23.333	66.667	10	33.3	33.3	3.3	13.3	6.7	10	0
2000	Plot095	Thin and Burn	4.667	4.667	42	42	0	30.243	30.243	46.667	0	21.429	66.667	11.905	21.4	35.7	11.9	9.5	11.9	7.1	2.4
2001	Plot095	Thin and Burn	4.5	4.5	34	34	0	26.239	26.239	45	2.941	20.588	64.706	11.765	23.5	41.2	8.8	2.9	11.8	8.8	2.9
2005	Plot095	Thin and Burn	4.411	4.411	56	56	0	33.007	33.007	44.107	1.786	25	60.714	12.5	14.3	39.3	19.6	8.9	12.5	5.4	0
2010	Plot095	Thin and Burn	4.274	4.344	62	61	1	33.655	33.93	43.091	3.226	25.806	62.903	8.065	19.4	40.3	17.7	8.1	12.9	1.6	0
2014	Plot095	Thin and Burn	4.426	4.426	54	54	0	32.524	32.524	44.259	0	27.778	62.963	9.259	14.8	42.6	16.7	9.3	11.1	5.6	0
2000	Plot096	Thin and Burn	4.476	4.476	42	42	0	29.009	29.009	44.762	0	21.429	76.19	2.381	21.4	50	9.5	2.4	9.5	4.8	2.4

2001	Plot096	Thin and Burn	4.647	4.647	51	51	0	33.187	33.187	46.471	0	19.608	70.588	9.804	13.7	43.1	15.7	7.8	9.8	5.9	3.9
2005	Plot096	Thin and Burn	4.325	4.325	77	77	0	37.949	37.949	43.247	2.597	24.675	64.935	7.792	11.7	49.4	13	7.8	10.4	5.2	2.6
2010	Plot096	Thin and Burn	4.452	4.452	84	84	0	40.807	40.807	44.524	1.19	23.81	64.286	10.714	11.9	45.2	16.7	10.7	9.5	3.6	2.4
2014	Plot096	Thin and Burn	4.577	4.643	71	70	1	38.57	38.845	46.1	2.817	19.718	66.197	11.268	11.3	47.9	14.1	9.9	9.9	7	0
2000	Plot097	Rx Fire	4.333	4.333	18	18	0	18.385	18.385	43.333	0	11.111	88.889	0	27.8	44.4	5.6	0	11.1	5.6	5.6
2001	Plot097	Rx Fire	4.222	4.222	18	18	0	17.913	17.913	42.222	0	27.778	61.111	11.111	22.2	27.8	5.6	5.6	16.7	16.7	5.6
2005	Plot097	Rx Fire	4.417	4.417	24	24	0	21.637	21.637	44.167	0	20.833	75	4.167	41.7	25	0	4.2	12.5	12.5	4.2
2010	Plot097	Rx Fire	4.679	4.679	28	28	0	24.757	24.757	46.786	0	14.286	78.571	7.143	28.6	39.3	0	7.1	14.3	7.1	3.6
2014	Plot097	Rx Fire	4.417	4.417	24	24	0	21.637	21.637	44.167	0	20.833	70.833	8.333	41.7	20.8	12.5	4.2	8.3	8.3	4.2
2000	Plot098	No Treatment	4.275	4.275	51	51	0	30.526	30.526	42.745	0	27.451	64.706	7.843	15.7	45.1	7.8	7.8	13.7	5.9	3.9
2001	Plot098	No Treatment	4.262	4.262	65	65	0	34.358	34.358	42.615	0	27.692	64.615	7.692	13.8	47.7	12.3	7.7	10.8	4.6	3.1
2005	Plot098	No Treatment	4.473	4.473	74	74	0	38.478	38.478	44.73	0	25.676	63.514	10.811	14.9	48.6	12.2	9.5	8.1	4.1	2.7
2010	Plot098	No Treatment	4.091	4.091	55	55	0	30.339	30.339	40.909	1.818	23.636	70.909	3.636	23.6	40	7.3	5.5	12.7	7.3	3.6
2014	Plot098	No Treatment	3.985	4.045	67	66	1	32.619	32.865	40.152	2.985	29.851	64.179	2.985	17.9	52.2	7.5	6	9	6	1.5
2000	Plot099	Thin Only	4.769	4.769	39	39	0	29.784	29.784	47.692	0	15.385	71.795	12.821	28.2	35.9	7.7	10.3	10.3	5.1	2.6
2001	Plot099	Thin Only	4.263	4.263	38	38	0	26.28	26.28	42.632	0	23.684	71.053	5.263	28.9	31.6	7.9	13.2	10.5	5.3	2.6
2005	Plot099	Thin Only	4.743	4.743	35	35	0	28.059	28.059	47.429	0	14.286	74.286	11.429	34.3	28.6	11.4	5.7	11.4	5.7	2.9
2010	Plot099	Thin Only	4.696	4.696	46	46	0	31.847	31.847	46.957	0	17.391	71.739	10.87	21.7	34.8	10.9	13	8.7	8.7	2.2
2014	Plot099	Thin Only	4.25	4.359	40	39	1	26.879	27.222	43.041	2.5	17.5	77.5	2.5	25	30	10	10	10	10	5
2000	Plot0100	Thin and Burn	4.833	4.833	24	24	0	23.678	23.678	48.333	0	12.5	79.167	8.333	41.7	25	0	4.2	16.7	8.3	4.2
2001	Plot0100	Thin and Burn	5.05	5.05	20	20	0	22.584	22.584	50.5	0	5	80	15	45	30	0	5	15	5	0
2005	Plot0100	Thin and Burn	4.514	4.514	35	35	0	26.707	26.707	45.143	0	22.857	62.857	14.286	28.6	31.4	11.4	2.9	17.1	8.6	0
2010	Plot0100	Thin and Burn	4.826	4.826	46	46	0	32.732	32.732	48.261	0	13.043	73.913	13.043	26.1	32.6	10.9	8.7	10.9	8.7	2.2
2014	Plot0100	Thin and Burn	4.75	4.75	48	48	0	32.909	32.909	47.5	2.083	18.75	62.5	16.667	22.9	52.1	10.4	4.2	6.2	4.2	0

Appendix F. Filing structure for supplementary Pineknot FQA results. The supplementary fold submitted along with the final Pineknot report is labeled "***Pineknot_Datasets***". Within the Pineknot_Datasets fold, there are three additional folders outlining three viewable folder categories of FQA results. They are as follows:

Folder Category 1 Path:

FQA_Results

1. **FQA_RESULTS_by_SITE_TREATMENT_PLOT.xls** – Excel workbook containing all calculated FQA results by site, by treatment regime, and by plot.

   - Worksheet 1: By_Site – Calculated FQA results for all 100 plots combined for each measure year.
   - Worksheet 2: By_Treatments – Calculated FQA results for each treatment regime by each measure year (No Treatment, Burn Only, Thin Only, and Thin & Burn).
   - Worksheet 3: By_Plot – Calculated FQA results for each plot by each measure year (1-100).

2. **FQA_Management_Activity_Sheet_by_Plot.xls** – Excel workbook containing calculated FQA results for each individual plot and the chronological management activity for each plot.

Folder Category 2 Path:

Graphs

By_Plot

- One hundred .pdf files showing linear regression models of FQA metrics for each plot. Each plot contains linear regressions of richness, Native Mean C, FQI, and Adjusted FQI.

Folder Category 3 Path:

RIV_Tables

By_Plot – In this folder, five folders are labeled by measure year (2000, 2001, 2005, 2010, 2014).

- *2000 folder* – Individual RIV tables of each 100 plots for year 2000.
- *2001 folder* – Individual RIV tables of each 100 plots for year 2001.
- *2005 folder* – Individual RIV tables of each 100 plots for year 2005.
- *2010 folder* – Individual RIV tables of each 100 plots for year 2010.
- *2014 folder* – Individual RIV tables of each 100 plots for year 2014.

By_Site – Contains Pineknot Site result RIV tables.

1. **RIV_SITE.xls** – file containing site-level RIV tables for each measure year.
   - Worksheet 1: RIV site-level results for year 2000.
   - Worksheet 2: RIV site-level results for year 2001.
   - Worksheet 3: RIV site-level results for year 2005.
   - Worksheet 4: RIV site-level results for year 2010.
   - Worksheet 5: RIV site-level results for year 2014.

By_Treatment – Four excel files containing RIV table results corresponding to each treatment regime.

1. **RIV_Burn_Only.xls**

   - Worksheet 1: RIV results table for Burn Only year 2000.
   - Worksheet 2: RIV results table for Burn Only year 2001.
   - Worksheet 3: RIV results table for Burn Only year 2005.
   - Worksheet 4: RIV results table for Burn Only year 2010.
   - Worksheet 5: RIV results table for Burn Only year 2014.

2. **RIV_No_Treatment.xls**

   - Worksheet 1: RIV results table of No Treatment year 2000.
   - Worksheet 2: RIV results table of No Treatment year 2001.
   - Worksheet 3: RIV results table of No Treatment year 2005.
   - Worksheet 4: RIV results table of No Treatment year 2010.
   - Worksheet 5: RIV results table of No Treatment year 2014.

3. **RIV_Thin_and_Burn.xls**

   - Worksheet 1: RIV results table for Thin & Burn year 2000.
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   - Worksheet 4: RIV results table for Thin & Burn year 2010.
   - Worksheet 5: RIV results table for Thin & Burn year 2014.

4. **RIV_Thin_Only.xls**

   - Worksheet 1: RIV results table for Thin Only year 2000.
   - Worksheet 2: RIV results table for Thin Only year 2001.
   - Worksheet 3: RIV results table for Thin Only year 2005.
   - Worksheet 4: RIV results table for Thin Only year 2010.
   - Worksheet 5: RIV results table for Thin Only year 2014.

Cane Ridge Floristic Quality Assessment Report

(18-CS-11090500-033)

SUBMITTED TO

U.S.D.A. Forest Service - Region 9 Mark Twain Nation Forest

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Summary

This report is in accordance with the cost share cooperation agreement (18-CS-11090500-013) between NatureCITE (cooperator) and the USDA Forest Service – Region 9 Mark Twain National Forest. The report has been prepared from the Cane Ridge FACTS dataset and includes data analyses and interpretations of Floristic Quality Assessment (FQA) metrics at the site-level and for each treatment regime (No Treatment, Burn Only, Thin Only, Thin and Burn).

***Description of the report*:** Floristic Quality Assessments were conducted at the MTNF's Cane Ridge site based on Heumann et al. (2002) sample design. The objectives of the report are to: (1) update all vascular plants and C-values from the Mark Twain National Forest Cane Ridge Site FACTS dataset according to the Missouri Ecological Checklist (Ladd and Thomas 2015), and (2) use the updated Cane Ridge dataset to quantify the independent and interactive effects of prescribed burning and logging on floristic quality in native shortleaf pine and mixed pine-oak woodland plant communities in southern Missouri.

***Methods*:** Prior to FQA analysis, the original dataset was updated to the current nomenclature and C-values of the Missouri Ecological Checklist (Ladd and Thomas 2015). Assessments were conducted separately at the site-level and treatment regime levels. All FQA results were generated in a R computer software based program developed by NatureCITE.

***Key results and conclusion*:** The data suggest that richness has decreased from 2009 to 2015 for the entire Cane Ridge site (n = 31 plots) and for all treatments except Burn Only, though none of these metrics were statistically significant. Floristic Quality Assessments for the entire site showed a statistically significant increase in Mean C but at the treatment level did not. Plot-by-plot comparisons will be needed to help understand the temporal behaviors of floristic quality across the site and for evaluating habitat recovery based on the restoration goals at Cane Ridge.

Introduction

Floristic Quality Assessment (FQA) has become a widely adopted and frequently used method to estimate an areas conservation value (floristic quality) based on the effects of anthropogenic disturbances and plant species composition (Mack, 2007; Matthews et al., 2009; Mabry et al., 2018). A large part of FQA popularity among conservation practitioners and ecologist is because of its ease of use, flexibility, and accuracy (Spyreas, 2014). An area's floristic quality is based on two metrics calculated by a regional species list; Mean Coefficient of Conservatism (Mean C) and Floristic Quality Index (FQI). Mean C is calculated from the combined Coefficient of Conservatism of each vascular plant species in a given area. Weedy species have low numbers (0-3) and species that are sensitive to ecological community degradation are given high numbers (7-10). Floristic Quality Index (FQI) is the product of the Mean C and the square root of the number of species present (richness).

FQA can be a powerful tool to measure a sites conservation value and its habitat degradation (Ladd and Thomas, 2015; Mabry et al., 2018; Spyreas, 2014; Swink and Wilhelm, 1994). Comparisons of FQA metrics are often complex to interpret where developing habitats at different age structures and successional stages may be taking place at a site in a given point in time (Sypreas, 2014). Additional variables such as landscape size, management regimes, treatment designs, and multiple community types can also exhibit variability in FQA scoring, resulting in confounding analysis of post-disturbance landscapes.

Another challenge with FQA is choosing which metrics can accurately measure a sites conservation value (Mabry et al., 2018; Taft et al., 2006). FQI has conclusively been shown to have very limited usefulness in predicting a site's floristic quality and biological integrity (Bried et al. 2013; Cohen et al. 2004; Fennessy and Roehrs 1997). FQI is heavily weighted by species richness, as it is directly associated in the calculation, making FQI scoring vulnerable to differences in richness. In other words, if a site is highly degraded and species rich, FQI can be artificially higher than an undisturbed natural site with few species. Furthermore, sample area (spatial scale) is largely affected by FQI (Francis et al., 2000; Rooney and Rogers, 2002; Spyreas, 2016). When comparing FQI values at two or more sites of different sizes that may otherwise have non-overlapping habitat characters and plant communities, FQI scores may not accurately represent the site's biological integrity. Because of these area-richness pitfalls, FQI values are not ideal nor the best option of use for ecological and conservation studies (Spyreas, 2014). Mean C, because it lacks these traits, is a much better indicator.

Some attempts have been made to create alternative metrics to eliminate the richness bias in FQI as well as provide insight into non-native richness. One of these widely adopted metrics is adjusted FQAI (I'), hereafter termed Adjusted FQI (Miller and Wardrop, 2006). However, Spyreas (2014) noted that Adjusted FQI performed nearly identical to Mean C and was highly correlated with one another, therefore suggesting this metric was purely redundant, and that non-standard FQA metrics require additional calculations and data manipulations that do not significantly improve the performance from standard FQA metrics. Even some studies have shown that Adjusted FQI are not as reliable in predicting floristic quality than Mean C (Forrest, 2010).

Mean C is a better predictor of floristic quality than FQI (Bried et al. 2013; Cohen et al. 2004; Fennessy and Roehrs, 1997). Because Mean C is independent of richness and spatial scale, non-subjective site comparisons can accurately be predicted and are self-reliant. Regardless of these supported assumptions, it is important to know the research methods, sample area, and sample intensity before incorporating and interpreting FQA metrics (FQI and/or Mean C) (Spyreas, 2014). Despite all the challenges researchers face in terms of assessing an areas floristic quality, quantifying plant community dynamics in post-disturbance landscapes is much more useful to management and restoration than any individual's qualitative assumptions (Sutter, 1996; Seastedt et al., 2008). Much of the achievements and influential management decisions in conservation and restoration management comes from our ability to document and monitor the changes of landscape over periods of time.

Here, we attempt to use FQA metrics to measure the degree of conservation value and floristic quality by comparing different restoration management techniques at Cane Ridge, as well as explore some of the FQA challenges when it comes to experimental designs. The goals of this section of the report are to update the nomenclature and C-values from the Cane Ridge FACTS dataset to the current Missouri flora ecological checklist (Ladd and Thomas, 2015), and use the updated dataset to infer independent and interactive effects of prescribe burning and logging on floristic quality in shortleaf pine and mixed hardwood woodland plant communities. More importantly, we will focus on Mean C and Native Mean C as the primary predictors of conservation value across the site and treatment regimes at Cane Ridge.

Methods

Three non-consecutive field seasons (2009, 2012, and 2015) of vascular plant community sampling based on the Heumann et al. (2002) plot design were conducted at Cane Ridge. Each sampling year, researchers completed vegetation sampling on the same 31 plots established in 2009. These data were compiled for FQA analysis.

Updated Species Assignments:

In order to analyze the data from across the period of data collection, the data had to be converted to one consistent botanical nomenclature. The Ecological Checklist of the Missouri Flora (Ladd and Thomas, 2015) offers the most useful source. A list of 63 plant names in the original FACTS dataset were either replaced or omitted (Appendix A). Fifty-one of those plant names were nomenclatural updates (e.g. *Desmodium nudiflorum = Hylodesmum nudiflorum)*. Five plant names needed updated to current plant species concepts (e.g. *Acalypha gracilens = A. monococca*), and one species was omitted entirely (*Carex microdonta*) because of it could not have occurred at this site. Some data fields had "null values" in place of the scientific names but had acronym information. These individual values were replaced to the correct name and included in the final analysis (Appendix A). *Crataegus* sp. and *Rubus* sp. were the only values in the dataset with genus information but that lacked a specific epithet. *Crataegus* sp. was omitted completely because these values were not useful for FQA analysis, except for blackberries and dewberries identified as *Rubus* sp. These were given a C-value = 2 and included in the FQA analysis. Given *Rubus'* ruderal behavior and that only two standard taxa were available in the dataset (*R. ablatus* [CoC = 2]; *R. flagellaris* [CoC = 3]), this was viewed as meaningful presence/absence data for FQA analysis. It should be noted that *R. flagellaris* was more prominent at Cane Ridge compared to *R. enslenii* at Pineknot Site. Therefore, assessments of dewberries were different for Cane Ridge and Pineknot Site.

Treatment Classification and FQA Data Analysis:

FQA metrics were generated at the site-level by combining data at all 31 study plots for each sample year (2009, 2012, and 2015). Treatment plots were identified from the "CaneRidgePlots_identity_tm_rx.xlt" and then were grouped into one of four treatments: No Treatment, Burn Only, Thin Only, and Thin and Burn. One of the designated Burn Only plots (plot #11) was not burned until 2017, two years after the final sampling event took place. This plot was grouped and analyzed in the No Treatment (Table 1). Three plots in the Thin and Burn treatment (plot: #4, #5, and #6) were excluded from FQA analysis (Table 1). These plots did not receive any sampling in 2015 and would have compromised the results for Thin and Burn

Table 1. Treatment regime data classification summary. Plot #11 was identified as a Burn Only treatment but grouped and analyzed as a control because the plot did not receive any management activity until 2017 after the final sampling event in 2015. Plot numbers 4, 5, and 6 were excluded from Thin and Burn treatment analysis due to no available date for sample year 2015.

Treatment Regime	Number of Plots	Plot Identity	Number of Nested 'Unique' Treatments	Habitat	Total Sample Area
No Treatment	**4** *(plot #11 analyzed as a control)*	11, 14, 15, 30	1	Closed Woodland (n=3) Open pine woodland (n=1)	50.0m²
Thin Only	**3**	13, 17, 31	3	Closed Woodland (n=3)	37.5m²
Burn Only	**6** (plot #11 identified as Burn Only treatment but grouped in No Treatment)	3, 19, 24, 25, 27, 29	1	"Savanna" (n=1) Open pine woodland (n=6)	75.0m²
Thin and Burn	**15** (plot #4, # 5, and #6 were excluded from analysis)	1, 2, 7, 8, 9, 10, 12, 16, 18, 20, 21, 22, 23, 26, 28	12	"Savanna" (n=5) Open pine woodland (n=9) Closed Woodland (n=1)	187.5m²

treatment. The Thin Only and Thin and Burn treatments had one or more plots that received different combinations of management techniques. These unique treatment types were also identified but not analyzed (Table 1).

FQA analyses were generated at the site-level and for each treatment. FQA analysis follows calculations and rationales developed by Taft et al. (1997), Swink and Wilhelm (1994), and

Miller and Wardrop (2006). FQA calculations were conducted using base functions in R version 3.4.3 (R Core Team, 2017), and all generated FQA output files were saved in .csv format. Linear Regression models of Native Mean C, Richness, Floristic Quality Index (FQI), and Adjusted FQI were created with ggplot function of the 'ggplot2' package (Wickham, 2016). Linear regression analyses of FQA metrics across spatial scales for each treatment were assessed in Microsoft Excel (2018). Correlations between FQI and richness were also assessed.

Two required physiognomy metrics (bryophytes & rushes) were excluded from the analysis. Bryophytes were not identified in the dataset and were therefore omitted from any analysis. *Juncus tenuis* was the only rush species encountered from 2009 - 2015 and was analyzed as a "sedge" physiognomy character according to Ladd & Thomas (2015). The FQA output fields utilized in this study are shown in Table 2.

Table 2. FQA metrics applied for each measure year at the site-level and treatment regime.

Conservatism-Based Metrics	Species Richness	Physiogonomy Metrics
Total C	Native Species	Number and Percent Trees
Native C	Non-Native Species	Number and Percent Forbs
Total FQI = Total C(√NT)	Richness	Number and Percent Grasses
Native FQI = Native C(√NT)		Number and Percent Sedges
Adjusted FQI = $(\bar{C}/10 * \sqrt{N}/\sqrt{S}) * 100$		Number and Percent Shrubs
Percent C-value – 0		Number and Percent Vines
Percent C-value 1 – 3		Number and Percent Ferns
Percent C-value 4 – 6		
Percent C-value 7 – 10		

Results

Updated Species Assignments & Treatment Classification

After nomenclature changes were updated and other irrelevant and erroneous data was omitted from the original FACTS dataset, 19,864 values remained of the total 20,172. A list of the updated and omitted plant species names can be viewed in Appendix A. 306 plant species were identified between 2009 – 2015 at Cane Ridge (Appendix B).

FQA site-level results were generated from a total of 31 plots. Of these 31 plots, three plots in the Thin and Burn (plot 4, 5, and 6) were excluded from FQA treatment analysis and one plot in the Burn Only treatment (plot 11) was grouped and analyzed in the No Treatment. Treatment summary of plot designations can be viewed in table 2. After plots were grouped into each treatment regime, No Treatment (n = 4 plots) served as the control treatment for comparison against the three management treatments. Burn Only treatment was the only other treatment that represented a standardized management design and was therefore meaningful to compare FQA results against control plots (No Treatment). The remaining two management treatments (Thin Only & Thin and Burn) had multiple plots that received different activity (burning and/or logging) in different years and in different months of the year within their respective treatment regime (see supplementary data file "FQA_Management_Activity_Sheet_by_Plot.xlt"; Appendix F). These are labeled "Nested Unique Treatments" in Table 2.

FQA Analysis

Cane Ridge (Site-Level): FQA linear regression models at the site-level (n = 31) suggest a decrease in overall richness ($p<0.16$; $r^2= 0.94$) from 2009 to 2015 (Fig. 1), but it is not statistically significant. Native species richness decreased from 229 species in 2009 to 216

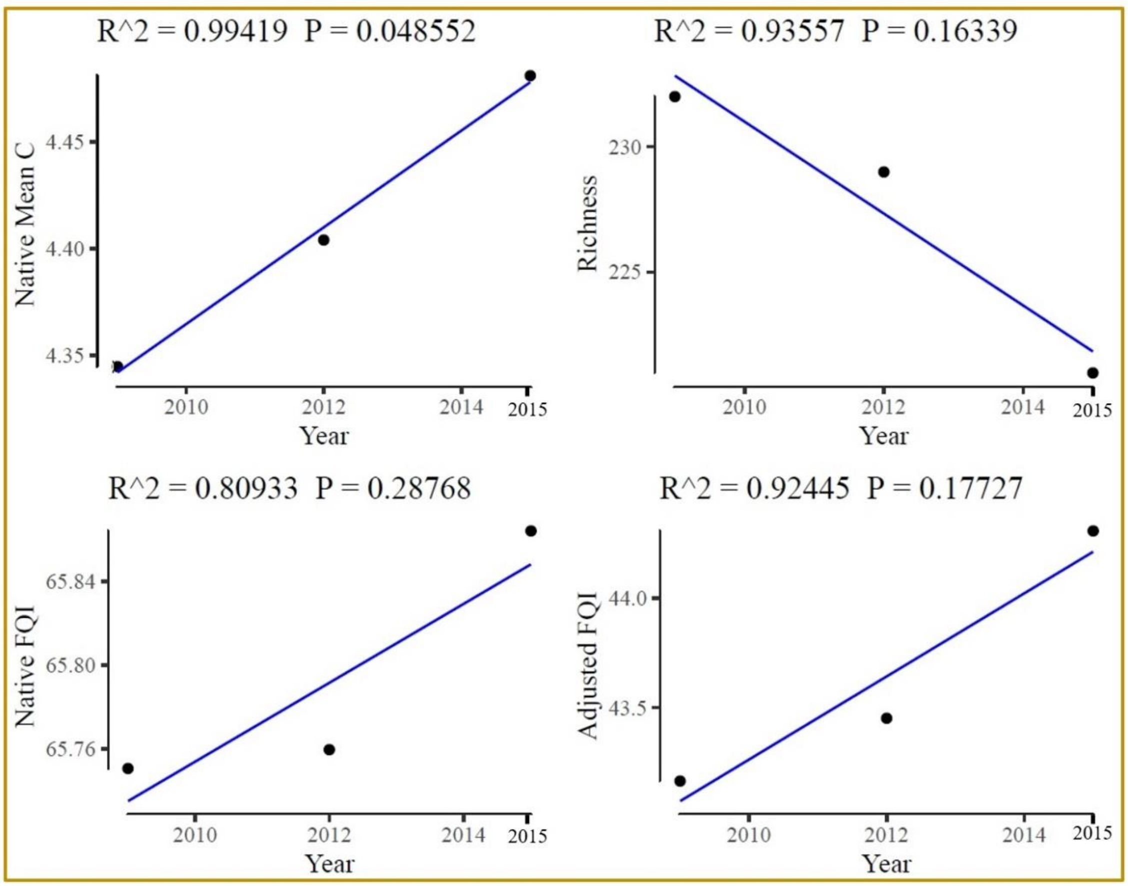

Figure 1. FQA linear regression models of Cane Ridge. Results of native Mean C, richness, native FQI, and Adjusted FQI for 2009, 2012, and 2015 (n = 31 plots). It is important to remember that Native FQI is calculated from richness and Mean C. Because of this, FQI and Adjusted FQI are redundant and potentially misleading.

species in 2015, and non-native increased from 3 in 2009 to 5 in 2015 (Appendix C). Total Mean C (4.38) and native Mean C (4.48) were at the highest values at the end of the 2015 sample year

(Fig. 1; Appendix C) and show a statistically significant increase (P = 0.049) from 2009 to 2015. FQI and Adjusted FQI generally increase over time (Fig. 1; Appendix C). Linear regression comparison of richness and native FQI were highly correlated but not significant ($p<0.12$; r^2= 0.98) (data not shown).

Year	Scientific Name	CoC	Freq.	Relative Freq.	Cover	Relative Cover	RIV	Physiognomy
2009	*Rubus ablatus*	2	381	5.182	5476	12.89	9.036	shrub
2009	*Quercus alba*	4	282	3.836	3373	7.94	5.888	tree
2009	*Rhus aromatica var. aromatica*	4	208	2.829	3048	7.175	5.002	shrub
2009	*Rhus copallinum var. latifolia*	2	182	2.476	2040	4.802	3.639	shrub
2009	*Smilax glauca*	4	397	5.4	788	1.855	3.628	vine
2009	*Parthenocissus quinquefolia*	3	356	4.842	1023	2.408	3.625	vine
2009	*Dichanthelium boscii*	5	280	3.808	1351	3.18	3.494	grass
2009	*Rubus flagellaris*	3	210	2.856	1649	3.882	3.369	shrub
2009	*Danthonia spicata*	3	202	2.748	1213	2.855	2.801	grass
2009	*Cornus florida*	5	121	1.646	1604	3.776	2.711	tree
Average	-	3.5	262	3.5623	2157	5.0763	4.319	-
2012	*Rhus copallinum var. latifolia*	2	269	3.655	2926	5.484	4.569	shrub
2012	*Rubus ablatus*	2	290	3.94	2729	5.115	4.527	shrub
2012	*Carya texana*	5	195	2.649	3185	5.969	4.309	tree
2012	*Quercus coccinea*	5	168	2.283	3065	5.744	4.013	tree
2012	*Dichanthelium boscii*	5	320	4.348	1746	3.272	3.81	grass
2012	*Quercus stellata*	4	176	2.391	2666	4.997	3.694	tree
2012	*Rhus aromatica var. aromatica*	4	192	2.609	2342	4.389	3.499	shrub
2012	*Helianthus hirsutus*	4	215	2.921	2147	4.024	3.473	forb
2012	*Nyssa sylvatica*	5	177	2.405	2344	4.393	3.399	tree
2012	*Carex umbellata*	6	307	4.171	958	1.795	2.983	sedge
Average	-	4.2	231	3.1372	2411	4.5182	3.828	-
2015	*Rubus ablatus*	2	217	4.212	2666	6.831	5.521	shrub
2015	*Quercus alba*	4	134	2.601	2302	5.898	4.249	tree
2015	*Rhus copallinum var. latifolia*	2	134	2.601	2048	5.247	3.924	shrub
2015	*Helianthus hirsutus*	4	177	3.436	1574	4.033	3.735	forb
2015	*Smilax glauca*	4	251	4.872	946	2.424	3.648	vine
2015	*Dichanthelium boscii*	5	192	3.727	1354	3.469	3.598	grass
2015	*Rhus aromatica var. aromatica*	4	99	1.922	1677	4.297	3.109	shrub
2015	*Pinus echinata*	5	212	4.115	692	1.773	2.944	tree
2015	*Rubus flagellaris*	3	140	2.717	1204	3.085	2.901	shrub
2015	*Lespedeza procumbens*	4	121	2.349	1343	3.441	2.895	forb
Average	-	3.7	168	3.2552	1581	4.0498	3.652	-

Table 3. Top ten RIV species for each measure year at Cane Ridge.

The top ten RIVs for species varied each sample year (Table 3). *Rubus ablatus*, *Rhus aromatica*, *Rhus copallinum*, and *Dichanthelium boscii* were the only species observed in the top ten for each sample year, and *R. ablatus* was the highest RIV for 2009 and 2015.

Treatment Regimes: No statistically meaningful change in any of the reported variables occurred in the any of the treatments except for a significant decline in FQI for Thin Only (Fig. 2; Fig. 3; Fig. 4). Richness for Burn Only ($p<0.18$; $r^2=0.92$) suggests an increase from 105 plant species in 2009 to 134 species (132 native; 2 exotic) by 2015 (Fig. 2; Appendix D). Native Mean C for Burn Only suggests an increase each year ($p<0.27$; $r^2=0.83$. The Thin and Burn treatment had the highest scores by 2015 for richness, which is expected since this treatment encompasses significantly more area than the other treatments.

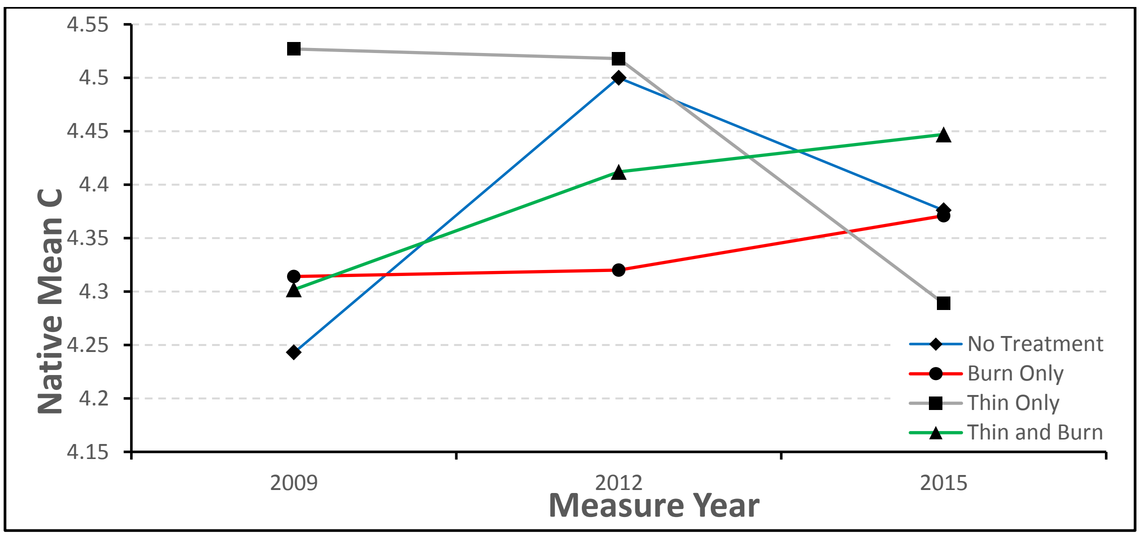

Figure 2. Change over time in native Mean C for each treatment regime. P-values are *, **, or *** for P<0.05, 0.01, and 0.001, respectively (***No Treatment*** [n=4 plots], $p<0.65$, $r^2=0.27$; ***Thin Only*** [n=3 plots], $p<0.31$, $r^2=0.78$; ***Burn Only*** [n=6 plots], $p<0.27$, $r^2=0.83$; and ***Thin and Burn*** [n=15 plots], $p<0.18$, $r^2=0.92$).

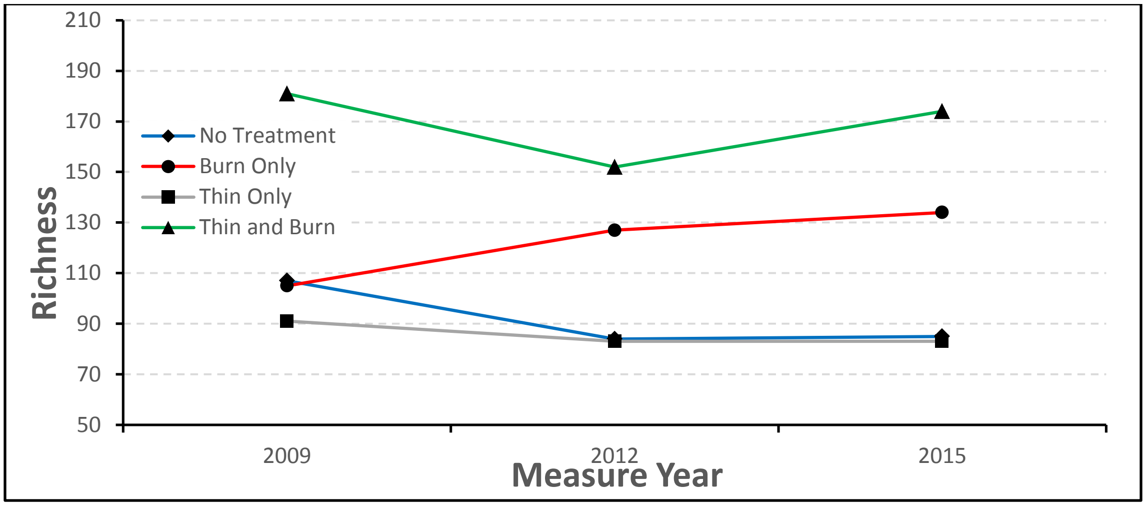

Figure 3. Change over time in richness for each treatment regime. P-values are *, **, or *** for P<0.05, 0.01, and 0.001, respectively (***No Treatment*** [n=4 plots], $p<0.36$, $r^2=0.72$; ***Thin Only*** [n=3 plots], $p<0.33$, $r^2=0.75$; ***Burn Only*** [n=6 plots], $p<0.18$, $r^2=0.92$; and ***Thin and Burn*** [n=15 plots], $p<0.85$, $r^2=0.05$). It is important to note that the initial low values for No Treatment, Thin Only, and Burn Only treatments are the result of there being many fewer plots (1/3rd to 1/5th the area of the Thin and Burn) and thus less sampled area (richness is area dependent).

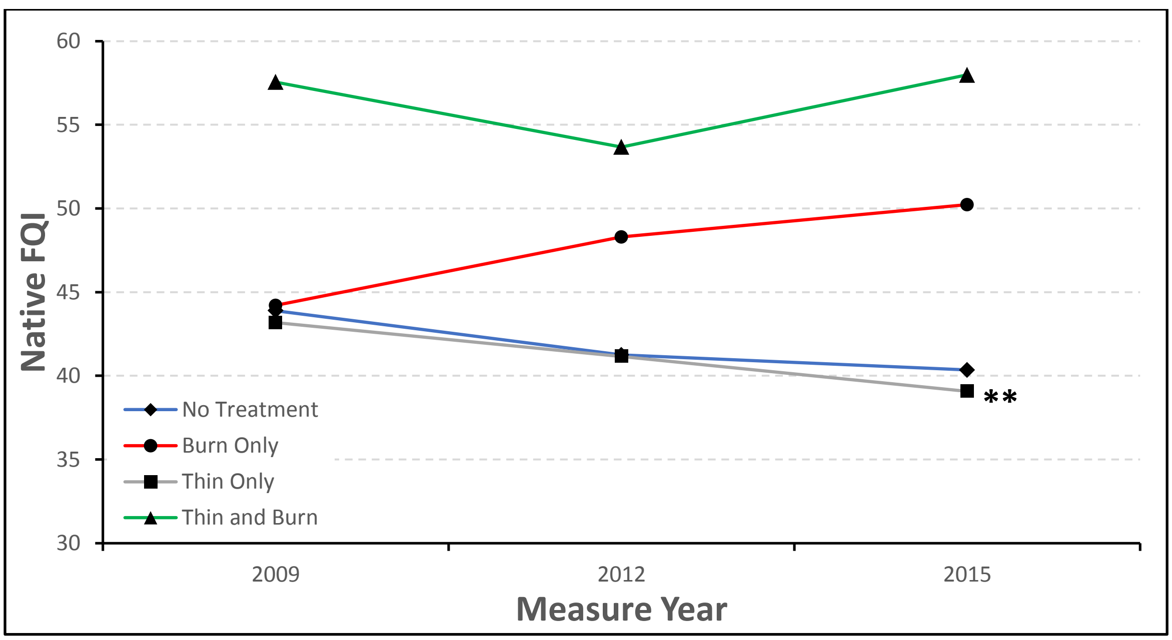

Figure 4. Change over time in native FQI for each treatment regime. P-values are *, **, or *** for P<0.05, 0.01, and 0.001, respectively (***No Treatment*** [n=4 plots], $p<0.18$, $r^2=0.92$; ***Thin Only*** [n=3 plots], $p<0.005$, $r^2=0.99$; ***Burn Only*** [n=6 plots], $p<0.13$, $r^2=0.96$; and ***Thin and Burn*** [n=15 plots], $p<0.94$, $r^2=0.09$). It is important to note that the initial low values for No Treatment, Burn Only, and Thin Only plots are potentially the result of there being much fewer (1/3rd to 1/5th the area of Thin and Burn) of these plots and thus less sampled area (richness is area dependent).

C-value range classes (0, 1-3, 4-6, 7-10) for each treatment regime were assessed (Table 4). The number of all C-value range plant individuals and the proportion gains and losses varied each year in all treatments (some gained, some lost). C-value range 4-6 had the highest number of plants observed out of all range classes but it also showed the slowest growth (Table 4).

Table 4. Total, percent, and percent difference of yearly C-value range classes for each treatment regime. Red numbers indicate annual percent losses.

Measure Year	ID	# CoC 0	% CoC 0	Annual % Gain/Loss 0	# CoC 1-3	% CoC 1-3	Annual % Gain/Loss 1-3	# CoC 4-6	% CoC 4-6	Annual % Gain/Loss 4-6	# CoC 7-10	% CoC 7-10	Annual % Gain/Loss 7-10
2009	Burn Only	2	1.905	0	27	25.714	0	67	63.81	0	9	8.571	0
2012	Burn Only	8	6.299	4.394	31	24.409	-1.305	73	57.48	-6.33	15	11.811	3.24
2015	Burn Only	5	3.731	-2.568	36	26.866	2.457	76	56.716	-0.764	17	12.687	0.876
2009	No Treatment	2	1.869	0	27	25.234	0	72	67.29	0	6	5.607	0
2012	No Treatment	0	0	-1.869	17	20.238	-4.996	62	73.81	6.52	5	5.952	0.345
2015	No Treatment	0	0	0	21	24.706	4.468	59	69.412	-4.398	5	5.882	-0.07
2009	Thin Only	1	1.099	0	18	19.78	0	65	71.429	0	7	7.692	0
2012	Thin Only	0	0	-1.099	19	22.892	3.112	57	68.675	-2.754	7	8.434	0.742
2015	Thin Only	2	2.41	2.41	19	22.892	0	56	67.47	-1.205	6	7.229	-1.205
2009	Thin and Burn	8	4.42	0	51	28.177	0	101	55.801	0	21	11.602	0
2012	Thin and Burn	9	5.921	1.501	34	22.368	-5.809	92	60.526	4.725	17	11.184	-0.418
2015	Thin and Burn	6	3.448	-2.473	46	26.437	4.069	101	58.046	-2.48	21	12.069	0.885

Physiognomy

Changes in physiognomy variables at the site and treatment levels were not found to be significant. They are reported in Appendix C and D.

Discussion

A relevant interpretation of the FQA analysis of the Cane Ridge site is complicated. On the surface, the overall increase in Mean C at the site level (Fig 1) is encouraging, but intriguing patterns emerge upon deeper investigation. And, while the graphs of other variables (Figs 1 and 2) do show fluctuations, they do not demonstrate a statistically significant change at the site or treatment levels. In order to adequately address the dynamics involved with these issues at these levels, richness and Mean C are addressed in context, separately, below. In order to do that, certain characteristics of the experimental design must be addressed first.

Experimental Design

In general, experimentation strives to assess the changes of one or few carefully controlled variables over time. It must be scaled to the variables and questions being addressed both spatially and temporally (Block et al., 2001). The plots of the Cane Ridge site exhibit considerable variation in initial conditions and in management histories that a lumping of plots into broad categories tends to ignore. For example, management of treatment areas began several years before the monitoring plots were installed. Also, 16 of the 27 treatment plots received burning and logging prescriptions in different years and sometimes at different seasons of the year; which is to say that each plot is experiencing different successional states. This type of variability is referred to as "nested unique treatments" of Table 2. It is also very likely that some of the plots differed substantially in terms of general ecological condition at the start of monitoring as well. It is also worth noting that management began several years before monitoring was initiated, thus some changes in the measured variables could have occurred before the first data were collected. This is evidenced by the presence of *Rubus ablatus*, *Rhus copallinum*, and *Rhus aromatica* (all species of disturbed systems) in the top 10 RIVs in 2009 and their relative stasis into 2015. More thorough and accurate comparisons likely occur at the plot level rather than the, somewhat, artificial treatment level. In short, while the Cane Ridge monitoring was well designed for a plot by plot analysis, it was not well designed, spatially or temporally, to accurately address floristic quality assessment as it relates to the four broadly defined treatment regimes. Doing so reduces the clarity and significance of the results.

The experimental design also makes comparisons of richness and FQI between treatments tenuous because the treatments have different numbers of plots and thus consist of different amounts of area sampled (richness and FQI are area sensitive). Comparing the treatments or plots with themselves over time is not problematic, however.

Richness

Though it appears that the linear regression of richness at the site-level across the sampling period showed a decline, the change was not statistically meaningful (Fig. 1). At the treatment level (Fig. 3) no statistically meaningful change occurred either, though the Burn Only treatment suggests an increase. When the numbers are coarsely reviewed at the plot level (n = 7) for the Burn Only treatment we see that four of the plots show an increase, three of the plots show a decrease, and one plot stays roughly the same. In the Thin and Burn treatment at the plot level, of the 15 plots, five increased in richness, seven decreased, and three did not change. Two conclusions can be drawn from these data. First, there is no unidirectional consistency in the response at the site or treatment level. Second, there appear to be trends worthy of exploration at the plot level. The plot level variability likely derives from subordinate features of management (as discussed in the "Experimental Design" section above) that we are not investigating here. If this unanalyzed variation was investigated it would likely provide significant insight into FQA dynamics that we do not currently understand.

Mean C (Floristic Quality)

Linear regression shows a significant increase in Mean C from 2009 to 2015 (Fig. 1; P = 0.048). However, this is too large of a scale to be particularly meaningful unless the trend also occurs at smaller scales. At the treatment scale the linear regressions do not show any significant directionality to the changes in Mean C (Fig. 2). At the plot scale within treatments we find that of the six Burn Only plots three did not change and three plots decreased in Mean C; of the 15 Thin and Burn plots, four increased, four decreased, and seven did not change; of the four No Treatment plots three slightly increased and one did not change; and of the three Thin Only plots two decreased and one stayed the same. Understanding the dynamics of Mean C in the study will require an in depth examination of the patterns of change at the plot level, especially in regard to their starting conditions and the details of applied management.

Conclusions

The goal of restoration is to achieve high floristic quality and richness that plateau to a stabile equilibrium. That stable equilibrium should relate to some sort of climax community or historically relevant landscape condition. Quantifying the restoration success at Cane Ridge based on each treatment regime is problematic due to the low number of replicates, differential starting points, legacy effects from anthropogenic disturbance, and variable management. There are likely multiple variables at play at the plot level that need to be teased out in order to best describe the more relevant dynamics at play. An analysis of dominant physiognomy classes or dominant species might better describe correlations in floristic quality and management inputs. For example, shrub dominance in some systems have shown to lower species diversity and cause major changes in plant community structure (Boscutti et al., 2018; Michelle and Knapp, 2003). A study by Hajny et al. (2011) found that *Rhus glabra* populations favor low intensity spring burning in tallgrass prairies. If some ruderal shrub species (*Rhus* spp. and *Rubus* spp.) positively respond to seasonality and intensity of fire at site, inferences could potentially be made about plant community assemblages that relate to the site's floristic quality. Similar observations from other species could be made about responses to light availability before and after subsequent logging activity.

Analyzing these data has been a valuable exercise in clarifying the properties of FQA measures in terms of the use of FQI, richness, and Mean C. These data have also proved valuable in understanding a broad perspective of landscape restoration management efforts in southern Missouri Ozarks. By address the concerns above, additional data collection, and a more thorough analysis beyond the scope of this report we may gain a better understand of the behavior of floristic quality as it pertains to prescribed burning and thinning in pineland systems of southern Missouri.

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Appendix A. List of updated and omitted scientific plant names from the original dataset according to Ladd & Thomas (2015).

Original Dataset Plant Names	Updated Plant Names
Acalypha gracilens	*Acalypha monococca*
Acer rubrum	*Acer rubrum var. rubrum*
Acer saccharum	*Acer saccharum subsp. saccharum*
Agrostis perennans	*Agrostis perennans var. perennans*
Aristida longespica	*Aristida longespica var. longespica*
Aristolochia serpentaria	*Aristolochia serpentaria var. serpentaria*
Aureolaria flava	*Aureolaria flava var. calycosa*
Baptisia bracteata	*Baptisia bracteata var. leucophaea*
Carex albicans	*Carex albicans var. albicans*
Carex microdonta	Omitted
Carex muehlenbergii	*Carex muehlenbergii var. muehlenbergii*
Carex nigromarginata	*Carex nigromarginata var. nigromarginata*
Carya alba	*Carya tomentosa*
Ceanothus sp.	*Ceanothus americanus*
Celtis tenuifolia	*Celtis pumila*
Circaea lutetiana	*Circaea canadensis*
Conyza canadensis	*Conyza canadensis var. canadensis*
Crataegus sp.	Omitted
Desmodium glutinosum	*Hylodesmum glutinosim*
Desmodium nudiflorum	*Hylodesmum nudiflorum*
Desmodium pauciflorum	*Hylodesmum pauciflorum*
Dichanthelium acuminatum	*Dichanthelium lanuginosum*
Dichanthelium boreale	*Dichanthelium bicknellii*
Dichanthelium commutatum	*Dichanthelium commutatum var. commutatum*
Dichanthelium dichotomum	*Dichanthelium dichotomum var. barbulatum*
Dichanthelium linearifolium	*Dichanthelium linearifolium var. linearifolium*
Dichanthelium oligosanthes	*Dichanthelium oligosanthes var. scribnerianum*
Digitaria villosa	*Digitaria violascens*
Frangula caroliniana	*Rhamnus caroliniana*
Fraxinus pennsylvanica	*Fraxinus pennsylvanica var. subintegerrima*
Galactia volubilis	*Galactia regularis*
Heliopsis helianthoides	*Heliopsis helianthoides var. helianthoides*
Houstonia longifolia	*Houstonia longifolia var. tenuifolia*
Juncus tenuis	*Juncus tenuis var. tenuis*
Leersia virginica	*Leersia virginica var. virginica*
Luzula bulbosa	*Luzula campestris var. multiflora*
Paspalum setaceum	*Paspalum setaceum var. ciliatifolium*
Phlox pilosa	*Phlox pilosa subsp. pilosa*
Physocarpus opulifolius	*Physocarpus opulifolius var. intermedius*

Prunella vulgaris	*Prunella vulgaris var. lanceolata*
Rhus aromatica	*Rhus aromatica var. aromatica*
Rhus copallinum	*Rhus copallinum var. latifolia*
Rosa carolina	*Rosa carolina subsp. carolina*
Rubus pensilvanicus	*Rubus ablatus*
Saccharum alopecuroides	*Erianthus alopecuroides*
Sideroxylon lanuginosum	*Sideroxylon lanuginosum subsp. oblongifolium*
Silene caroliniana	*Silene caroliniana var. wherryi*
Silphium integrifolium	*Silphium integrifolium var. integrifolium*
Smilax tamnoides	*Smilax hispida*
Solanum dulcamara	*Solanum carolinense*
Solidago altissima	*Solidago canadensis var. hargeri*
Solidago nemoralis	*Solidago nemoralis var. nemoralis*
Sphenopholis intermedia	*Sphenopholis obtusata var. major*
Sphenopholis obtusata	*Sphenopholis obtusata var. major*
Strophostyles helvola	*Strophostyles helvola var. helvola*
Teucrium canadense	*Teucrium canadense var. canadense*
Tridens flavus	*Tridens flavus var. flavus*
Viola triloba	*Viola palmata*
AGALI	*Agalinis tenuifolia*
CAPL5	*Carex planispicata*
RUBUS	*Rubus sp.*
RUFR4	*Rubus ablatus*
VEGIG	*Vernonia gigantea*

Appendix B. List of all 306 species encountered in the Cane Ridge floristic quality survey from 2009 - 2015, including Acronym, Nativity, CoC, Physiognomy traits, and life form. Nomenclature and CoC follows Ladd & Thomas (2015).

Scientific Name	Acronym	Native/Non-Native	CoC	Physiognomy	Duration
Acalypha monococca	ACAMON	native	3	forb	annual
Acalypha virginica	ACAVIR	native	2	forb	annual
Acer rubrum var. rubrum	ACERUR	native	5	tree	perennial
Acer saccharum subsp. saccharum	ACESUG	native	5	tree	perennial
Achillea millefolium	ACHMIL	native	1	forb	perennial
Actaea racemosa	ACTRAC	native	7	forb	perennial
Agalinis purpurea	AGAPUR	native	10	forb	annual
Agalinis tenuifolia	AGATEN	native	4	forb	annual
Ageratina altissima	AGEALT	native	2	forb	perennial
Agrimonia rostellata	AGRROS	native	4	forb	perennial
Agrostis perennans var. perennans	AGRPEP	native	3	grass	perennial
Ambrosia artemisiifolia	AMBART	native	0	forb	annual
Ambrosia bidentata	AMBBID	native	0	forb	annual
Amelanchier arborea	AMEARB	native	6	tree	perennial
Amphicarpaea bracteata	AMPBRA	native	4	forb	annual
Andropogon gerardii	ANDGER	native	5	grass	perennial
Andropogon virginicus	ANDVIR	native	2	grass	perennial
Anemone virginiana	ANEVIR	native	4	forb	perennial
Antennaria parlinii	ANTPAR	native	5	forb	perennial
Apocynum cannabinum	APOCAN	native	3	forb	perennial
Aralia spinosa	ARASPI	native	6	shrub	perennial
Aristida longespica var. longespica	ARILOL	native	2	grass	annual
Aristolochia serpentaria var. serpentaria	ARISES	native	6	forb	perennial
Asclepias quadrifolia	ASCQUA	native	6	forb	perennial
Asimina triloba	ASITRI	native	5	tree	perennial
Aureolaria flava var. calycosa	AURFLC	native	8	forb	perennial
Baptisia bracteata var. leucophaea	BAPBRA	native	7	forb	perennial
Berchemia scandens	BERSCA	native	6	vine	perennial
Bidens frondosa	BIDFRO	native	2	forb	annual
Botrychium biternatum	BOTBIT	native	10	fern	perennial
Botrychium dissectum	BOTDIS	native	5	fern	perennial
Botrychium virginianum	BOTVIR	native	4	fern	perennial
Brachyelytrum erectum	BRAERE	native	5	grass	perennial
Bromus pubescens	BROPUB	native	5	grass	perennial
Campsis radicans	CAMRAD	native	3	vine	perennial
Carex alata	CXALAT	native	9	sedge	perennial
Carex albicans var. albicans	CXALBB	native	6	sedge	perennial

Carex amphibola	CXAMPH	native	3	sedge	perennial
Carex blanda	CXBLAN	native	2	sedge	perennial
Carex cephalophora	CXCEPH	native	5	sedge	perennial
Carex digitalis	CXDIGI	native	7	sedge	perennial
Carex glaucodea	CXGLAU	native	4	sedge	perennial
Carex hirsutella	CXHIRS	native	4	sedge	perennial
Carex jamesii	CXJAME	native	4	sedge	perennial
Carex meadii	CXMEAD	native	6	sedge	perennial
Carex muehlenbergii var. muehlenbergii	CXMUHM	native	5	sedge	perennial
Carex nigromarginata var. nigromarginata	CXNIGN	native	7	sedge	perennial
Carex oligocarpa	CXOLIG	native	6	sedge	perennial
Carex planispicata	CXPLAN	native	8	sedge	perennial
Carex retroflexa	CXRETR	native	4	sedge	perennial
Carex rosea	CXROSE	native	6	sedge	perennial
Carex umbellata	CXUMBE	native	6	sedge	perennial
Carya cordiformis	CARCOR	native	5	tree	perennial
Carya glabra	CARGLA	native	6	tree	perennial
Carya ovalis	CAROVL	native	6	tree	perennial
Carya ovata	CAROVT	native	4	tree	perennial
Carya texana	CARTEX	native	5	tree	perennial
Carya tomentosa	CARTOM	native	5	tree	perennial
Ceanothus americanus	CEAAME	native	7	shrub	perennial
Celastrus scandens	CELSCA	native	3	vine	perennial
Celtis occidentalis	CELOCC	native	3	tree	perennial
Celtis pumila	CELPUM	native	6	tree	perennial
Cercis canadensis	CERCAN	native	3	tree	perennial
Chamaecrista fasciculata	CHAFAS	native	2	forb	annual
Chamaecrista nictitans	CHANIC	native	2	forb	annual
Chasmanthium latifolium	CHALAT	native	4	grass	perennial
Circaea canadensis	CIRCAD	native	2	forb	perennial
Cirsium altissimum	CIRALT	native	4	forb	perennial
Cirsium carolinianum	CIRCAR	native	8	forb	biennial
Cirsium discolor	CIRDIS	native	3	forb	perennial
Clitoria mariana	CLIMAR	native	7	forb	perennial
Comandra umbellata	COMUMB	native	7	forb	perennial
Conoclinium coelestinum	CONCOE	native	3	forb	perennial
Conyza canadensis var. canadensis	CONCAC	native	0	forb	annual
Coreopsis grandiflora	CORGRA	native	6	forb	perennial
Coreopsis lanceolata	CORLAN	native	5	forb	perennial
Coreopsis palmata	CORPAL	native	7	forb	perennial
Coreopsis tripteris	CORTRI	native	6	forb	perennial
Cornus alternifolia	CORALT	native	8	tree	perennial
Cornus drummondii	CORDRU	native	2	shrub	perennial

Cornus florida	CORFLO	native	5	tree	perennial
Corylus americana	CORYAM	native	4	shrub	perennial
Crataegus viridis	CRAVIR	native	5	tree	perennial
Croton monanthogynus	CROMON	native	2	forb	annual
Croton willdenowii	CROWIL	native	4	forb	annual
Cunila origanoides	CUNORI	native	6	forb	perennial
Cynoglossum virginianum	CYNVIR	native	6	forb	perennial
Danthonia spicata	DANSPI	native	3	grass	perennial
Desmodium ciliare	DESCIL	native	5	forb	perennial
Desmodium cuspidatum	DESCUS	native	5	forb	perennial
Desmodium glabellum	DESGLA	native	3	forb	perennial
Desmodium laevigatum	DESLAE	native	7	forb	perennial
Desmodium marilandicum	DESMAR	native	5	forb	perennial
Desmodium nuttallii	DESNUT	native	7	forb	perennial
Desmodium rotundifolium	DESROT	native	6	forb	perennial
Dichanthelium bicknellii	DICBIC	native	6	grass	perennial
Dichanthelium boscii	DICBOS	native	5	grass	perennial
Dichanthelium commutatum var. commutatum	DICCOM	native	7	grass	perennial
Dichanthelium depauperatum	DICDEP	native	4	grass	perennial
Dichanthelium dichotomum var. barbulatum	DICDIB	native	6	grass	perennial
Dichanthelium lanuginosum	DICLAN	native	2	grass	perennial
Dichanthelium laxiflorum	DICLAX	native	6	grass	perennial
Dichanthelium linearifolium var. linearifolium	DICLIL	native	5	grass	perennial
Dichanthelium oligosanthes var. scribnerianum	DICOLS	native	4	grass	perennial
Dichanthelium ravenelii	DICRAV	native	7	grass	perennial
Dichanthelium sphaerocarpon	DICSPH	native	5	grass	perennial
Dichanthelium villosissimum	DICVIL	native	6	grass	perennial
Digitaria violascens	DIGVIO	non-native	0	grass	annual
Diodia teres	DIODTE	native	2	forb	annual
Dioscorea quaternata	DIOQUA	native	5	forb	perennial
Diospyros virginiana	DIOSVI	native	3	tree	perennial
Elephantopus carolinianus	ELECAR	native	3	forb	perennial
Elymus virginicus	ELYVIR	native	5	grass	perennial
Erechtites hieracifolius	EREHIE	native	1	forb	annual
Erianthus alopecuroides	ERIALO	native	8	grass	perennial
Erigeron annuus	ERIGAN	native	1	forb	annual
Erigeron strigosus	ERISTG	native	3	forb	annual
Eryngium yuccifolium	ERYYUC	native	8	forb	perennial
Eupatorium altissimum	EUPALT	native	3	forb	perennial
Eupatorium serotinum	EUPSER	native	1	forb	perennial
Euphorbia corollata	EPHCOR	native	3	forb	perennial
Euphorbia dentata	EPHDEN	native	0	forb	annual
Fragaria virginiana	FRAVIR	native	3	forb	perennial

Fraxinus americana	FRAAME	native	4	tree	perennial
Fraxinus pennsylvanica var. subintegerrima	FRAPES	native	2	tree	perennial
Galactia regularis	GALREG	native	6	forb	perennial
Galium arkansanum	GALARK	native	6	forb	perennial
Galium circaezans	GALCIR	native	4	forb	perennial
Galium concinnum	GALCON	native	4	forb	perennial
Galium pilosum	GALPIL	native	6	forb	perennial
Gamochaeta purpurea	GAMPUR	native	3	forb	annual
Gaura coccinea	GAUCOC	native	4	forb	perennial
Geranium maculatum	GERMAC	native	5	forb	perennial
Geum canadense	GEUCAN	native	2	forb	perennial
Gillenia stipulata	GILSTI	native	5	forb	perennial
Hedeoma pulegioides	HEDPUL	native	4	forb	annual
Helianthus hirsutus	HELHIR	native	4	forb	perennial
Helianthus silphioides	HELSIL	native	7	forb	perennial
Heliopsis helianthoides var. helianthoides	HELHEH	native	5	forb	perennial
Hieracium gronovii	HIEGRO	native	4	forb	perennial
Houstonia longifolia var. tenuifolia	HOULOT	native	5	forb	perennial
Hydrastis canadensis	HYDSCA	native	6	forb	perennial
Hylodesmum glutinosim	HYLGLU	native	3	forb	perennial
Hylodesmum nudiflorum	HYLNUD	native	4	forb	perennial
Hylodesmum pauciflorum	HYLPAU	native	8	forb	perennial
Hypericum hypericoides	HYPHYP	native	8	forb	perennial
Hypericum prolificum	HYPPRO	native	4	shrub	perennial
Hypericum punctatum	HYPPUN	native	3	forb	perennial
Ilex decidua	ILEDEC	native	5	shrub	perennial
Juncus tenuis var. tenuis	JUNTET	native	0	forb	perennial
Juniperus virginiana	JUNVIR	native	2	tree	perennial
Krigia biflora	KRIBIF	native	5	forb	perennial
Kummerowia striata	KUMSTR	non-native	0	forb	annual
Lactuca canadensis	LACCAN	native	3	forb	biennial
Lactuca hirsuta	LACHIR	native	4	forb	annual
Lathyrus hirsutus	LATHIR	non-native	0	forb	annual
Lechea mucronata	LECMUC	native	5	forb	perennial
Lechea tenuifolia	LECTEN	native	4	forb	perennial
Leersia virginica var. virginica	LEEVIV	native	4	grass	perennial
Lepidium virginicum	LEPVIR	native	0	forb	annual
Lespedeza frutescens	LESFRU	native	5	forb	perennial
Lespedeza hirta	LESHIR	native	7	forb	perennial
Lespedeza procumbens	LESPRO	native	4	forb	perennial
Lespedeza repens	LESREP	native	4	forb	perennial
Lespedeza violacea	LESVIO	native	6	forb	perennial
Lespedeza virginica	LESVIR	native	5	forb	perennial

Liatris aspera	LIAASP	native	6	forb	perennial
Liatris squarrulosa	LIASQL	native	8	forb	perennial
Lindera benzoin	LINBEN	native	5	shrub	perennial
Lobelia inflata	LOBINF	native	3	forb	annual
Lobelia spicata	LOBSPI	native	5	forb	perennial
Lonicera flava	LONFLA	native	7	vine	perennial
Lonicera japonica	LONJAP	non-native	0	vine	perennial
Luzula campestris var. multiflora	LUZCAU	native	4	forb	perennial
Lysimachia lanceolata	LYSLAN	native	4	forb	perennial
Maianthemum racemosum	MAIRAC	native	4	forb	perennial
Monarda bradburiana	MONBRA	native	5	forb	perennial
Monarda fistulosa	MONFIS	native	4	forb	perennial
Morus rubra	MORRUB	native	4	tree	perennial
Muhlenbergia schreberi	MUHSCH	native	0	grass	perennial
Muhlenbergia sobolifera	MUHSOB	native	4	grass	perennial
Nyssa sylvatica	NYSSYL	native	5	tree	perennial
Orbexilum pedunculatum	ORBPED	native	6	forb	perennial
Ostrya virginiana	OSTVIR	native	4	tree	perennial
Oxalis dillenii	OXADIL	native	0	forb	perennial
Oxalis stricta	OXASTR	native	0	forb	perennial
Panicum anceps	PANANC	native	3	grass	perennial
Panicum flexile	PANFLE	native	3	grass	annual
Parthenium integrifolium	PARINT	native	6	forb	perennial
Parthenocissus quinquefolia	PARQUI	native	3	vine	perennial
Paspalum setaceum var. ciliatifolium	PASSCI	native	3	grass	perennial
Passiflora lutea	PASLUT	native	4	forb	perennial
Penstemon pallidus	PENPAL	native	5	forb	perennial
Perilla frutescens	PERFRU	non-native	0	forb	annual
Phlox pilosa subsp. pilosa	PHLPIP	native	6	forb	perennial
Phryma leptostachya	PHRLEP	native	2	forb	perennial
Physalis virginiana	PHSAVI	native	3	forb	perennial
Physocarpus opulifolius var. intermedius	PHYOPU	native	5	shrub	perennial
Phytolacca americana	PHYAME	native	2	forb	perennial
Pinus echinata	PINECH	native	5	tree	perennial
Polystichum acrostichoides	POLACR	native	5	fern	perennial
Potentilla canadensis	POTCAN	native	8	forb	perennial
Potentilla simplex	POTSIM	native	3	forb	perennial
Prenanthes altissima	PREALT	native	5	forb	perennial
Prunella vulgaris var. lanceolata	PRUVUA	native	1	forb	perennial
Prunus americana	PRUAME	native	4	tree	perennial
Prunus serotina	PRUSER	native	2	tree	perennial
Pseudognaphalium obtusifolium	PSEOBT	native	2	forb	annual
Pteridium aquilinum	PTEAQU	native	4	fern	perennial

Pycnanthemum tenuifolium	PYCTEN	native	4	forb	perennial
Quercus alba	QUEALB	native	4	tree	perennial
Quercus coccinea	QUECOC	native	5	tree	perennial
Quercus falcata	QUEFAL	native	6	tree	perennial
Quercus imbricaria	QUEIMB	native	3	tree	perennial
Quercus marilandica	QUEMAR	native	4	tree	perennial
Quercus rubra	QUERUB	native	5	tree	perennial
Quercus stellata	QUESTE	native	4	tree	perennial
Quercus velutina	QUEVEL	native	4	tree	perennial
Rhamnus caroliniana	RHACAR	native	6	shrub	perennial
Rhus aromatica var. aromatica	RHUARA	native	4	shrub	perennial
Rhus copallinum var. latifolia	RHUCOP	native	2	shrub	perennial
Rhus glabra	RHUGLA	native	1	shrub	perennial
Rosa carolina subsp. carolina	ROSCAC	native	4	shrub	perennial
Rosa multiflora	ROSMUL	non-native	0	shrub	perennial
Rubus ablatus	RUBABL	native	2	shrub	perennial
Rubus allegheniensis	RUBALL	native	4	shrub	perennial
Rubus flagellaris	RUBFLA	native	3	shrub	perennial
Rubus occidentalis	RUBOCC	native	3	shrub	perennial
Rubus sp.	RUBUS	native	2	shrub	perennial
Rudbeckia hirta	RUDHIR	native	1	forb	perennial
Ruellia pedunculata	RUEPED	native	5	forb	perennial
Salvia lyrata	SALLYR	native	3	forb	perennial
Sanicula canadensis	SANICA	native	3	forb	biennial
Sassafras albidum	SASALB	native	2	tree	perennial
Schizachyrium scoparium	SCHSCO	native	5	grass	perennial
Scirpus cyperinus	SCICYP	native	5	sedge	perennial
Scleria ciliata	SCLCIL	native	8	sedge	perennial
Scleria oligantha	SCLOLI	native	8	sedge	perennial
Scleria pauciflora	SCLPAU	native	6	sedge	perennial
Scleria triglomerata	SCLTRI	native	6	sedge	perennial
Scutellaria incana	SCUINC	native	5	forb	perennial
Senna marilandica	SENMAR	native	4	forb	perennial
Setaria faberi	SETFAB	non-native	0	grass	annual
Sideroxylon lanuginosum subsp. oblongifolium	SIDLAN	native	5	tree	perennial
Silene virginica	SILVIR	native	7	forb	perennial
Silphium integrifolium var. integrifolium	SILINI	native	4	forb	perennial
Sisyrinchium campestre	SISCAM	native	5	forb	perennial
Smilax bona-nox	SMIBON	native	3	vine	perennial
Smilax ecirrhata	SMIECI	native	5	forb	perennial
Smilax glauca	SMIGLA	native	4	vine	perennial
Smilax hispida	SMIHIS	native	3	vine	perennial
Smilax pulverulenta	SMIPUL	native	6	forb	perennial

Smilax rotundifolia	SMIROT	native	6	vine	perennial
Solanum carolinense	SOLCAR	native	0	forb	perennial
Solidago buckleyi	SOLBUC	native	8	forb	perennial
Solidago canadensis var. hargeri	SOLCAN	native	1	forb	perennial
Solidago hispida	SOLHIS	native	6	forb	perennial
Solidago nemoralis var. nemoralis	SOLNEN	native	2	forb	perennial
Solidago odora	SOLODO	native	8	forb	perennial
Solidago petiolaris	SOLPET	native	8	forb	perennial
Solidago rugosa	SOLRUG	native	6	forb	perennial
Solidago ulmifolia	SOLULM	native	4	forb	perennial
Sorghastrum nutans	SORNUT	native	4	grass	perennial
Sphenopholis nitida	SPHNIT	native	7	grass	perennial
Sphenopholis obtusata var. major	SPHOBM	native	6	grass	perennial
Sporobolus clandestinus	SPOCLA	native	5	grass	perennial
Sporobolus heterolepis	SPOHET	native	6	grass	perennial
Sporobolus vaginiflorus	SPOVAG	native	0	grass	annual
Strophostyles helvola var. helvola	STRHEH	native	2	forb	annual
Strophostyles umbellata	STRUMB	native	3	forb	perennial
Stylosanthes biflora	STYBIF	native	5	forb	perennial
Symphoricarpos orbiculatus	SYMORB	native	1	shrub	perennial
Symphyotrichum anomalum	SYMANO	native	6	forb	perennial
Symphyotrichum lateriflorum	SYMLAT	native	3	forb	perennial
Symphyotrichum oolentangiense	SYMOOL	native	7	forb	perennial
Symphyotrichum patens	SYMPAT	native	5	forb	perennial
Symphyotrichum pilosum var. pilosum	SYMPIP	native	0	forb	perennial
Symphyotrichum turbinellum	SYMTUR	native	6	forb	perennial
Symphyotrichum urophyllum	SYMURO	native	4	forb	perennial
Taraxacum officinale	TAROFF	non-native	0	forb	perennial
Tephrosia virginiana	TEPVIR	native	5	forb	perennial
Teucrium canadense var. canadense	TEUCAC	native	2	forb	perennial
Toxicodendron pubescens	TOXPUB	native	7	vine	perennial
Toxicodendron radicans	TOXRAD	native	1	vine	perennial
Trichophorum planifolium	TRIPLA	native	9	sedge	perennial
Tridens flavus var. flavus	TRIFLF	native	1	grass	perennial
Ulmus alata	ULMALA	native	4	tree	perennial
Ulmus americana	ULMAME	native	4	tree	perennial
Ulmus rubra	ULMRUB	native	5	tree	perennial
Vaccinium arboreum	VACARB	native	6	shrub	perennial
Vaccinium pallidum	VACPAL	native	4	shrub	perennial
Vaccinium stamineum	VACSTA	native	6	shrub	perennial
Verbascum thapsus	VERTHA	non-native	0	forb	biennial
Verbesina alternifolia	VERALT	native	4	forb	perennial
Verbesina helianthoides	VERHEL	native	5	forb	perennial

Vernonia baldwinii	VERBAL	native	2	forb	perennial
Vernonia gigantea	VERGIG	native	6	forb	perennial
Vernonia missurica	VERMIS	native	5	forb	perennial
Viburnum rufidulum	VIBRUF	native	4	shrub	perennial
Vicia caroliniana	VICCAR	native	6	forb	perennial
Viola palmata	VIOPAT	native	5	forb	perennial
Viola pedata	VIOPEA	native	5	forb	perennial
Viola sororia	VIOSOR	native	2	forb	perennial
Vitis aestivalis	VITAES	native	5	vine	perennial
Vitis vulpina	VITVUL	native	5	vine	perennial

Appendix C. Site-level FQA results for each measure year (2009, 2012, and 2015).

Measure Year	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% trees	% forbs	% grasses	% sedges	% ferns	% shrubs	% vines
2009	4.289	4.345	229	3	232	65.325	65.751	43.168	4.31	27.586	56.897	11.207	14.2	51.7	12.1	7.3	1.3	8.2	5.2
2012	4.288	4.404	223	6	229	64.892	65.76	43.455	6.55	22.707	59.825	10.917	14.8	49.3	12.7	7.9	1.3	9.6	4.4
2015	4.38	4.481	216	5	221	65.115	65.864	44.305	4.072	25.792	56.561	13.575	13.1	52.5	13.1	4.5	1.8	9.5	5.4

Appendix D. Treatment Regime FQA results for each measure year (2009, 2012, and 2015).

Measure Year	Treatment	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value = 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% Trees	% forbs	% Grasses	% Sedges	% Ferns	% Shrubs	% Vines
2009	No Treatment	4.243	4.243	107	0	107	43.89	43.89	42.43	1.869	25.234	67.29	5.607	24.3	37.4	10.3	9.3	1.9	9.3	7.5
2012	No Treatment	4.5	4.5	84	0	84	41.243	41.243	45	0	20.238	73.81	5.952	29.8	26.2	10.7	9.5	1.2	15.5	7.1
2015	No Treatment	4.376	4.376	85	0	85	40.349	40.349	43.765	0	24.706	69.412	5.882	23.5	36.5	10.6	8.2	2.4	9.4	9.4
2009	Burn Only	4.314	4.314	105	0	105	44.208	44.208	43.143	1.905	25.714	63.81	8.571	15.2	47.6	16.2	4.8	0	11.4	4.8
2012	Burn Only	4.252	4.32	125	2	127	47.917	48.299	42.858	6.299	24.409	57.48	11.811	14.2	48	18.1	5.5	0.8	10.2	3.1
2015	Burn Only	4.306	4.371	132	2	134	49.845	50.221	43.385	3.731	26.866	56.716	12.687	13.4	54.5	14.2	4.5	1.5	7.5	4.5
2009	Thin and Burn	4.254	4.302	179	2	181	57.234	57.553	42.778	4.42	28.177	55.801	11.602	14.4	51.9	13.8	5	1.7	9.4	3.9
2012	Thin and Burn	4.296	4.412	148	4	152	52.965	53.676	43.537	5.921	22.368	60.526	11.184	15.1	46.7	15.1	5.3	0.7	12.5	4.6
2015	Thin and Burn	4.345	4.447	170	4	174	57.312	57.983	43.956	3.448	26.437	58.046	12.069	14.4	48.9	14.9	4	1.7	10.9	5.2
2009	Thin Only	4.527	4.527	91	0	91	43.189	43.189	45.275	1.099	19.78	71.429	7.692	23.1	41.8	8.8	6.6	2.2	9.9	7.7
2012	Thin Only	4.518	4.518	83	0	83	41.162	41.162	45.181	0	22.892	68.675	8.434	28.9	26.5	9.6	10.8	1.2	15.7	7.2
2015	Thin Only	4.289	4.289	83	0	83	39.076	39.076	42.892	2.41	22.892	67.47	7.229	25.3	42.2	8.4	7.2	1.2	9.6	6

Appendix E. FQA results for individual plot by each measure year (2009, 2012, and 2015).

Measure Year	Plot ID	Treatment	Total C	Native C	Native Species	Non-Native Species	Richness	Total FQI	Native FQI	Adjusted FQI	Percent C-value = 0	Percent C-value 1-3	Percent C-value 4-6	Percent C-value 7-10	% Trees	% forbs	% Grasses	% Sedges	% Ferns	% Shrubs	% Vines
2009	Plot01	Thin and Burn	4.032	4.032	62	0	62	31.75	31.75	40.323	3.226	33.871	56.452	6.452	16.1	43.5	19.4	4.8	0	12.9	3.2
2012	Plot01	Thin and Burn	4.019	4.098	51	1	52	28.983	29.266	40.584	7.692	25	57.692	9.615	17.3	36.5	23.1	5.8	1.9	13.5	1.9
2015	Plot01	Thin and Burn	4.176	4.292	72	2	74	35.921	36.416	42.333	2.703	32.432	52.703	12.162	12.2	47.3	20.3	6.8	1.4	9.5	2.7
2009	Plot02	Thin and Burn	4.148	4.148	54	0	54	30.483	30.483	41.481	0	31.481	61.111	7.407	18.5	33.3	18.5	5.6	0	16.7	7.4
2012	Plot02	Thin and Burn	4.5	4.5	62	0	62	35.433	35.433	45	0	24.194	66.129	9.677	19.4	32.3	22.6	4.8	0	16.1	4.8
2015	Plot02	Thin and Burn	4.219	4.286	63	1	64	33.75	34.017	42.521	1.562	31.25	56.25	10.938	18.8	37.5	18.8	6.2	1.6	10.9	6.2
2009	Plot03	Rx Fire Only	4.296	4.296	54	0	54	31.571	31.571	42.963	1.852	27.778	62.963	7.407	16.7	35.2	22.2	7.4	0	11.1	7.4
2012	Plot03	Rx Fire Only	4.149	4.212	66	1	67	33.963	34.219	41.806	5.97	23.881	61.194	8.955	14.9	34.3	26.9	6	1.5	13.4	3
2015	Plot03	Rx Fire Only	4.022	4.115	87	2	89	37.948	38.382	40.684	5.618	29.213	55.056	10.112	11.2	53.9	16.9	5.6	1.1	6.7	4.5
2009	Plot04	Thin and Burn	3.655	3.655	55	0	55	27.103	27.103	36.545	0	43.636	54.545	1.818	23.6	34.5	16.4	5.5	1.8	10.9	7.3
2012	Plot04	Thin and Burn	4.073	4.073	55	0	55	30.204	30.204	40.727	3.636	29.091	60	7.273	10.9	36.4	12.7	9.1	1.8	18.2	10.9
2009	Plot05	Thin and Burn	4.085	4.155	58	1	59	31.376	31.645	41.198	1.695	33.898	57.627	6.78	20.3	37.3	16.9	5.1	0	11.9	8.5
2012	Plot05	Thin and Burn	4.111	4.196	97	2	99	40.905	41.325	41.533	5.051	26.263	61.616	7.071	15.2	48.5	15.2	5.1	0	11.1	5.1
2009	Plot06	Thin and Burn	3.759	3.857	77	2	79	33.415	33.8	38.08	3.797	36.709	56.962	2.532	17.7	46.8	13.9	5.1	0	8.9	7.6
2012	Plot06	Thin and Burn	3.825	3.923	78	2	80	34.212	34.6	38.737	7.5	31.25	55	6.25	13.8	47.5	15	6.2	1.2	10	6.2
2009	Plot07	Thin and Burn	4.281	4.281	64	0	64	34.25	34.25	42.812	0	31.25	57.812	10.938	20.3	37.5	17.2	7.8	1.6	7.8	7.8
2012	Plot07	Thin and Burn	4.043	4.13	46	1	47	27.714	28.014	40.863	2.128	29.787	61.702	6.383	29.8	19.1	21.3	8.5	0	12.8	8.5
2015	Plot07	Thin and Burn	3.857	4	54	2	56	28.864	29.394	39.279	3.571	33.929	60.714	1.786	19.6	37.5	14.3	3.6	0	16.1	8.9
2009	Plot08	Thin and Burn	4	4.077	52	1	53	29.12	29.399	40.383	1.887	33.962	60.377	3.774	22.6	30.2	18.9	5.7	0	13.2	9.4
2012	Plot08	Thin and Burn	4.077	4.157	51	1	52	29.399	29.686	41.167	3.846	26.923	65.385	3.846	28.8	19.2	19.2	7.7	0	17.3	7.7

2015	Plot08	Thin and Burn	3.98	4.149	47	2	49	27.857	28.444	40.634	6.122	28.571	59.184	6.122	18.4	34.7	16.3	8.2	2	12.2	8.2
2009	Plot09	Thin and Burn	3.821	3.891	55	1	56	28.597	28.856	38.56	5.357	30.357	62.5	1.786	23.2	28.6	14.3	10.7	1.8	16.1	5.4
2012	Plot09	Thin and Burn	4.512	4.512	41	0	41	28.892	28.892	45.122	0	19.512	75.61	4.878	39	14.6	14.6	9.8	0	17.1	4.9
2015	Plot09	Thin and Burn	4.147	4.273	33	1	34	24.181	24.545	42.094	2.941	26.471	67.647	2.941	26.5	26.5	14.7	5.9	0	11.8	14.7
2009	Plot010	Thin and Burn	4.306	4.306	49	0	49	30.143	30.143	43.061	2.041	22.449	67.347	8.163	24.5	24.5	16.3	10.2	2	16.3	6.1
2012	Plot010	Thin and Burn	4.595	4.595	37	0	37	27.948	27.948	45.946	0	16.216	72.973	10.811	35.1	16.2	16.2	13.5	0	10.8	8.1
2015	Plot010	Thin and Burn	4.229	4.229	35	0	35	25.017	25.017	42.286	2.857	28.571	62.857	5.714	28.6	31.4	11.4	5.7	0	8.6	14.3
2009	Plot011	Rx Fire Only	4.739	4.739	46	0	46	32.142	32.142	47.391	0	10.87	82.609	6.522	30.4	32.6	13	4.3	0	8.7	10.9
2012	Plot011	Rx Fire Only	4.483	4.483	29	0	29	24.14	24.14	44.828	0	17.241	79.31	3.448	41.4	20.7	10.3	6.9	0	10.3	10.3
2015	Plot011	Rx Fire Only	4.871	4.871	31	0	31	27.12	27.12	48.71	0	9.677	83.871	6.452	32.3	22.6	12.9	9.7	0	9.7	12.9
2009	Plot012	Thin and Burn	4.318	4.318	44	0	44	28.644	28.644	43.182	2.273	20.455	72.727	4.545	29.5	27.3	15.9	9.1	0	11.4	6.8
2012	Plot012	Thin and Burn	4.368	4.368	38	0	38	26.929	26.929	43.684	0	21.053	73.684	5.263	36.8	18.4	13.2	10.5	0	15.8	5.3
2015	Plot012	Thin and Burn	4.465	4.465	43	0	43	29.28	29.28	44.651	2.326	16.279	72.093	9.302	23.3	25.6	16.3	9.3	0	16.3	9.3
2009	Plot013	Thin Only	4.538	4.538	65	0	65	36.59	36.59	45.385	1.538	18.462	72.308	7.692	20	40	9.2	7.7	1.5	12.3	9.2
2012	Plot013	Thin Only	4.435	4.435	62	0	62	34.925	34.925	44.355	0	24.194	67.742	8.065	25.8	27.4	12.9	12.9	1.6	12.9	6.5
2015	Plot013	Thin Only	4.511	4.511	47	0	47	30.923	30.923	45.106	0	21.277	72.34	6.383	21.3	38.3	14.9	8.5	2.1	6.4	8.5
2009	Plot014	No Treatment	4.034	4.034	58	0	58	30.726	30.726	40.345	1.724	31.034	62.069	5.172	29.3	24.1	8.6	13.8	1.7	12.1	10.3
2012	Plot014	No Treatment	4.256	4.256	43	0	43	27.907	27.907	42.558	0	27.907	65.116	6.977	34.9	18.6	4.7	11.6	0	18.6	11.6
2015	Plot014	No Treatment	4.059	4.059	34	0	34	23.667	23.667	40.588	0	26.471	70.588	2.941	38.2	23.5	2.9	8.8	0	11.8	14.7
2009	Plot015	No Treatment	4.237	4.237	38	0	38	26.118	26.118	42.368	0	23.684	71.053	5.263	34.2	34.2	2.6	5.3	2.6	10.5	10.5
2012	Plot015	No Treatment	4.378	4.378	37	0	37	26.633	26.633	43.784	0	16.216	81.081	2.703	37.8	13.5	8.1	5.4	2.7	18.9	13.5
2015	Plot015	No Treatment	4.414	4.414	29	0	29	23.769	23.769	44.138	0	20.69	68.966	10.345	34.5	27.6	3.4	6.9	3.4	10.3	13.8
2009	Plot016	Thin and Burn	4.711	4.711	45	0	45	31.603	31.603	47.111	0	13.333	80	6.667	28.9	37.8	8.9	4.4	2.2	11.1	6.7
2012	Plot016	Thin and Burn	4.559	4.559	34	0	34	26.582	26.582	45.588	0	14.706	79.412	5.882	41.2	17.6	8.8	5.9	0	14.7	11.8

2015	Plot016	Thin and Burn	4.519	4.519	27	0	27	23.479	23.479	45.185	0	11.111	88.889	0	40.7	22.2	7.4	3.7	0	11.1	14.8
2009	Plot017	Thin Only	4.286	4.286	35	0	35	25.355	25.355	42.857	0	25.714	68.571	5.714	31.4	42.9	0	0	2.9	8.6	14.3
2012	Plot017	Thin Only	4.514	4.514	37	0	37	27.455	27.455	45.135	0	18.919	72.973	8.108	45.9	21.6	0	2.7	0	16.2	13.5
2015	Plot017	Thin Only	4.026	4.026	38	0	38	24.82	24.82	40.263	2.632	26.316	65.789	5.263	31.6	28.9	5.3	5.3	0	18.4	10.5
2009	Plot018	Thin and Burn	4.421	4.421	57	0	57	33.378	33.378	44.211	1.754	26.316	61.404	10.526	12.3	42.1	22.8	5.3	0	12.3	5.3
2012	Plot018	Thin and Burn	4.463	4.547	53	1	54	32.796	33.104	45.049	1.852	22.222	64.815	11.111	20.4	37	18.5	7.4	0	14.8	1.9
2015	Plot018	Thin and Burn	4.352	4.414	70	1	71	36.672	36.933	43.831	1.408	29.577	56.338	12.676	12.7	46.5	19.7	5.6	0	12.7	2.8
2009	Plot019	Rx Fire Only	4.794	4.794	63	0	63	38.048	38.048	47.937	0	17.46	69.841	12.698	12.7	42.9	19	6.3	0	14.3	4.8
2012	Plot019	Rx Fire Only	4.619	4.619	84	0	84	42.334	42.334	46.19	2.381	19.048	67.857	10.714	15.5	47.6	16.7	6	0	10.7	3.6
2015	Plot019	Rx Fire Only	4.699	4.699	73	0	73	40.145	40.145	46.986	0	20.548	67.123	12.329	13.7	53.4	15.1	4.1	1.4	11	1.4
2009	Plot020	Thin and Burn	4.639	4.639	72	0	72	39.362	39.362	46.389	0	27.778	55.556	16.667	18.1	45.8	12.5	6.9	0	11.1	5.6
2012	Plot020	Thin and Burn	4.435	4.5	68	1	69	36.838	37.108	44.673	4.348	23.188	59.42	13.043	13	44.9	18.8	4.3	0	13	5.8
2015	Plot020	Thin and Burn	4.746	4.746	67	0	67	38.85	38.85	47.463	0	26.866	53.731	19.403	10.4	46.3	19.4	4.5	0	13.4	6
2009	Plot021	Thin and Burn	4.354	4.354	99	0	99	43.317	43.317	43.535	1.01	29.293	57.576	12.121	14.1	53.5	16.2	4	0	8.1	4
2012	Plot021	Thin and Burn	4.487	4.487	80	0	80	40.137	40.137	44.875	0	25	61.25	13.75	17.5	45	17.5	3.8	0	12.5	3.8
2015	Plot021	Thin and Burn	4.658	4.658	73	0	73	39.794	39.794	46.575	0	21.918	63.014	15.068	11	46.6	20.5	4.1	0	12.3	5.5
2009	Plot022	Thin and Burn	4.317	4.317	82	0	82	39.093	39.093	43.171	0	28.049	62.195	9.756	13.4	46.3	19.5	4.9	0	11	4.9
2012	Plot022	Thin and Burn	4.243	4.243	74	0	74	36.502	36.502	42.432	1.351	27.027	64.865	6.757	17.6	44.6	20.3	4.1	0	9.5	4.1
2015	Plot022	Thin and Burn	4.587	4.587	75	0	75	39.722	39.722	45.867	0	20	69.333	10.667	16	41.3	21.3	4	1.3	10.7	5.3
2009	Plot023	Thin and Burn	4.618	4.618	76	0	76	40.262	40.262	46.184	1.316	23.684	60.526	14.474	18.4	40.8	19.7	5.3	1.3	10.5	3.9
2012	Plot023	Thin and Burn	4.825	4.825	63	0	63	38.3	38.3	48.254	0	19.048	63.492	17.46	19	38.1	17.5	4.8	1.6	14.3	4.8
2015	Plot023	Thin and Burn	4.397	4.397	58	0	58	33.483	33.483	43.966	1.724	24.138	62.069	12.069	20.7	41.4	15.5	5.2	1.7	10.3	5.2
2009	Plot024	Rx Fire Only	4.309	4.309	55	0	55	31.957	31.957	43.091	1.818	20	72.727	5.455	20	38.2	18.2	5.5	0	12.7	5.5
2012	Plot024	Rx Fire Only	4.558	4.558	52	0	52	32.866	32.866	45.577	1.923	23.077	63.462	11.538	21.2	28.8	15.4	11.5	0	17.3	5.8

2015	Plot024	Rx Fire Only	4.327	4.327	52	0	52	31.202	31.202	43.269	0	30.769	61.538	7.692	23.1	34.6	19.2	5.8	0	13.5	3.8
2009	Plot025	Rx Fire Only	4.405	4.405	37	0	37	26.797	26.797	44.054	0	21.622	72.973	5.405	27	24.3	16.2	8.1	0	16.2	8.1
2012	Plot025	Rx Fire Only	4.479	4.479	48	0	48	31.033	31.033	44.792	0	20.833	72.917	6.25	18.8	29.2	20.8	10.4	0	14.6	6.2
2015	Plot025	Rx Fire Only	4.255	4.255	47	0	47	29.173	29.173	42.553	0	25.532	68.085	6.383	19.1	36.2	17	8.5	0	12.8	6.4
2009	Plot026	Thin and Burn	4.255	4.255	51	0	51	30.386	30.386	42.549	0	19.608	78.431	1.961	27.5	37.3	3.9	3.9	2	19.6	5.9
2012	Plot026	Thin and Burn	4.529	4.529	51	0	51	32.346	32.346	45.294	0	21.569	68.627	9.804	21.6	29.4	19.6	5.9	0	17.6	5.9
2015	Plot026	Thin and Burn	4.1	4.1	60	0	60	31.758	31.758	41	1.667	28.333	66.667	3.333	16.7	43.3	15	5	1.7	13.3	5
2009	Plot027	Rx Fire Only	4.793	4.793	29	0	29	25.812	25.812	47.931	0	13.793	72.414	13.793	31	24.1	17.2	3.4	0	17.2	6.9
2012	Plot027	Rx Fire Only	4.354	4.354	48	0	48	30.167	30.167	43.542	2.083	22.917	66.667	8.333	27.1	27.1	20.8	8.3	0	10.4	6.2
2015	Plot027	Rx Fire Only	4.484	4.484	31	0	31	24.965	24.965	44.839	0	25.806	61.29	12.903	16.1	29	16.1	12.9	0	16.1	9.7
2009	Plot028	Thin and Burn	4.359	4.359	39	0	39	27.222	27.222	43.59	0	23.077	71.795	5.128	30.8	28.2	15.4	7.7	0	10.3	7.7
2012	Plot028	Thin and Burn	4.692	4.692	52	0	52	33.837	33.837	46.923	0	19.231	71.154	9.615	25	34.6	15.4	5.8	0	13.5	5.8
2015	Plot028	Thin and Burn	4.385	4.385	65	0	65	35.35	35.35	43.846	1.538	23.077	67.692	7.692	13.8	46.2	18.5	6.2	0	12.3	3.1
2009	Plot029	Rx Fire Only	4.75	4.75	40	0	40	30.042	30.042	47.5	0	15	72.5	12.5	20	40	15	5	0	10	10
2012	Plot029	Rx Fire Only	4.6	4.694	49	1	50	32.527	32.857	46.467	4	18	64	14	22	28	20	6	0	16	8
2015	Plot029	Rx Fire Only	4.615	4.615	52	0	52	33.282	33.282	46.154	0	21.154	63.462	15.385	13.5	44.2	15.4	5.8	0	11.5	9.6
2009	Plot030	No Treatment	4.259	4.259	54	0	54	31.299	31.299	42.593	1.852	22.222	70.37	5.556	27.8	31.5	14.8	11.1	1.9	7.4	5.6
2012	Plot030	No Treatment	4.711	4.711	38	0	38	29.038	29.038	47.105	0	7.895	86.842	5.263	34.2	31.6	13.2	2.6	0	7.9	10.5
2015	Plot030	No Treatment	4.5	4.5	52	0	52	32.45	32.45	45	0	21.154	71.154	7.692	19.2	40.4	15.4	11.5	1.9	5.8	5.8
2009	Plot031	Thin Only	4.532	4.532	47	0	47	31.069	31.069	45.319	0	19.149	74.468	6.383	27.7	29.8	12.8	10.6	0	10.6	8.5
2012	Plot031	Thin Only	4.529	4.529	34	0	34	26.411	26.411	45.294	0	17.647	73.529	8.824	38.2	20.6	11.8	5.9	0	14.7	8.8
2015	Plot031	Thin Only	4.395	4.395	43	0	43	28.822	28.822	43.953	2.3	20.93	67.442	9.302	23.3	44.2	9.3	9.3	0	7	7

Appendix F. Filing structure for supplementary Cane Ridge FQA results. The supplementary fold submitted along with the final report is labeled "***Cane_Ridge_Datasets***". Within the Cane_Ridge_Datasets fold, there are three additional folders outlining three viewable folder categories of FQA results. They are as follows:

<u>Folder Category 1 Path:</u>

FQA_Results

1. **CR_FQA_RESULTS_by_SITE_TREATMENT_PLOT.xls** – Excel workbook containing all calculated FQA results by site, by treatment regime, and by plot.
   - Worksheet 1: By_Site – Calculated FQA results for all 31 plots combined for each measure year.
   - Worksheet 2: By_Treatments – Calculated FQA results for each treatment regime by each measure year (No Treatment, Burn Only, Thin Only, and Thin & Burn).
   - Worksheet 3: By_Plot – Calculated FQA results for each plot by each measure year (1-31).

2. **CR_FQA_Management_Activity_Sheet_by_Plot.xls** – Excel workbook containing calculated FQA results for each individual plot and the chronological management activity for each plot.

<u>Folder Category 2 Path:</u>

Graphs

By_Plot

- Thirty-One .pdf files showing linear regression models of FQA metrics for each plot. Each plot contains linear regressions of richness, Native Mean C, FQI, and Adjusted FQI.

<u>Folder Category 3 Path:</u>

RIV_Tables

By_Plot – In this folder, three folders are labeled by measure year (2009, 2012, 2015).

- *2009 folder* – Individual RIV tables of each 31 plots for year 2009.
- *2012 folder* – Individual RIV tables of each 31 plots for year 2012.
- *2015 folder* – Individual RIV tables of each 31 plots for year 2015.

By_Site – Contains one Cane Ridge site results RIV table.

1. **RIV_SITE.xls** – file containing site-level RIV tables for the measure year.
    - Worksheet 1: RIV site-level results for year 2009.
    - Worksheet 2: RIV site-level results for year 2012.
    - Worksheet 3: RIV site-level results for year 2015.

By_Treatment – Four excel files containing RIV table results corresponding to each treatment regime.

1. **RIV_Burn_Only.xls**

    - Worksheet 1: RIV results table for Burn Only year 2009.
    - Worksheet 2: RIV results table for Burn Only year 2012.
    - Worksheet 3: RIV results table for Burn Only year 2015.

2. **RIV_No_Treatment.xls**

    - Worksheet 1: RIV results table for Burn Only year 2009.
    - Worksheet 2: RIV results table for Burn Only year 2012.
    - Worksheet 3: RIV results table for Burn Only year 2015.

3. **RIV_Thin_and_Burn.xls**

    - Worksheet 1: RIV results table for Burn Only year 2009.
    - Worksheet 2: RIV results table for Burn Only year 2012.
    - Worksheet 3: RIV results table for Burn Only year 2015.

4. **RIV_Thin_Only.xls**

    - Worksheet 1: RIV results table for Burn Only year 2009.
    - Worksheet 2: RIV results table for Burn Only year 2012.
    - Worksheet 3: RIV results table for Burn Only year 2015.

Ozarks Environmental and Water Resources Institute (OEWRI)
Missouri State University (MSU)

DRAFT REPORT

Soil and Vegetation Monitoring to Evaluate Hydrological Effects of Prescribed Burning in Big Barren Creek Watershed, Mark Twain National Forest, SE Missouri.

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SCOPE AND OBJECTIVES

Fire is a major component of forest disturbance that plays an important role in the management and maintenance of forest ecosystems. Prescribed burning, as opposed to wildfire, is a forest management practice that is used to reduce understory growth, eradicate invasive species and create clear-open stands. Prescribed fires are used to meet objectives that have social, cultural, ecological, and economic benefits that often include stand structure improvement, habitat restoration, enhancing biodiversity, and reducing the risk of wildfires, pathogens and pests (Gray et al. 2013). Prescribed burns are also commonly used to promote the restoration of dominant vegetation through eradication of invasive species and by returning forests with shade-tolerant shrubs to their original clear-open stands (Certini, 2005; Gurbir et al., 2017; Tiedemann et al., 1998).

Forest fires can change conditions at the vegetation and soil interface, which can have a direct effect on hydrologic processes leading to increased runoff and leaching (Elliot and Vose, 2006). Increased runoff and erosion can ultimately degrade forest productivity and water quality by removing leaf litter and duff layers exposing the soil surface. Unlike wildfires, prescribed fires have fewer negative effects on forest and soil characteristics and can improve soil productivity and infiltration (Certini, 2005). However, there are concerns about the effects of prescribed fire on forest conditions that effect vegetation cover and local hydrology that can ultimately effect water quality.

The Mark Twain National Forest (MTNF) is located in the Ozark Highlands region of southern Missouri. The Eleven Point Ranger District (EPRD) of the MTNF is located in southeast Missouri and was identified in 2006 as an Ozark landscape with significant pine-oak woodland restoration potential. In 2012, the Collaborative Forest Landscape Restoration Project (CFLRP) was implemented in the EPRD to restore the forest to its original shortleaf pine-oak stands. The CFLRP uses a combination of prescribed burning practices and silvicultural management to restore the forest. Big Barren Creek watershed within the EPRD has experienced increased flooding, stream bank erosion, and gravel deposition in local streams over the last decade during the implementation of the CFLRP. Precipitation analysis in the Big Barren Creek watershed found that over the last decade extreme rainfall events have become more frequent (Pavlowsky et al., 2016). However, the role prescribed burns have on hydrology, such as infiltration and runoff, which may be contributing to increases in flooding within the watershed, is still not fully understood.

From 2015 to 2016, Hente (2017) assessed the influence of prescribed burning on upland forest and soil physical properties that could influence erosion processes across sites with varying prescribed burn histories. This study evaluated 30 sites within Big Barren Creek watershed and found significant differences between burned and unburned sites as well as differences in stand types (pine, oak, and mixed). Significant differences between vegetation variables including basal area and coarse woody debris (CWD) were attributed to stand type differences. Other ground cover variables including leaf litter and duff depths were significantly lower in burned sites compared to unburned sites. However, recovery trend analysis showed leaf litter and duff layers recover within one year following a prescribed burn. Soil organic matter was higher and soil bulk density was lower in burned sites compared to unburned sites within the top 5 cm of the soil profile. Additionally, soil bulk density and organic matter were found to have an inverse relationship which has been found in other studies (Chaudhari et al., 2013). No significant differences were found in seedling and sampling densities, soil texture, and soil properties below 5 cm between burned and unburned sites as well as between different stand types.

The purpose of this study is to continue forest soil and vegetation monitoring in the Big Barren Creek watershed to better understand the influences of prescribe burning on forest soil characteristics and ground cover in MTNF. The United States Forest Service (USFS) contracted the Ozarks Environmental and Water Resources Institute (OEWRI) at Missouri State University to conduct a Forest Watershed Monitoring Study under Agreement No. 15-CS-11090500-036. The goal of this study is to assess changes in forest soil and vegetation characteristics based on prescribed burn history to infer changes in forest hydrology in MTNF.

The specific objectives of this assessment are to:

1. Implement a monitoring network to determine baseline conditions for unburned forest sites in Big Barren Creek which can be compared to burned sites of varying frequency;
2. Assess spatial soil and vegetation cover differences between burned and unburned sites by stand types and using statistical tests and;
3. Discuss the implications of these findings.

STUDY AREA

Big Barren Creek is a tributary of the Current River Basin (8-digit Hydrological Unit Code (HUC) #11010008) located in portions of Ripley, Oregon and Carter Counties in southeast Missouri (Figure 1). The Big Barren Creek watershed (190.6 km^2 (73.6 mi^2)) is made up of two 12-digit HUCs, #110100080606 (Headwaters Big Barren Creek) and #110100080611 (Big Barren Creek). The watershed is located in the Salem Plateau physiographic subdivision of the Ozarks Highlands, which is underlain by flat, Paleozoic age sedimentary rock underlain by a structural dome that is part of a series uplifts about 150 m (492 ft) higher in elevation than the Mississippi Alluvial Plain located just to the southeast (Adamski et. al 1995). Southeast Missouri has a temperate climate with a mean annual temperature of 14.4^{o} C (58°F) and mean annual precipitation around 112 cm (44 in) (Adamski et. al 1995). Land cover within the watershed is about 92% forested, with around 78% being National forest lands (Figure 1). The majority of the remainder is pasture and hay, along with small areas of developed open space.

METHODS

Geospatial & Site Selection

Geospatial databases and ArcGIS maps were used to store forest and soil characteristics data and for randomized site selection. Sources of this data include MSDIS, USDA-NRCS geospatial data gateway, and the USFS Geodata Clearinghouse. Soil data were obtained from the USDA-NRCS geospatial data gateway for Carter, Oregon and Ripley counties (USDA-NRCS, 2017). Burn unit polygons were obtained from the USFS Geodata Clearinghouse (USDA-FS, 2017). Burn frequency was compiled using these burn units and USFS records to identify specific areas influenced by prescribed fires (Figure 2).

Hente (2017) used a stratified random sampling method to locate monitoring sites. Random points were generated by adding transect points every 200 meters along roads that intersected the Macedonia soil series polygons in both burned and unburned areas. The Macedonia soil series was selected as the control soil for both burned and unburned sites because it occurred most frequently on upland sites with the least amount of rock fragments. The Macedonia soil series has slopes ranging from 2 to 15 percent and consist of deep, well drained soils on ridgetops and uplands that consist of thin layers of loess or silty slope alluvium underlain by residuum from clayey shales and cherty dolomite and limestone (USDA-NCSS, 2005). Points located within burned areas of different years, and unburned areas were assigned a set of numbers. A random number generator was used to eliminate sampling bias by generating 3-7 points for each burned area and unburned area to create a total of 30 sampling sites across the watershed (Figure 2). A total of 26 of the original 30 sites were used for this study. Sites were removed due to either canopy consumption during a previous prescribed burn, an excess of brambles due to lack of canopy cover, or timber harvesting activities.

Field Setup & Sampling

Sampling sites were organized into subplots in accordance with the USFS Forest Soil Inventory and Analysis subplot sampling layout (FIA, 2014). Subplots were located between 50 to 200 m from the forest roads to the center of the Macedonia soil series area. A GPS location was collected at each site and imported into ArcMap to ensure accuracy of the sampling location. These GPS points were taken in the center of subplot one which was labeled by hammering a stake into the ground (Photo 1 & 2). Centers for the other 3 subplots were then measured 37 m from the stake at subplot 1 following azimuths of 0/360° for subplot 2, 120° for subplot 3 and 240° for subplot 4 (Figure 3). A white wooden sign with the subplot number was attached to a witness tree at each subplot for easy identification (Photo 3).

Soil and vegetation information was collected at each subplot in order to describe overall site ground cover, soil health, and vegetation cover. Leaf litter and duff depth measurements were collected using a one meter diameter sampling frame (Photo 4). Five measurements were taken within the frame at three different points within a subplot to create a subplot average. This was done at three of the four subplots to determine an overall site average for leaf litter and duff depths. Soil samples were collected at each site and taken from the first 5 cm of soil using a 5 cm by 5 cm steel bulk density sampling ring (Photo 5 & 6). Slope was also measured at each subplot using a clinometer. Finally, vegetation cover was estimated by using DBH measurements and by collecting standing tree and CWD inventories.

Laboratory

Soil samples were processed in the OEWRI geomorphology laboratory at Missouri State University. Samples were dried in an oven at 60° C for 24 to 48 hours, or until all moisture had been removed. Once samples were dried they were disaggregated and passed through a 2 mm sieve to remove rocks and larger particles. Bulk density was calculated as the dry soil mass (< 2 mm) divided by soil volume (USDA Kellogg Soil Survey, 2014). Soil volume was estimated using water displacement methods to estimate root and rock fragment bulk density which was then subtracted from the total known volume of the bulk density ring. The mass of each soil sample was then divided by the sample volume to obtain soil bulk density. Organic matter content in the soil was analyzed by using the loss on ignition technique (LOI) following procedures defined in the Soil Science Society of America Methods of Soil Analysis (Sparks, 1996, p. 1004), and the OEWRI standard operating procedure (OEWRI, 2007).

Statistical

Descriptive statistics and one-way ANOVA were used to analyze statistical significance using Microsoft Excel and IBM SPSS Statistical software. Descriptive statistics include measures of central tendency (mean), and measures of dispersion (standard deviation, standard error, variance, minimum and maximum). One-way ANOVA was used to determine if there were any statistically significant differences between the means of two or more independent groups. The independent groups for this study were burned versus unburned sites in the first round of ANOVA testing, and burned and unburned stand types (burned pine, burned oak/mixed, unburned pine, unburned oak/mixed) in the second round of testing. A homogeneity of variance test was used to examine the assumptions of ANOVA in SPSS. A Least Significance Difference post-hoc test was used to specify statistically significant differences between groups in the second round of ANOVA testing.

RESULTS

General Characteristics

A total of 19 sites were classified as being burned and the remaining 7 sites were classified as unburned. Of the 19 sites that were burned, 4 were categorized as pine stand type and 15 as oak/mixed stand type. Of the 7 unburned sites 3 were categorized as pine and 4 as oak/mixed. Percent slope of burned pine sites ranged from 1.57-5.03% while burned oak/mixed sites ranged from 0.43-7.87%. Percent slope of unburned sites were similar in that unburned pine sites ranged from 1.00-6.80% and unburned oak/mixed ranged from 0.70-3.30%. Approximately half of these sites have also experienced some sort of past timber harvest activity such as commercial thinning or improvement cutting (Table 1).

Vegetation Cover

Vegetation cover is important in protecting soils from raindrop impact and subsequent erosion and includes mature trees as well as woody and herbaceous understory flora. In general, for both burned and unburned sites, basal area increases with percent pine (Figure 4). Basal area, however, is not statistically different between burned and unburned sites (Table 2). When differences between stand types were examined it was found that burned and unburned pine sites had significantly higher basal area than burned and unburned oak/mixed sites (Table 3, Figure 5). Overall, unburned sites tended to have greater volumes of CWD than burned sites (Figure 6). However, ANOVA testing showed that differences in CWD volumes between burned and unburned sites as well as stand types were not statistically significant (Tables 4 & 5). These results are similar to the 2015-2016 results in that they indicate that differences in basal area and CWD amongst sites is due to differences in stand type and possibly the management practices associated with those stand types.

Ground Cover

Ground cover is a function of forest canopy and vegetation cover and acts as a secondary barrier of protection to prevent soil erosion. Leaf litter and duff are two major components of ground cover. Leaf litter can be defined as the layer of freshly fallen leaves, needles, twigs and loose plant material that can still be easily identified. Whereas duff is defined as the mat-like layer below litter and above the A-horizon that consists of decomposed litter components, which are not easily identified. Similar to the 2015-2016 results, leaf litter depths were significantly smaller in burned compared to unburned sites (Table 2). This trend was also present among the different stand types, but was only significantly different between burned and unburned pines (Table 3, Figure 7). Burned and unburned sites showed no significant difference in duff depths (Table 2). Burned pine sights experienced larger duff depths than unburned pine sights, however this was not statistically significant (Table 3, Figure 8). Burned and unburned oak sites had very similar duff depths, and overall pine duff depths were significantly larger than overall oak/mixed duff depths.

Soil Condition

Soil physical properties such as organic matter and bulk density are important indicators of soil health. Between burned and unburned sites, organic matter was found to be significantly different, in that burned sites have significantly larger percentages of soil organic matter than unburned sites (Table 2). This trend was also significantly different among stand types in that burned pine and oak/mixed sites had larger amounts of soil organic matter than unburned pine and oak/mixed sites (Table 3, Figure 9). Average bulk density values indicate that unburned sites tend to have larger bulk density values (Table 2). However, this trend was not statistically significant between burned and unburned sites nor between stand types (Table 3, Figure 10). When plotted against each other it appears that for burned sites organic matter and bulk density have an inverse relationship, similar to the one found in the 2015-2016 results (Chaudhari et al., 2013) (Figure 11). In contrast, the relationship between bulk density and organic matter is inconclusive for unburned sites. This trend persists when stand type is considered in that burned pine and oak/mixed sites show an inverse relationship and there is no clear trend between bulk density and organic matter in unburned pine and unburned oak/mixed sites (Figure 11).

DISCUSSION

Overall the 2015-2016 and 2018 monitoring results were fairly similar. For only three variables were there differences in the outcomes of the statistical analysis. These variables included CWD, duff depth, and soil bulk density.

CWD differences between sites were determined to be dissimilar between the two monitoring periods. The 2015-2016 monitoring results indicate that CWD volumes were significantly higher in burned pine sites versus burned oak/mixed. However, the 2018 monitoring results found no significant differences between burned and unburned sites as well as between stand types. Other studies have found that CWD varies naturally by stand type, season, and with varying management practices such as timber stand improvement (Tiedemann et al., 1998; Wang et al., 2005). Overall, both basal area and CWD appear to be generally unaffected by prescribed burning and are more dependent on stand type differences and the management practices implemented based on those differences.

Duff depth was another variable that was dissimilar between monitoring results. The 2015-2016 monitoring showed that duff depths were significantly smaller in burned sites compared to unburned sites. The 2018 monitoring results showed that duff depths were significantly larger in pine sites compared to oak/mixed sites. Duff depths can vary naturally by stand type and time since leaf fall as well as season sampled, as warmer temperatures promote decomposition and accumulation of duff (Sierra et al., 2016). The variability in these results demonstrates that prescribed burning has the potential to decrease duff depths. Prescribed fire's effects on duff is limited by fire severity which can vary burn to burn, and even vary locally during the same burn event (Parr and Brockett, 1999; Johansen et al., 2001). Like litter, the removal of the protective duff layer has a negative effect on soil condition as it leaves soils vulnerable to rain and wind erosion.

Bulk density was the last variable with dissimilar outcomes for the two monitoring periods. The 2015-2016 monitoring periods showed that bulk density was significantly lower in burned sites than in unburned sites. However, the 2018 monitoring determined that there were no significant difference in bulk density between burned or unburned sites nor stand type. Other studies have also documented that prescribed burns do not have a significant effect on soil bulk density (Hester et al., 1997, Massman and Frank, 2006). Bulk density is also known to be affected by anthropogenic influences that remove vegetation cover and cause soil compaction which can cause variation in soil bulk densities. It is unclear whether prescribed burns have the potential to affect bulk density, and further monitoring is needed to determine if fire has an affect and if it is significant. However, if prescribe fires are influencing soil bulk density, in that prescribed burning reduces bulk density creating less dense soils, this would improve soil conditions and allow for increased rates of infiltration.

Differences between the 2015 to 2016 monitoring and the 2018 monitoring could also potentially be due to the removal of four sites that misrepresent forest conditions and prescribed fire intensity. Three of the four sites that were removed between the 2015-2016 and the 2018 monitoring were removed due to canopy consumption during a previous prescribed burn and excess of brambles due to lack of canopy cover. Canopy consumption is not a typical characteristic of prescribed fires that are typically low intensity and can be indicative of areas where prescribed fires burned too hot. Canopy consumption can also increase the amount of sunlight that reaches the ground which can cause shade-intolerant invasive species to thrive.

Sites with these characteristics were excluded in 2018 and may be the reason for discrepancies between the two different monitoring periods. Including sites that represent more severe burning could have caused there to be significant differences in CWD, duff depth, and soil bulk density. When these sites were excluded, no significant differences were found between burned and unburned sites for these variables.

CONCLUSION

There are four main conclusion from this study:

1. **Sites managed with prescribed burns had significantly less leaf litter but can recover to pre-burn conditions within one growing season.** These results were consistent across the two monitoring periods and have been well documented in other studies. Decreases in leaf litter were shown by Hente (2017) to be a short term effect of prescribed burns in that leaf litter depths recover to pre-burn conditions within one season. Considering decreased litter depth from prescribed burns is a short term trend, increased erosion potential due to decreased litter is limited to the time it takes for surface cover to be re-established. Removing the protective litter layer and exposing soils to runoff and erosion in early spring when rainfall events are more frequent and intense could be a factor contributing to an increase in flooding in the watershed. With that being said, precipitation analysis for the Big Barren Creek watershed has also indicated that more extreme rainfall events have become more common over the past decade which could also be leading to increased flooding events. Overall, more seasonal monitoring of leaf litter is needed to understand its temporal variability and how prescribed burns effect leaf litter variability.

2. **Basal area and duff thickness were significantly different among stand types regardless of burn history.** The forest monitoring done in spring of 2018 showed that sites that are dominated by pines tend to have higher basal area and duff thickness compared to oak dominated or mixed hardwood stand types. Significant differences in basal area based on stand type may be due to natural variations among stand types as well as differences in land management practices that are dependent on stand type. For instance, sites that are dominated by oaks and other hardwood species may be targeted for timber harvesting or improvement which could then reduce basal area for those stand types. Pines and oak/mixed dominated sites also have different leaf litter and duff composition that could contribute to differences in duff depths. Pine trees are also coniferous in that they never lose all their needles and can continually contribute to increased litter, and therein duff, all

year long. As it seems, natural forest variability, as opposed to burn management variability, has a bigger influence on differences seen between site basal area and duff thickness.

3. **Prescribed fires can improve soil physical properties such as increasing soil organic matter and lowering bulk density in the upper 5 cm of the soil profile.** Soil organic matter was found to be significantly higher in burned sites compared to unburned sites. While burned sites had lower bulk densities compared to unburned sites, this trend was not statistically significant. However, burned sites show an inverse relationship between organic matter and bulk density. Considering organic matter's significant difference between sites, this relationship may be indicating that bulk density is slowly being decreased by prescribed burning. Unlike burned sites, unburned sites do not appear to have a correlation between organic matter and bulk density. While differences in bulk density between burned and unburned sites were not statistically significant, the strong inverse relationship between bulk density and organic matter in burned sites suggests fire may be slowly improving infiltration rates by lowering bulk density in the upper layers of the soil profile. Hente (2017) also found no significant effects of prescribed burns on soil properties below 5 cm.

4. **The 2015 to 2016 monitoring and the 2018 monitoring show no clear negative effects of prescribed burning.** Overall, results of the two studies support the same conclusion that prescribed fire does not negatively affect soil and vegetation characteristics that affect runoff rates. In some cases, burned areas had soil organic matter and bulk density values that would be expected to lead to slightly higher rates of infiltration than unburned forest soils. Of course, litter thickness is also expected to decrease after a burn in comparison to an unburned site and can help reduce forest fuel loads. Removal of litter, however, is a short-lived effect and duff and A-horizon integrity tend to remain intact following a prescribed burn. More short-term monitoring of the seasonal changes in litter and duff thickness in burned and unburned sites is needed to better understand the recovery times of burned soils and associated ground cover.

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TABLES

Table 1. General site characteristics for the 26 sites assessed for the 2018 monitoring.

Site	Stand Type	Number of Times Burned	Years Burned	USFS Timber Harvest Activity
1	Oak/Mixed	0	Never	Commercial thinning- 2011
2	Oak/Mixed	4	2007, 2009, 2013, 2016	Sanitation Cut- 1981
3	Oak/Mixed	4	2007, 2009, 2013, 2016	Salvage Cut- 1997
4	Oak/Mixed	0	Never	None
5	Oak/Mixed	0	Never	Commercial thinning- 2008
6	Pine	0	Never	Commercial thinning- 2009
7	Oak/Mixed	2	2012, 2016	None
8	Oak/Mixed	2	2012, 2016	None
9	Oak/Mixed	2	2012, 2016	None
10	Oak/Mixed	1	2011	Stand clear-cut- 1987
11	Oak/Mixed	1	2011	Salvage Cut- 1991
12	Pine	3	2011, 2012, 2015	None
13	Oak/Mixed	2	2012, 2015	None
14	Oak/Mixed	2	2012, 2015	None
15	Pine	3	2009, 2012, 2015	Sanitation Cut- 1981
16	Oak/Mixed	2	2012, 2015	Sanitation Cut- 1985
17	Oak/Mixed	4	2012, 2014, 2016, 2018	Stand clear-cut- 1984
18	Pine	5	2009, 2012, 2014, 2016, 2018	None
19	Oak/Mixed	4	2012, 2014, 2016, 2018	Improvement cut- 1997
20	Oak/Mixed	5	2009, 2012, 2014, 2016, 2018	Stand clear-cut- 1985
21	Pine	5	2009, 2012, 2014, 2016, 2018	Commercial thinning- 1994
22	Oak/Mixed	0	Never	Stand clear-cut- 1991
23	Pine	0	Never	None
24	Pine	0	Never	None
28	Oak/Mixed	4	2008, 2009, 2012, 2015	Stand clear-cut- 1982
29	Oak/Mixed	1	2007, 2009, 2013, 2016	Commercial thinning- 2014

Table 2. 2018 monitoring burned vs. unburned statistical test results for.

	Burned Mean ± SD	**Unburned** Mean ± SD	p (**α = 0.05**)*
Basal Area (m^2/ha)	94.79 ± 40.57	109.28 ± 51.82	0.138
CWD (m^3/ha)	54.71 ± 74.47	72.60 ± 130.52	0.385
Standing Trees (#)	7.76 ± 3.33	8.75 ± 4.92	0.245
Litter depth (mm)	24.30 ± 13.62	39.67 ± 14.17	**3.47E-06**
Duff depth (mm)	16.67 ± 7.13	16.82 ± 5.45	0.924
OM (%)	6.74 ± 2.51	4.76 ± 0.80	**5.12E-05**
BD (g/cm^3)	1.05 ± 0.23	1.07 ± 0.13	0.664

*Significant values are in bold as determined by one-way ANOVA.

Table 3. 2018 monitoring burned vs. unburned by stand type statistical test results.

		Burned Mean ± SD	**Unburned** Mean ± SD	p (**α = 0.05**)*
Basal Area (m^2/ha)	Pine	130.93 ± 44.78	130.77 ± 57.33	**4.68E-05**
	Oak/Mixed	85.15 ± 33.66	93.17 ± 42.16	
CWD (m^3/ha)	Pine	74.46 ± 70.89	86.57 ± 171.65	0.545
	Oak/Mixed	49.44 ± 75.09	62.12 ± 93.72	
Standing Trees (#)	Pine	20.47 ± 11.92	49.27 ± 12.98	**1.64E-07**
	Oak/Mixed	25.33 ± 13.95	31.43 ± 9.24	
Litter depth (mm)	Pine	9.00 ± 3.56	11.33 ± 5.73	**0.0034**
	Oak/Mixed	7.43 ± 3.22	6.81 ± 3.19	
Duff depth (mm)	Pine	23.38 ± 7.17	19.44 ± 3.77	**8.46E-06**
	Oak/Mixed	14.88 ± 6.01	14.57 ± 5.77	
OM (%)	Pine	7.22 ± 2.47	4.89 ± 0.79	**0.0006**
	Oak/Mixed	6.62 ± 2.53	4.66 ± 0.81	
BD (g/cm^3)	Pine	1.00 ± 0.17	1.06 ± 0.13	0.779
	Oak/Mixed	1.05 ± 0.22	1.07 ± 0.14	

*Significant values are in bold as determined by one-way ANOVA.

FIGURES

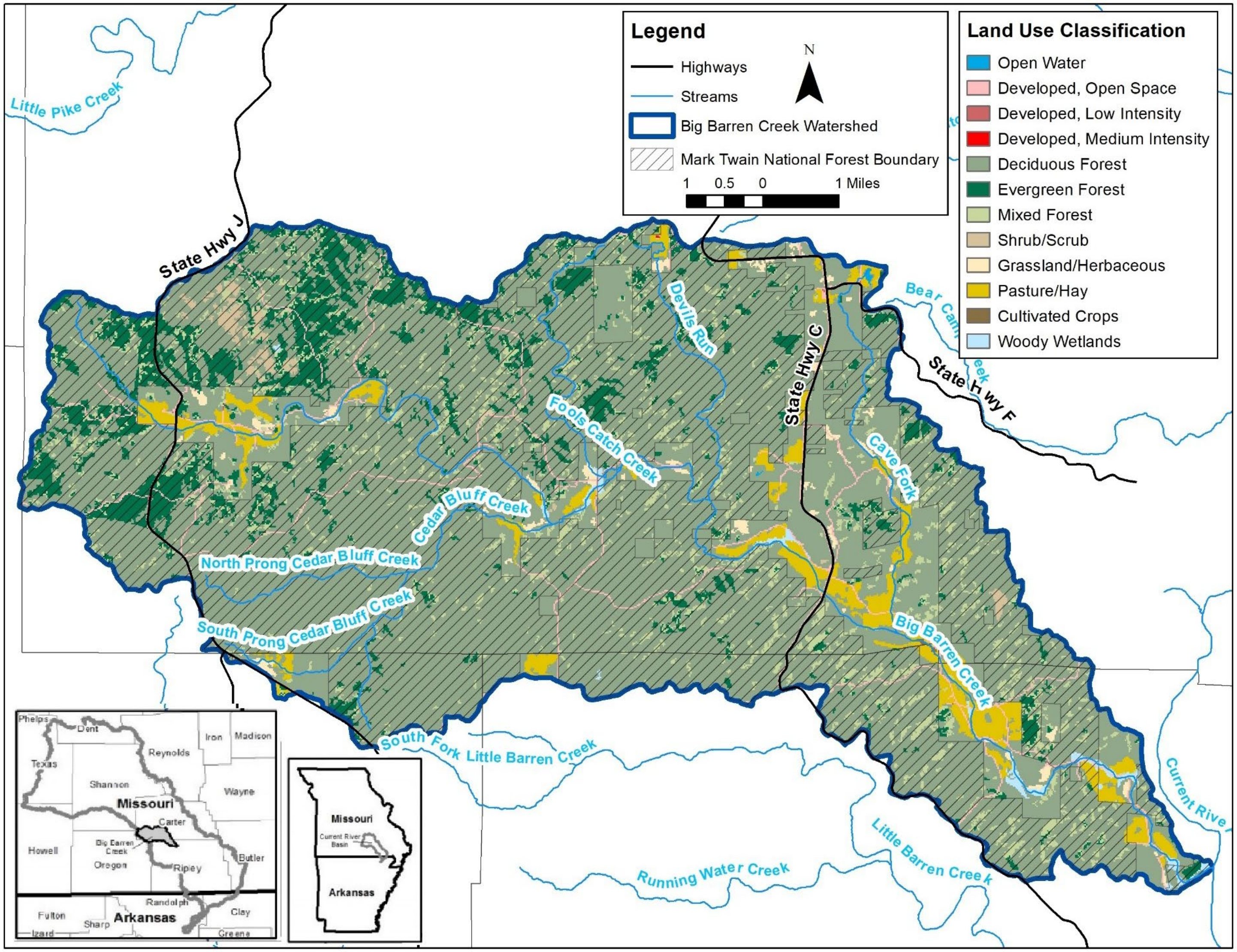

Figure 1. Location and land use of the Big Barren Creek Watershed in Southeast Missouri.

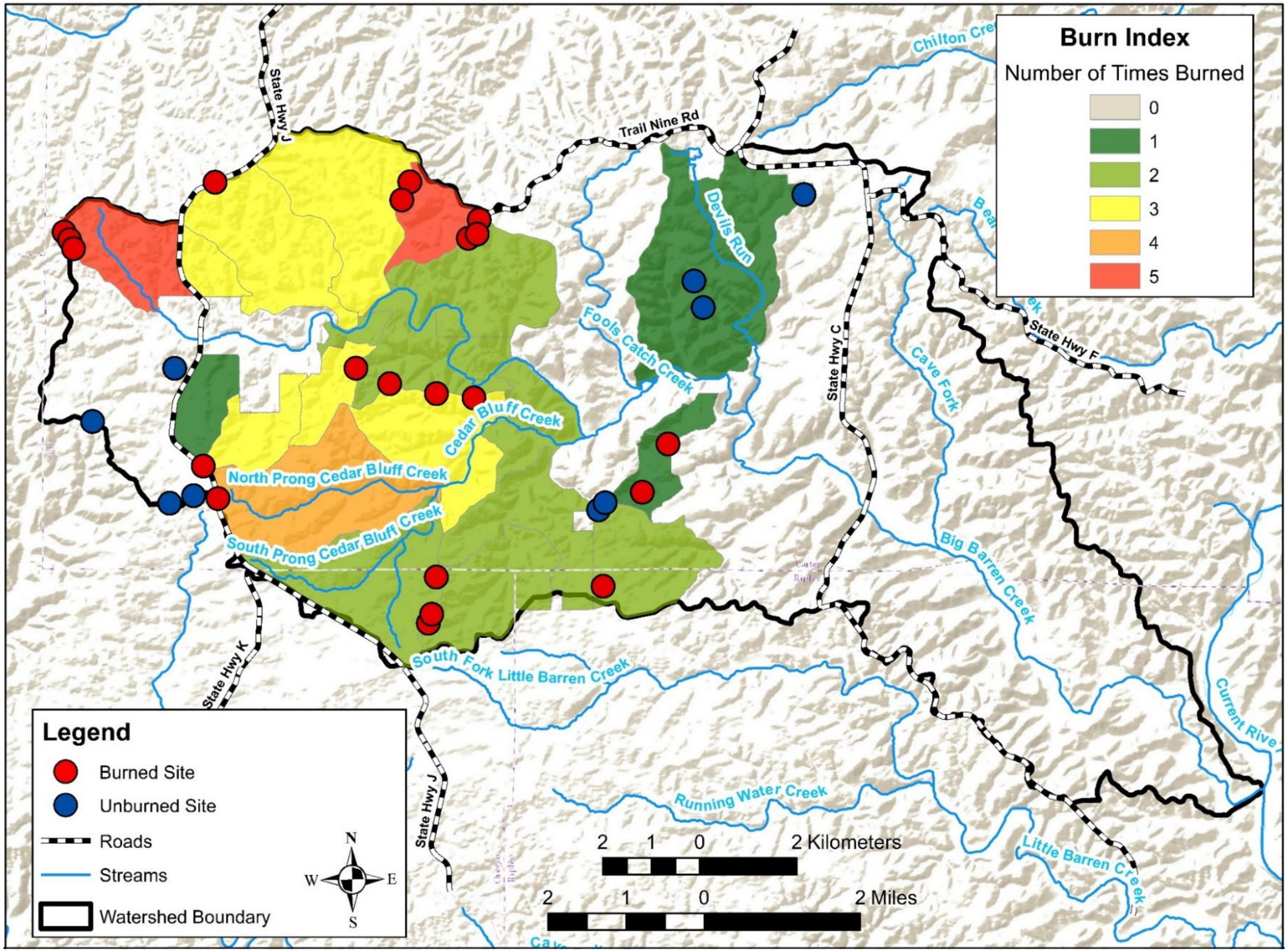

Figure 2. Burn history and of the Big Barren Creek Watershed and study site locations.

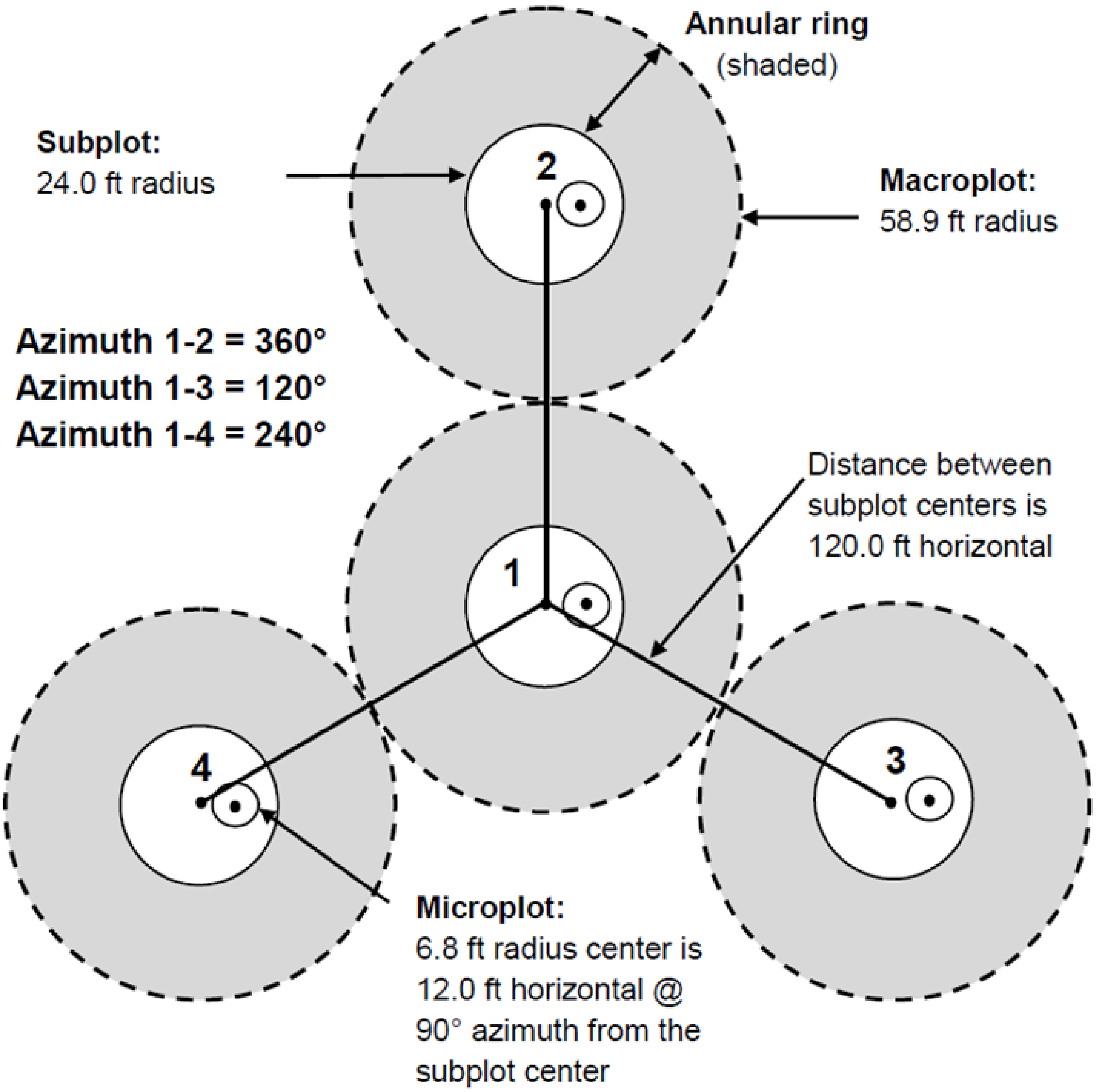

Figure 3. USFS Forest Inventory and Analysis subplot sampling layout.

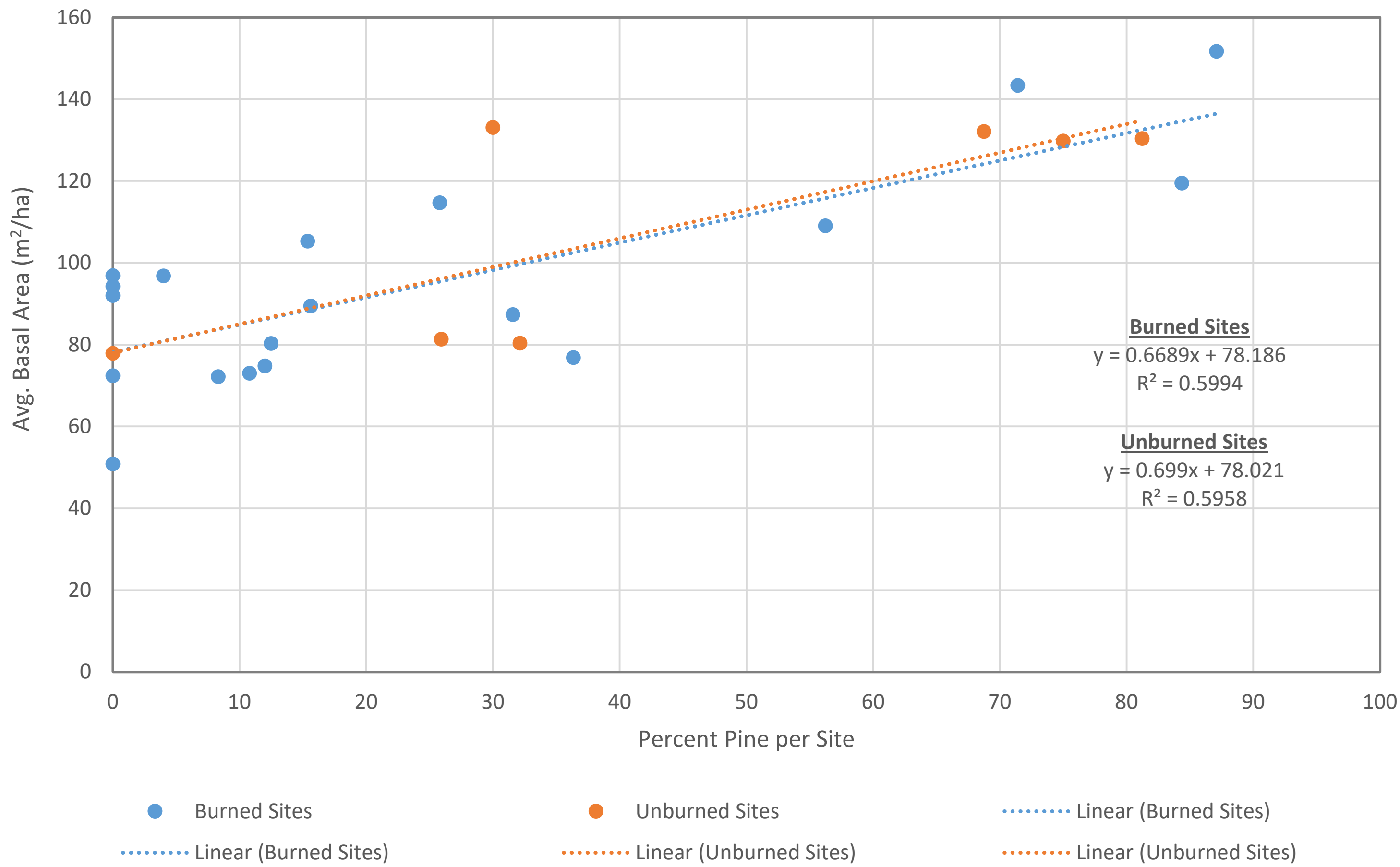

Figure 4. Percent pine vs. basal area for burned and unburned sites.

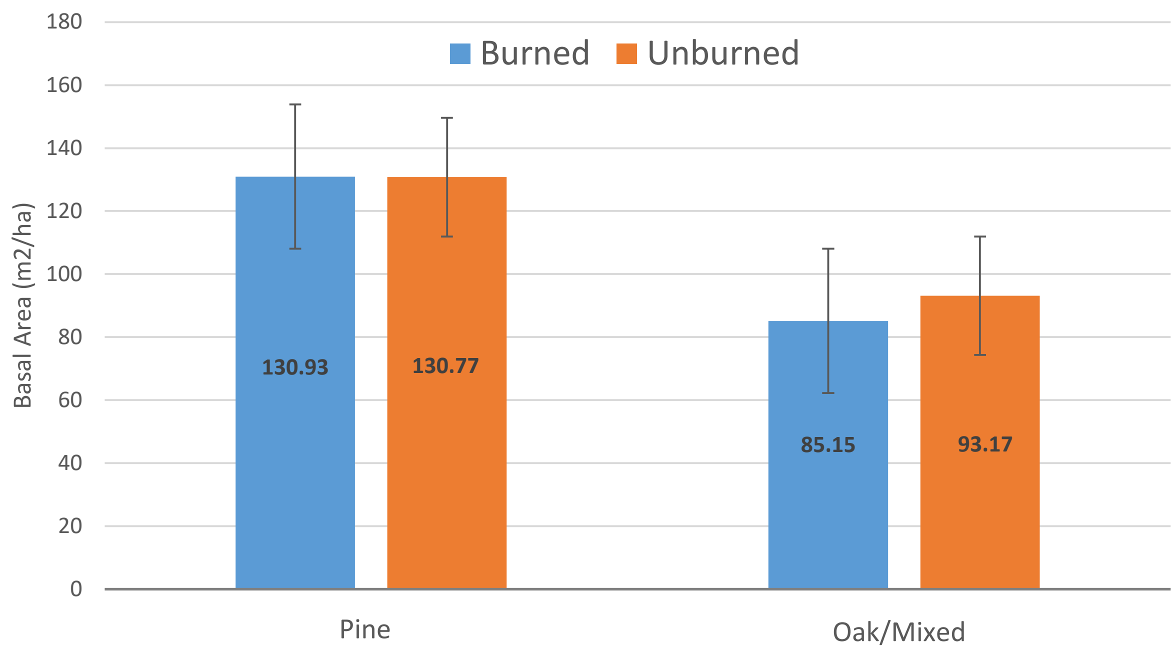

Figure 5. Basal area among stand types.

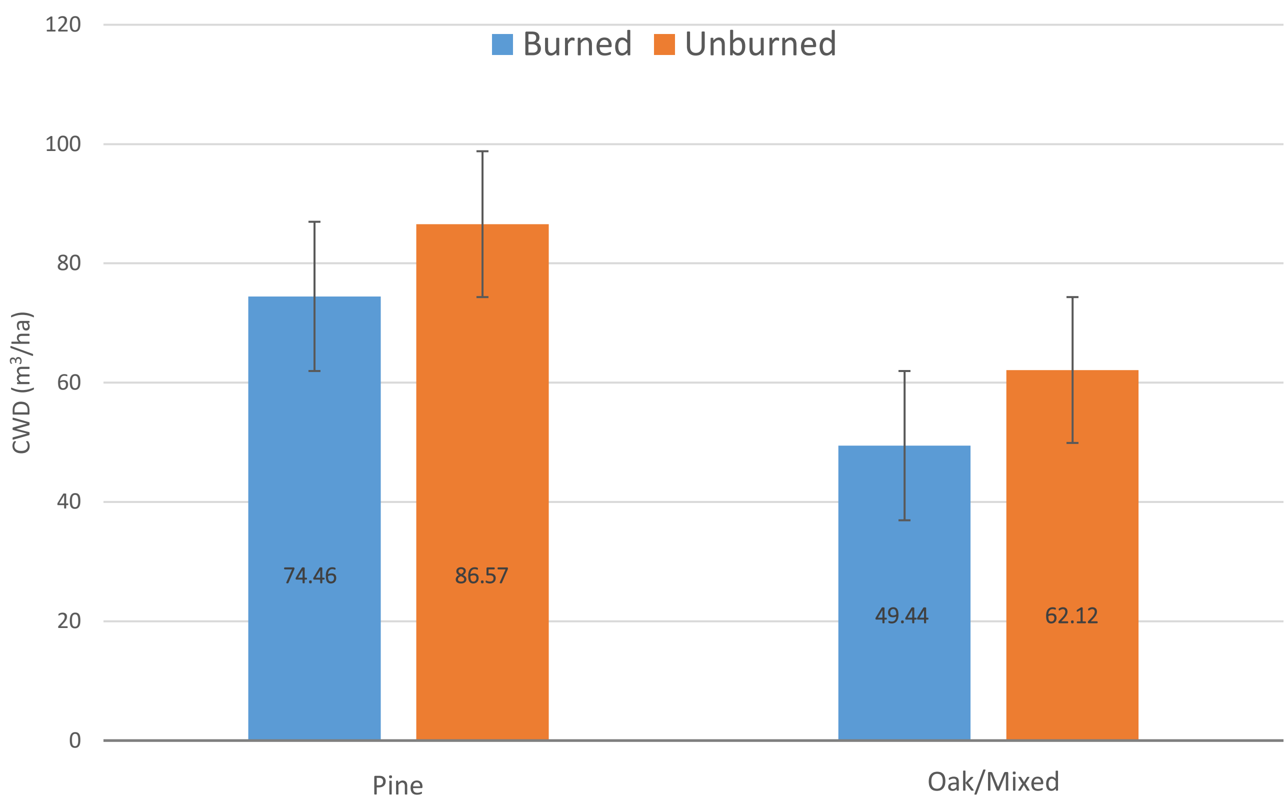

Figure 6. Coarse woody debris volumes by stand type.

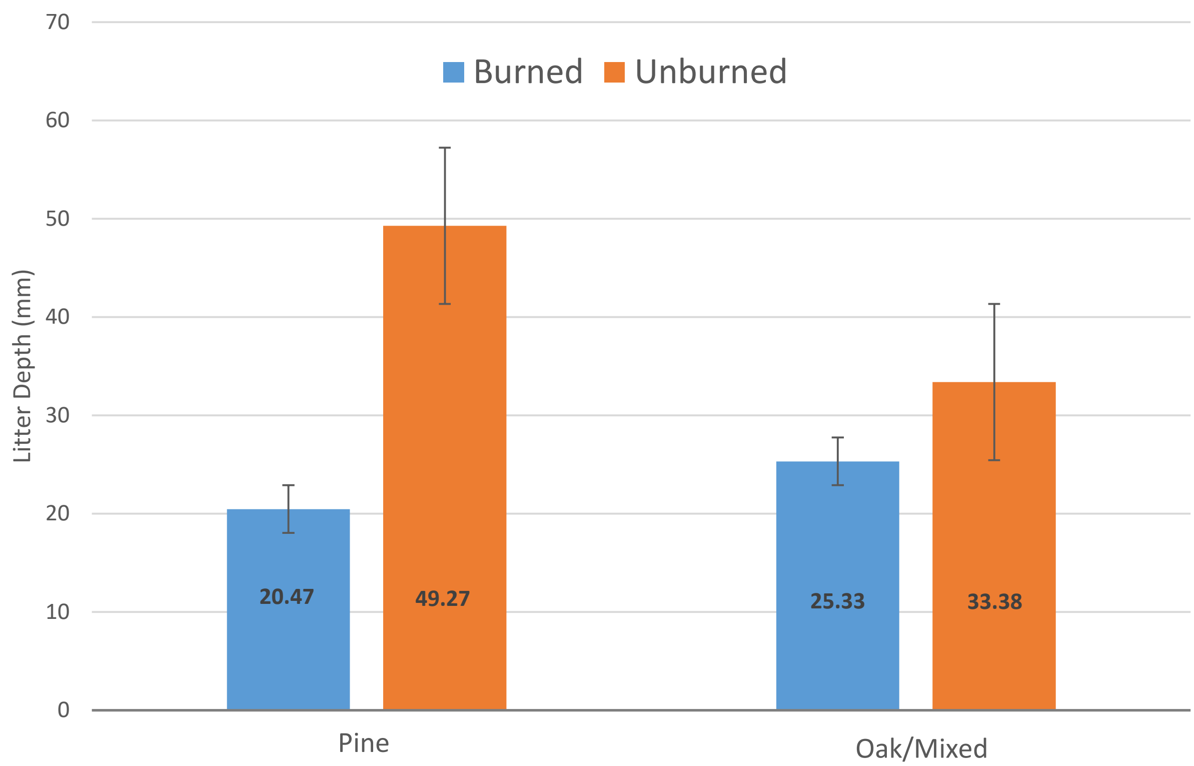

Figure 7. Leaf litter depths by stand type.

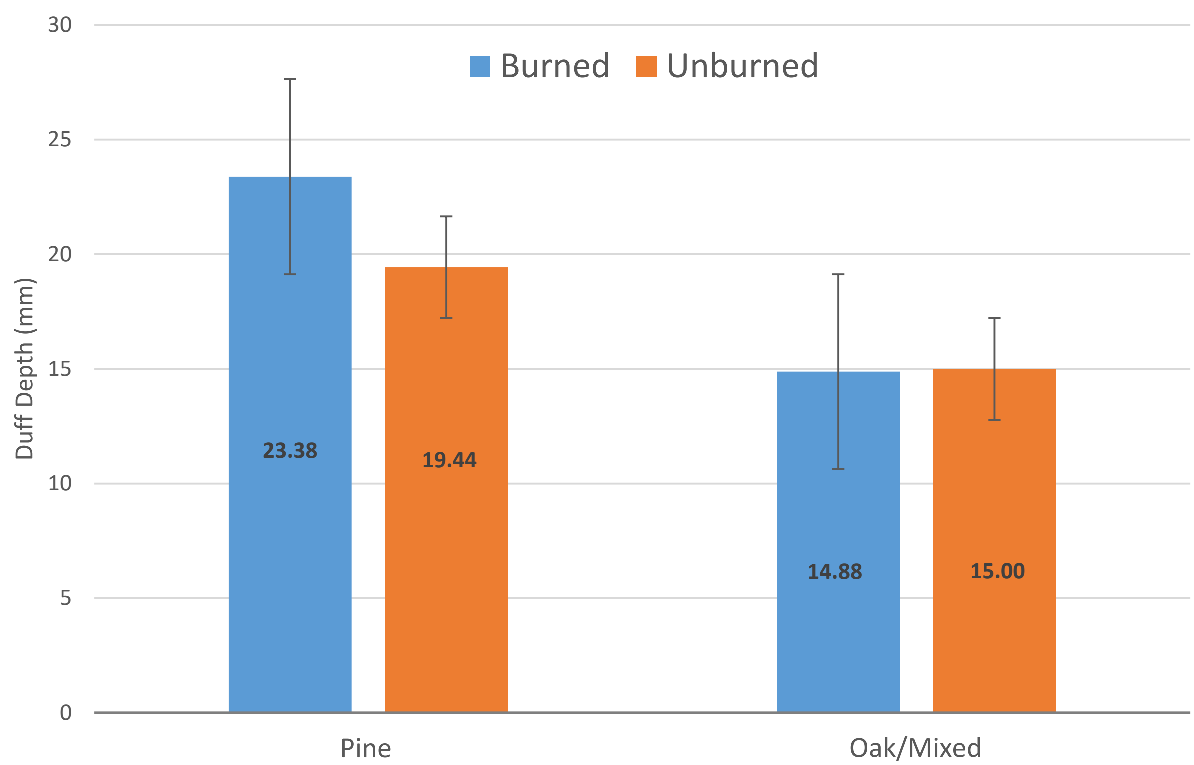

Figure 8. Duff depths by stand type.

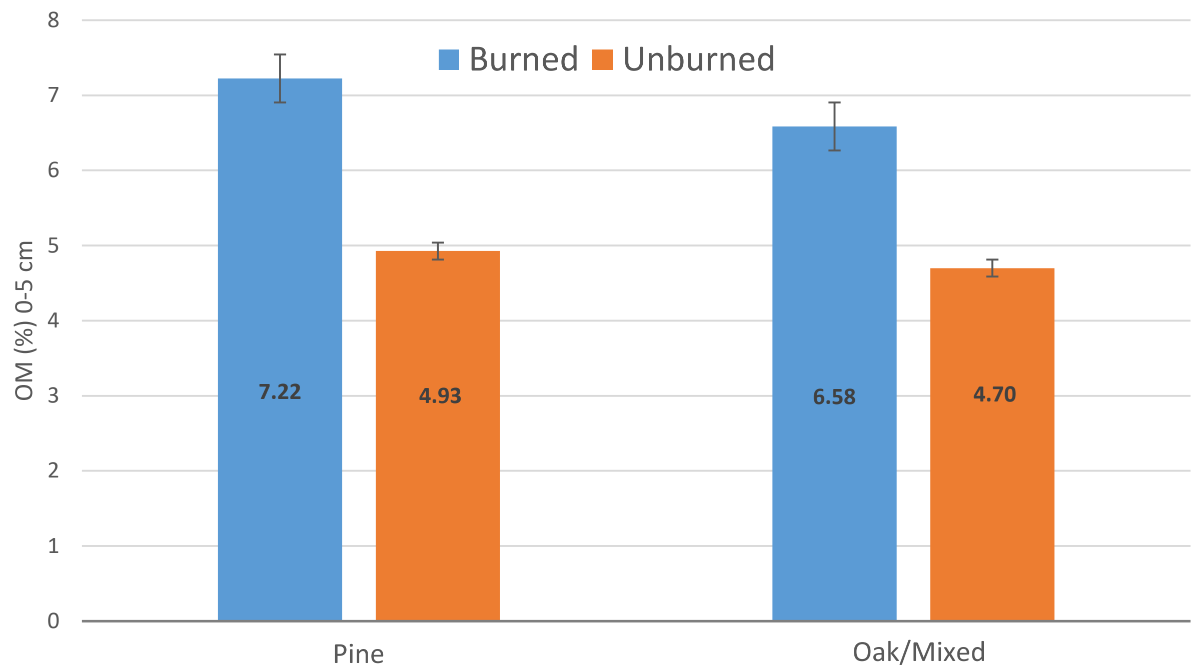

Figure 9. Soil organic matter by stand type.

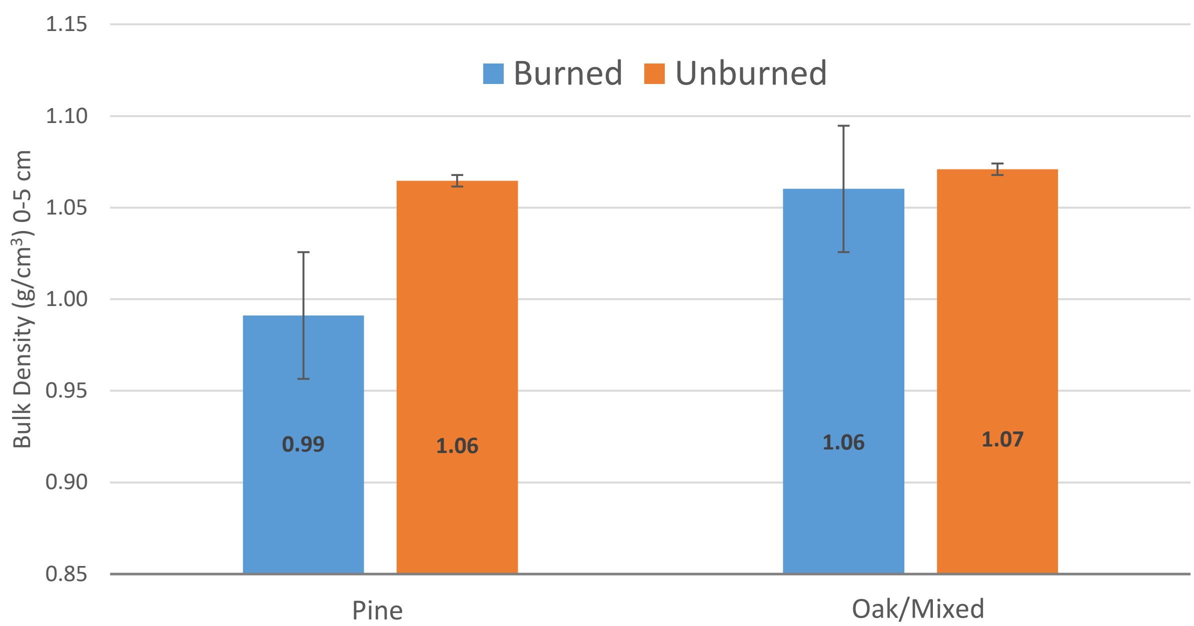

Figure 10. Soil bulk density by stand type.

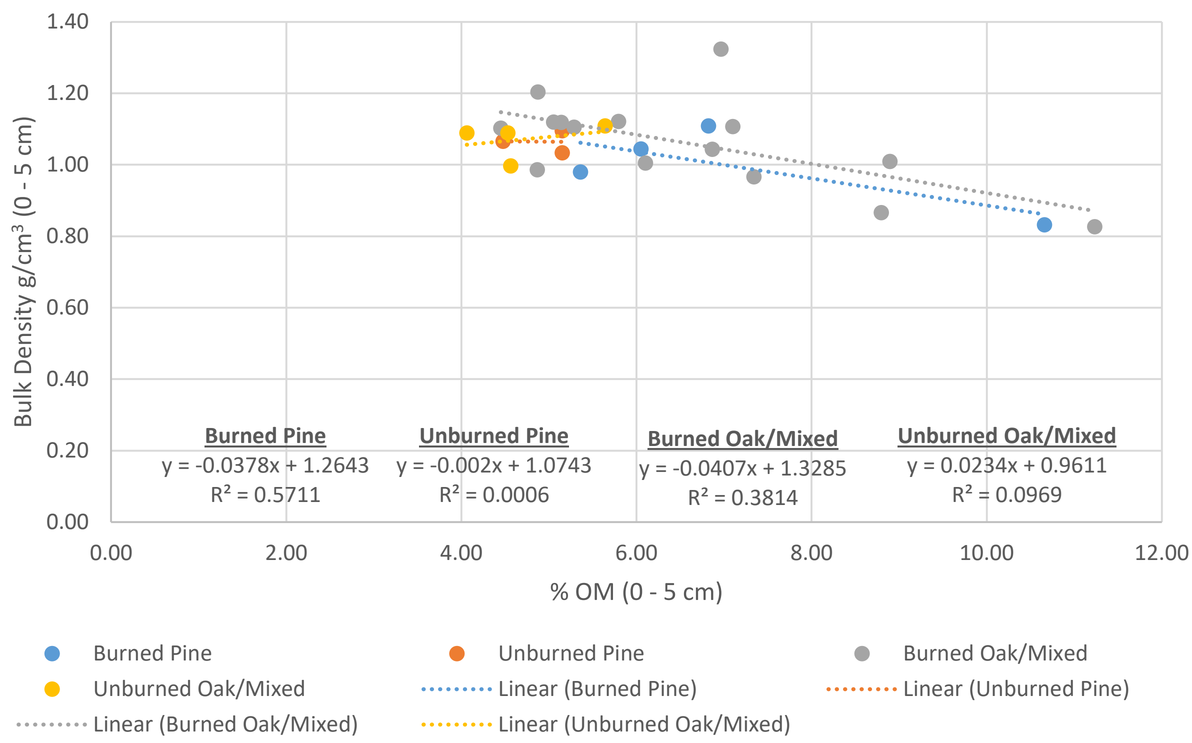

Figure 11. Soil organic matter vs. soil bulk density for burned and unburned sites by stand type.

PHOTOGRAPHS

Photo 1. Site 1, subplot 1 with stake at center.

Photo 2. Center stake and transect being used to establish other subplots, device in center is the RTK used to obtain GPS data.

Photo 3. Site 14, subplot 4 designated by white sign on adjacent witness tree.

Photo 4. An example of a soil pit dug for soil sampling and sampling frame at site 1, subplot 3.

Photo 5. Preparing an area to take a soil bulk density sample with the bulk density ring.

Photo 6. Measuring soil depth to collect soil samples.

Photo 7. Site 3 has been frequently burned and most trees show remnant fire scares at the base.

Photo 8. In comparison to photo 4, site 1 has never been burned.

Photo 9. Site 30, subplot 3 shows signs of canopy consumption and was one of the sites excluded from 2018 monitoring.