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Agriculture

Forest Service

Mark Twain
National Forest

Spring 2022



Fiscal Years 2015 Through 2020

Monitoring Evaluation Report



**Mark Twain
National Forest**

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

In general, required monitoring is being accomplished. The Mark Twain National Forest is on target to meet or exceed most of the goals and objectives, and results indicate that management is generally moving the landscape towards desired conditions. There are a few monitoring indicators or goals that are not being achieved as anticipated or as desired. Most of those items have been identified in previous monitoring evaluations as well.

After over a decade of implementation of the Mark Twain National Forest 2005 Land and Resource Management Plan (2005 Forest Plan), some questions remain about whether management activities are resulting in the ecological changes that were envisioned when the 2005 Forest Plan was developed, as well as whether those goals envisioned remain realistic. The focus of the next decade of monitoring and evaluation should be on “connecting the dots” and evaluating the data that is available in a holistic, integrated resources manner.

Table 1 briefly summarizes recommendations related to each of the 19 monitoring questions, including any changes that have been recommended this year, as well as historically.

Table 1. 2005 Forest Plan Monitoring Questions, Evaluation Status, and Change Recommendations

<i>Monitoring Question</i>	<i>Date of Most Current Evaluation</i>	<i>Currently, are any changes being recommended because of the evaluation for this item?</i>	<i>Date of Previous Evaluation</i>	<i>Previously, were changes recommended?</i>	<i>Changes made because of previous recommendations?</i>
1. To what extent is Forest management affecting water quality?	Spring 2022	No – continue to evaluate BMP effectiveness	Summer 2019	No	NA
2. To what extent is Forest management affecting priority watershed condition?	June 2021	No – continue to follow national and regional protocol & direction	May 2013	Not specifically addressed	NA
3. Are vegetation management practices moving conditions towards desired natural community type structural characteristics?	Summer 2019	Yes – hire a contractor to assess data, evaluate results, and provide a report	May 2013	Yes	Increased roundwood being removed by contract in addition to sales

Monitoring Question	Date of Most Current Evaluation	Currently, are any changes being recommended because of the evaluation for this item?	Date of Previous Evaluation	Previously, were changes recommended?	Changes made because of previous recommendations?
4. Are restoration activities increasing plant species richness and native plant cover for woodlands, glades, and forests?	Spring 2022	No - Continue sampling using the community health index (CHI) and continue development of terrestrial ecosystem unit inventory	Summer 2019	Yes – complete comprehensive analysis of the data	Yes – surveys have been ongoing
5. To what extent are prescribed fires used to mimic natural processes, maintain/improve vegetative condition and/or restore natural processes and functions to ecosystems?	Spring 2022	Yes – better evaluation of effects & change schedule, intensity, objectives as indicated by results of evaluation Yes – prescribed fire objectives need more alignment with objectives by resource area	Summer 2019	Yes – better evaluation of effects & change schedule, intensity, objectives as indicated by results of evaluation Yes – prescribed fire objectives need more alignment with objectives by resource area	No progress
6. To what extent are hazardous fuels being treated in the Wildland-Urban Interface (WUI) and/or in high-risk areas?	Spring 2022	Yes – update Risk Assessment and use updated WUI layer	Summer 2019	Yes – update Risk Assessment and use updated WUI layer	GIS data available and reporting application have links
7. To what extent are fuel treatments affecting the successful suppression of wildfires?	Spring 2022	No	Summer 2019	No	NA

Monitoring Question	Date of Most Current Evaluation	Currently, are any changes being recommended because of the evaluation for this item?	Date of Previous Evaluation	Previously, were changes recommended?	Changes made because of previous recommendations?
8. Are lentic ecosystems providing habitat for fish and other aquatic species?	Spring 2022	No – find specific research on the impacts of fish stocking in lakes in MTNF related to public use and satisfaction; locate information on amphibian use of vernal pools	Summer 2019	No	NA
9. Are lotic ecosystems providing habitat for fish and other aquatic species?	Spring 2022	No – continue fish and mussel surveys and increase efforts to gather additional baseline data in streams lacking that information	Summer 2019	No	NA
10. To what extent is Forest management contributing to the maintenance and establishment of shortleaf pine and pine-oak woodlands as described in Appendix A (of the 2005 Forest Plan)?	Summer 2019	No - Continue cooperative research to acquire statistically significant data and evaluate that data when it is available	May 2013	No - Not specifically addressed, although restoration objectives not on track	Still collecting data
11. To what extent is Forest management contributing to the conservation of threatened, endangered, and sensitive species and moving toward objectives for their habitat conditions?	Spring 2022	Yes – increase old growth designation in MP 6.1	Summer 2019	Yes – increase old growth designation in MP 6.1	No progress

Monitoring Question	Date of Most Current Evaluation	Currently, are any changes being recommended because of the evaluation for this item?	Date of Previous Evaluation	Previously, were changes recommended?	Changes made because of previous recommendations?
12. What is the status and trend of visitor use, visitor satisfaction, and progress toward meeting recreation objectives in the plan?	Spring 2022	No	Summer 2019	No	NA
13. To what extent do Forest recreation facilities and opportunities meet accessibility, health, safety, and maintenance requirements and achieve resource and social objectives?	Spring 2022	No	Summer 2019	No - Continue to look for funding to decrease deferred maintenance	NA
14. To what extent are management activities meeting Recreation Opportunity Spectrum (ROS) objectives?	Summer 2019	No - Continue to consider ROS as part of project-level planning, but consider deleting this item from monitoring report	May 2013	No	NA
15. How are management activities affecting unauthorized OHV use?	Summer 2019	Yes – consider changing the monitoring indicators to better reflect the intent of this question	May 2013	No	NA
16. How is the occurrence of mortality across the plan area changing on an annual basis?	Spring 2022	Yes – reprioritize project area scheduling, evaluate resource management responses, develop additional projects to meet objectives	Summer 2019	Yes - consider adding the cause of mortality (if known) for better assessment of management response	Forest Health EA signed in 2018; Disturbance Recovery EA signed in 2020

Monitoring Question	Date of Most Current Evaluation	Currently, are any changes being recommended because of the evaluation for this item?	Date of Previous Evaluation	Previously, were changes recommended?	Changes made because of previous recommendations?
17. How close are projected outputs and services to actual?	Spring 2022	No – track ASQ without exceeding limit by more than 10% in any given year	Summer 2019	No	NA
18. What progress has been made towards meeting objectives in the plan?	Spring 2022	Yes – need to survey streams to determine need for stabilization work and large woody debris (LWD) structures; need to determine if 100 to 300 pieces LWD per stream mile is appropriate; prioritize maintaining and improving native grass areas; change Forest Plan from Management Indicator Species to focal species; continue designating old growth in MP 6.1; consider prescribed fire seasonality goals & outcomes; increase prescribed fire per year to reach objective	Summer 2019	Yes - increase old growth designation in MP 6.1; consider prescribed fire seasonality goals & outcomes; look for ways to improve analysis with GIS data; not meeting 45,000 acre/year prescribed fire objective	Old growth meeting MP 2.1 & 6.2 goals for designated acres. No progress in prescribed fire seasonality
19. Are the effects of forest management, including prescriptions, resulting in significant changes to productivity of the land?	Spring 2022	No – continue adding sites to obtain National Soils Monitoring Protocol data and follow-up on post-treatment sites at five-year intervals	Summer 2019	Yes - continue soil plots & research partnerships to acquire soils data and evaluate data when available	National Soils Monitoring Protocol was developed, pre-treatment data collected in 2018, post-treatment data collected in 2020

1.0 INTRODUCTION

Effective Land and Resource Management Plan (Forest Plan) monitoring evaluation fosters improved management and more informed planning decisions. It helps identify the need to adjust management direction, such as desired conditions, goals, objectives, standards, and guidelines as conditions change. Monitoring evaluation helps the Agency and public determine how a Forest Plan is being implemented, whether plan implementation is achieving desired outcomes, and whether assumptions made in the planning process are valid.

Monitoring and evaluation are learning tools that form the backbone of adaptive management (fig. 1). With these tools, information is collected and compiled to serve as reference points for the future; new scientific understanding and technology, changes in law, policy, and resource conditions, growing concerns, trends and changing societal values are incorporated into land management planning; and the scientific validity and appropriateness of assumptions used in the development of the 2005 Forest Plan is evaluated. In short, they breathe life into a static document—the 2005 Forest Plan—to make it dynamic, relevant, and useful.

Several kinds of activities can be referred to as “monitoring.” Programmatic monitoring tracks and evaluates trends of ecological, social, or economic outcomes. Project implementation monitoring evaluates compliance with 2005 Forest Plan standards and guidelines. Effectiveness monitoring evaluates how effective our management actions are at achieving desired outcomes. Validation monitoring verifies assumptions and models used in 2005 Forest Plan implementation. Monitoring may also address issues for large geographic areas of which the Mark Twain National Forest is only a small portion.

2.0 MONITORING & EVALUATION REQUIREMENTS

Minimum monitoring and evaluation requirements have been established through the National Forest Management Act (NFMA) at 36 CFR 219. Some requirements provide guidance for the development of a monitoring program, while others include specific compliance requirements.

Monitoring and evaluation are separate, sequential activities required by NFMA regulations. Monitoring involves the repeated collecting of data by observation or measurement. Evaluation involves analyzing and interpreting monitoring data. The information gained from monitoring and evaluation is used to determine how well the desired conditions, goals, objectives, and outcomes of the 2005 Forest Plan are being met. Monitoring and evaluation are critical steps in the process of keeping the 2005 Forest Plan responsive to changing conditions, thereby providing the feedback mechanism for an adaptive management framework (fig. 1). The results are used to identify when changes are needed to the 2005 Forest Plan or the way it is implemented.

Forest plan monitoring on the Mark Twain National Forest has two major components: the Monitoring Program (contained within the 2005 Forest Plan) and the Monitoring Evaluation Report. Each are described below.

The 2012 Planning Rule (36 CFR 219.12) requires the monitoring program to address the following eight resource items with at least one monitoring question and associated indicator(s):

- The status of select watershed conditions.
- The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.
- The status of focal species to assess ecological conditions.
- The status of a select set of ecological conditions that contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.
- The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.
- Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
- Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.
- The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 USA 1604(g)(3)c)).

Budgetary constraints may affect the level of monitoring that can be done in a particular fiscal year. If budget levels limit our ability to perform all monitoring tasks, then those items specifically required by law are given the highest priority.

2.1 Monitoring Program

Monitoring involves collecting data by observation or measurement. Evaluation involves analyzing and interpreting monitoring data. The information gained from monitoring and evaluation is used to determine how well the desired conditions, goals, objectives, and outcomes of the 2005 Forest Plan have been met. Monitoring and evaluation form the basis for continuous improvement of the plan and provide the feedback mechanism for adaptive management (fig. 1). The results of monitoring and evaluation are used to identify when changes are needed to either the Forest Plan itself or the way it is implemented and helps ensure the Forest Plan is kept up-to-date and responsive to changing conditions and issues.

The plan monitoring program sets out the monitoring questions and associated indicators. Monitoring questions and associated indicators are designed to inform the management of resources in the plan area, including by testing relevant assumptions, tracking relevant changes, and measuring management effectiveness and progress toward achieving or maintaining the plan's desired conditions or objectives.

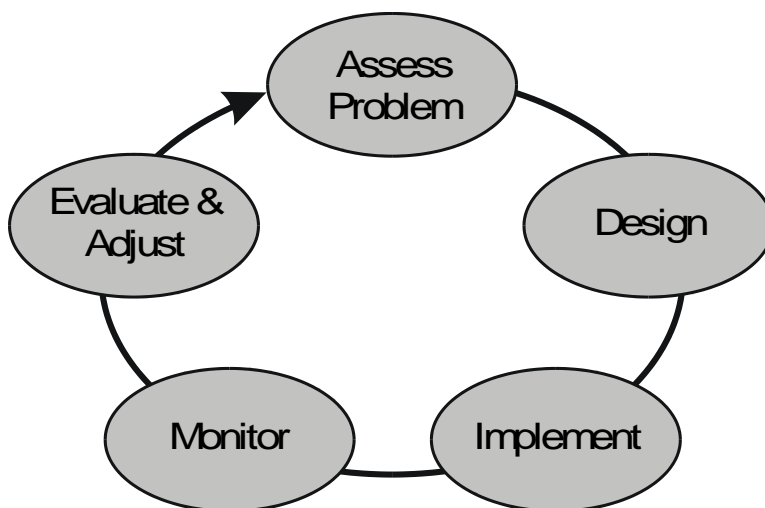


Figure 1. Evaluation and monitoring provide the feedback mechanism for adaptive forest management

The monitoring program contained within chapter 4 of the 2005 Forest Plan is strategic in nature and provides programmatic direction for monitoring and evaluating Forest Plan implementation. The Monitoring Program in the 2005 Forest Plan is organized by required Planning Rule topic areas, and includes the following components:

Monitoring Questions - Specific monitoring questions are developed to provide information essential to measuring accomplishment and effectiveness.

Monitoring Indicators –A quantitative or qualitative parameter that is measured to answer monitoring questions. One or more indicators can be associated with each question.

2.2 Monitoring Evaluation Report

The Forest Supervisor is responsible for conducting an evaluation of information gathered through the plan monitoring program and any relevant information from broader-scale monitoring. Each evaluation should build on the evaluations that precede it. A written report summarizing the monitoring reports and evaluation will be produced and made available to the public (36 CFR 219.12 (d)(1)). The report must indicate whether a change to the plan, management activities, the monitoring program, or a new assessment may be warranted based on the new information. The report is not a decision document and is not subject to the objection process provisions of 36 CFR 219.12, Subpart B.

Providing timely, accurate monitoring information to the decision makers and public is a key requirement of the monitoring and evaluation strategy. The monitoring evaluation report, which provides the analysis and summary of the monitoring results, is the vehicle for disseminating this information.

Evaluation is the process of transforming data into information—a value-added process. It is a process of synthesis that brings together value, judgment, and reason with monitoring information to answer the question, “So what?” and perhaps, “Why?”. Evaluation requires context. A sense of the history of the

place or the circumstances (temporal and spatial context) are important to the evaluation of management activities. Evaluation describes movement from a known point (base line or reference condition) either toward or away from a desired condition.

The monitoring evaluation report is intended to be a comprehensive compilation of all the monitoring and evaluation described in the plan. This report will provide summaries of data collected, and complete evaluations of the data. The evaluation process determines whether the observed changes are consistent with 2005 Forest Plan desired conditions, goals, and objectives and identifies adjustments that may be needed. Continuous updating and evaluation of monitoring data provides a means to track management effectiveness over time and to evaluate the changes that have been made or are still needed.

Key information displayed in the monitoring evaluation report includes:

- Forest accomplishments toward achieving multiple use objectives for providing goods and services
- The degree to which on-the-ground management is maintaining or making progress toward the desired conditions and objectives for the plan
- The effects of various resource management activities within the plan area on the productivity of the land
- Conclusions and recommendations regarding the need to adjust monitoring or change the Forest Plan
- Status of other agency/institution cooperative monitoring
- Update of research needs
- Documentation of any monitoring that has not been completed and the reasons and rationale (budget or staffing limitations or unexpected conditions, such as a severe fire season)

This report is of value for the public and Forest Service leadership, managers, and employees. The information gained from the monitoring evaluation report is used to determine how well the desired conditions, goals, objectives, and outcomes of the Forest Plan are being met. The monitoring evaluation report provides a readily available reference document for Forest Service managers as they plan, evaluate the effects of actions on resources, and implement future projects. The information can illuminate changes needed in project planning and implementation, or changes needed in Forest Plan direction.

3.0 HISTORY OF MONITORING ACTIVITIES ON THE MARK TWAIN NATIONAL FOREST

The Mark Twain National Forest (and before that the Clark & Mark Twain National Forest) has been collecting data in various ways and for various purposes since its designation in 1939.

The 1986 Forest Plan incorporated goals and objectives for a variety of resources. During implementation of the 1986 Forest Plan, monitoring was conducted in accordance with chapter V – Implementation: Monitoring, Evaluation, Amendments and Revisions. The purpose of monitoring was to determine progress in meeting Forest Plan direction. Table 5-1 of that chapter identified elements of the monitoring plan for the Mark Twain National Forest. Documentation of monitoring efforts was in annual reports from 1987-1998.

Prior to development of the 2005 Forest Plan, an Analysis of Management Situation (AMS) was completed. The AMS is basically a summary of monitoring efforts made during the implementation period of the 1986 Forest Plan (1986-2003).

Chapter 4 of the 2005 Forest Plan identifies the monitoring and evaluation program for the Mark Twain National Forest. The monitoring plan was developed in 2004 and revised in 2016 to implement the requirements of the 2012 Planning Rule.

The 2005 Forest Plan is organized differently than the 1986 Forest Plan, and items monitored are not always comparable. However, for comparison purposes, this report uses the goals of the 2005 Forest Plan to organize monitoring information and summaries over the past three decades.

The Forest Plan for the Mark Twain National Forest was signed in 2005. Annual monitoring reports are available for the years 2006 to 2012. The most recent monitoring evaluation report was completed for fiscal years 2015 and 2016.

In 2014, final requirements for monitoring were changed under the 2012 Planning Rule, and this report is the second to be completed under the new 2012 Planning Rule directives. Monitoring questions for the Mark Twain National Forest were reviewed and evaluated in 2015 and 2016. Several changes were made to the questions to better conform to the 2012 Planning Rule directives. The questions used for this report are discussed in detail in section 4.

In the 2011-2012 monitoring evaluation report, previous major conclusions were:

- Floristic quality in pine woodlands and glades is increasing, but restoration activities are not keeping pace with 2005 Forest Plan objectives.
- The objective for non-native invasive species control has been met but questioned if the overall area of infestation decreased.
- Soil and water protection appears to be effective, although isolated occurrences of soil disturbance have been documented and addressed.
- Old growth designations are lagging far behind where they should be according to the 2005 Forest Plan objectives.
- Amount of roundwood sold has increased, but the ratio of sawtimber to roundwood is still heavily skewed toward sawtimber.
- The number of permits administered to standard exceed the target but is not yet 100 percent.

- Most prescribed burns are being conducted in management prescriptions 1.1 and 1.2, but generic burn plan objectives make it difficult to tell if we are really achieving what we want to on the ground.
- Growing season burns are far short of the objective.
- ATV trail monitoring has been minimal.
- Large areas within the Mark Twain National Forest are at risk for oak decline, but project development has been slowed by environmental analysis requirements.
- Recreation facilities are mostly maintained to meet critical standards, but deferred maintenance needs are significant.
- All seven designated wildernesses meet minimum stewardship standards.
- Cultural resources in non-project areas suffer from human-caused and natural impacts.

In the 2015-2016 monitoring evaluation report, previous major conclusions were:

- In general, best management practices are being implemented as required. Roads and trails, steep slopes, and aquatic organism passages are the resource areas with the most issues regarding best management practice implementation and effectiveness.
- Watershed condition class hasn't been scored since 2012. Priority watershed conditions need scored at intervals to determine the trend of forest management on priority watershed condition.
- Initial assessment indicates a trend toward meeting the structural parameters for open and closed woodland and ground cover has increased, however basal area and canopy have decreased. More data analysis needs completed for a more comprehensive evaluation.
- It appears our management is moving the area toward the objectives for native species richness and cover, however there is not enough data for statistically significant representation.
- 90 percent of prescribed fire acres were in management prescriptions 1.1, 1.2, 5.1, and 8.1. This is an increase of prescribed fires in these management prescriptions than the previous decade.
- The 10-year average of hazardous fuel treatments within wildland urban interface or high-risk areas is 21,487 acres per year.
- Only two wildfires burned into hazardous fuel treated acres. Pre-existing control lines for those treatment areas helped to keep containment acres small on both wildfires.
- Ripley Lake increased in the catch per unit effort (CPUE), however Palmer Lake has shifted to a smaller size class of largemouth bass. Management of aquatic vegetation, along with improvements in bank fishing accessibility and improving the gravel boat ramp could increase use at Palmer Lake. The control of aquatic vegetation on many National Forest System lakes is necessary to promote balanced fish populations. In general, we purchase the aquatic herbicides and Missouri Department of Conservation treats the lakes. Some lakes are drawn down to kill aquatic vegetation. Most of the lakes in the Mark Twain National Forest need an updated lake management plan.
- One stream project affected one mile of the North Fork of the White River. Project implementation began in 2016, however a major rain event in 2017 caused damage to the project that was still in-progress. This caused a redesign of the facilities and work resumed in 2018.
- Densities of Eastern wood pewee and pine warblers were positively related to prescribed fire activity. Eastern wood-pewee and pine warbler were more abundant in areas with more prescribed

fires in the 10-years prior. Similarly, these two species had positive relationships with the amount of area that had been burned within one kilometer of the detection point. These two species did not appear to benefit greatly from pine thinning, but the addition of prescribed fire resulted in species benefits.

- We met the objective for old growth in management prescriptions 2.1 and 6.2; minimally met the objective for shrub/grass/forb/regeneration across all management prescriptions; and exceeded the objective for the proportion of native grassland. We also met the objective to “provide specialized habitats that are a healthy, functioning part of the larger landscape and require no special protection or additional management considerations”. There is no shortage of snags of all sizes in the Mark Twain National Forest, primarily due to oak decline, wildfire, early and late frosts, ice storms and windstorms. Numbers of species vary annually, but data shows trends downward, primarily due to the decimation of bat species by white-nose syndrome, which was identified as present in Missouri in 2011. Regardless of how much summer habitat is available, or what the quality of the habitat is, bats continue to die from white-nose syndrome. We have taken steps to reduce the spread of white-nose syndrome, but with limited success so far.
- More than 80 percent of visitors are very satisfied with their overall recreation experience. Satisfaction ratings for both safety and access items were over 90 percent for all types of sites.
- Bacterial results have been within acceptable levels in Council Bluff Lake.
- 57 percent of projects reviewed specifically identified recreation opportunity spectrum (ROS) objectives and stated consistency of proposed activities with ROS objectives.
- “Vehicle off-road” is consistently in the top four violations each of the last five years. That includes other vehicles besides off-highway vehicles (OHVs), but that is an indicator unauthorized OHV use is a recurring issue on the Mark Twain National Forest. Damage from unauthorized OHV use such as soil rutting and erosion have been identified at both ATV trail areas (Sutton Bluff and Chadwick) and in the general forest.
- Mortality has increased roughly 30 percent in less than a decade. Annual mortality increase was precipitated by the 2012 drought; however, losses appear to be stabilizing due to less droughty years recently.
- We should maintain around a 44 million board foot program in sawtimber given current markets and funding. If markets develop for small round wood, then we could sustain a higher target. There is a decline in acres cut and sold starting in 2016 even though the volume is increasing. This is due to the amount of oak decline harvested stands with a higher volume per acre than in the previous years (FACTS data).
- A more robust geographic information system analysis by community type within each subsection to track progress on number of treated acres is needed to evaluate restoration of terrestrial natural communities (goal 1.1).
- For goal 1.2, we have surpassed the 10-year objective of treating 2,000-acres of non-native invasive species, however treatment does not necessarily equal control or eradication. We must remain aggressive in the identification and treatment of non-native invasive species.
- For goal 1.3, we have only achieved about 4.5-miles of stream stabilization of the 10-mile objective. We need to survey streams to determine stream stabilization work needed. We have likely surpassed the 10-year objective of restoring 125-acres of bottomland hardwood forest, however the reporting metrics don’t lend themselves to clear identification of bottomland hardwood forest restoration. We have only achieved 1-mile of the 3-mile objective for 100 to 300 pieces of large woody material per stream mile. We need to survey streams to determine large woody material work needed. We also need to determine if 100 to 300 pieces per stream mile is

an appropriate measure. We have achieved approximately 688-acres of the 900-acre goal for wetland management.

- For goal 1.4, we have achieved approximately 3,000-acres per year since 2005 of improvement of open woodland. This far exceeds the objective of 10,500-acres, however a single treatment may not meet the structural and composition characteristics needed for habitat of the species listed in the objective. We have reached approximately 90 percent of the Mark Twain National Forest in forest, closed woodland, or open woodland, which exceeds the 85 percent objective. Approximately 5,282-acres of glade habitat was treated, which exceeds the objective of 4,000-acres. We have designated approximately 8.7 percent old growth in management prescription 2.1, 11 percent in management prescription 6.1, and 10 percent in management prescription 6.2. We need to continue designating old growth in management prescription 6.1 to achieve the objective 15 percent.
- For goal 2.2, we have not made any progress toward meeting the objective of growing season and fall prescribed burns. We need to decide whether to change this objective or plan to implement it. We also have not met the objective of prescribed burning 45,000-acres per year. This objective may need changed.
- Meaningful results for significant changes to productivity of the land will be available after the first data collection scheduled for 2018.

Goal 1.1 Terrestrial Natural Communities

	1986-2005	2006-2020
Emphasis	Wildlife management approach focused on Management Indicator Species and 8 habitat conditions	Site-appropriate natural community management
Issues	Population data for species costly & often unreliable; no connection between species & habitat changes	Short on acres burned, roundwood volume
Data collected	CDS/FSVeg & Timber harvest stats; Historic veg mapping (GRC-MU); Landsat Imagery pilot study 1992/6?; FIA	FIA; FQI plots; TNC plots; Landsat; FSVeg; Timber harvest stats
Publications	1992 Missouri Biodiversity Report; Ozark/Ouachita Highlands Assessment; MOFEP	Northern Research Station publications
Results & Recommendations	Small stand treatments on local scale may contribute to lack of regional diversity; data collected insufficient to evaluate ecosystem condition/changes	Continue floristic quality surveys; adjust project planning to prioritize at risk ecosystem projects

Goal 1.2 Non-Native Invasive Species

	1986-2003	2006-2020
Emphasis	Meet state laws for noxious weeds; minimize, prevent, treat pest problems	Prevent new invasions & control or reduce existing occurrences of non-native invasive species (NNIS)

	1986-2003	2006-2020
Issues	Public resistance to herbicide use; increasing acres of non-natives in Forest; feral hogs; ground disturbance from resource mgmt. can spread non-native invasive species	Acres treated, but unsure if overall extent changing
Data collected	2003 started inventory of 18 species to be inventoried and mapped according to national protocol	GIS layer of identified NNIS locations; feral hog sightings
Publications		NNIS Herbicide EIS
Results & Recommendations	Need to inventory & monitor, noting trend changes in location, extent, and density of plant population over time; need plan for prevention, containment, control; education program for FS & public	Develop & implement monitoring for effectiveness of treatments

Goal 1.3 Soils, Watersheds, and Water Quality

	1986-2003	2006-2020
Emphasis	Riparian area protection; specialized wildlife habitat; recreation opportunities;	Maintenance of water quality; implement best management practices (BMPs)
Issues	No protection in the 1986 Forest Plan to maintain the health of headwater streams; karst geology; groundwater complexity; no specific goals or objectives for karst features; bank erosion; non-forested riparian issues on private lands	Minor site-specific instances of not meeting BMP implementation or BMP not effective
Data collected	USGS WRD water quality/flow; water quality at Council Bluff Lake swim beach; water quality at rec site drinking water; Stream Team monitors; 7/13/99, the Mark Twain National Forest and USGS entered into an interagency agreement to assess the effects of forest land management practices on aquatic resources; Ozark Ecoregional Conservation Assessment (The Nature Conservancy [TNC] 2003); cave surveys & mapping by Cave Research Foundation;	USGS WRD water quality/flow; water quality at Council Bluff Lake swim beach; water quality at recreation site drinking water; Stream Team monitors; cave surveys & mapping by Cave Research Foundation

	1986-2003	2006-2020
Publications	2000 Missouri Nonpoint Source Management Plan; Watershed Assessment Report (USDA Forest Service 2001); Aquatic ECS classified stream types, flow conditions, water temperatures, and major fish species. No field verification; East-wide Watershed Assessment Protocol (EWAP)	BMP Protocols and Evaluations; Priority Watersheds
Results & Recommendations	Forest Plan amendments # 11 (1992) & 25 (2000); consider the ecological functions of watersheds; need clear desired future conditions identified for riparian areas and wetlands; need clear definition and criteria for riparian area identification and delineation on the ground; need protection for headwater streams; need specific karst standards and guidelines (S&Gs); need specific direction to monitor the implementation, effectiveness, or validation of water quality standards; revise/update AECS; identification of reference or benchmark watersheds and riparian areas with relatively low levels of disturbance to address questions of natural range of variability, desired future condition, and restoration goals and objectives; identify the effect of land management practices—such as prescribed burning, roading, and timber harvest—on riparian areas, the aquatic environment, and karst landscapes	Develop documentation of mitigation or restoration where BMPs not implemented or effective

Goal 1.4 Wildlife and Aquatic Habitat

	1986-2003	2006-2020
Emphasis	Wildlife management approach focused on 12 management indicator species (MIS) and 8 habitat conditions; MIS population changes believed to indicate effects of management	Manage natural communities to provide habitat for terrestrial, karst, & aquatic native plants & animals

	1986-2003	2006-2020
Issues	Population data for species costly & often unreliable; no connection between species & habitat changes; some MIS seem to be poor indicators of mgmt. effects; difficult to separate effects of National Forest management versus effects of private land ownership; no data on non-consumptive use or demand for wildlife	Difficult to measure cause-effect between management activities & population response
Data collected	CDS/FSVeg & Timber harvest stats; historic vegetation mapping (GRC-MU); breeding bird surveys; bat hibernacula surveys; hellbender surveys; mist-netting & bat acoustic surveys	Breeding bird surveys; bat hibernacula, mist net, acoustic surveys; research on eastern peewee & pine warbler; FQI; MDC fish & aquatic surveys
Publications	1992 Missouri Biodiversity Report; Ozark/Ouachita Highlands Assessment	Northern Research publications
Results & Recommendations	Forest Plan amendment # 5 (1988) re accipiters; Forest Plan amendment # 8 (1991) re riparian; Forest Plan amendment # 25 (2000) re FWS BE; Amendment # 26 (2002) re Indiana bat areas of influence; Amendment # 27 (2002) re fisheries; SIR 2001 re Regional Forester Sensitive Species; 3 of 8 habitat conditions do not meet minimum viable acres; change MIS to better reflect ecological changes; emphasize ecosystems rather than species; coordinate with other landowners	Continue ongoing monitoring for this goal

Goal 2.2. Prescribed Fire, Fuels, and Wildland Fire Management

	1986-2003	2006-2020
Emphasis	Cost-efficient response to wildfire suppression; prescribed burn as a tool to meet resource mgmt. objectives; no established target for prescribed burning or fuels treatment	Reestablish the role of fire in Ozark ecosystems & restore fire regime condition class from 2 or 3 to 1
Issues	Threatened and endangered bat conflicts with fire prescriptions = limit on annual acres; forest health; activity fuels; tree density & lack of ground cover; definition of Wildland-Urban Interface (WUI)	Generic prescribed burn objectives; not meeting seasonality for growing season burns; public issues with smoke from prescribed fires

	1986-2003	2006-2020
Data collected	CDS/FSVeg & timber harvest stats; fire frequency modeling; research from Ozark/Ouachita NF & others; Brown's transects on sporadic basis	Project-driven dead downed woody transects; photo points; anecdotal smoke monitoring; FQI; TNC plots
Publications	Ozark/Ouachita Highlands Assessment; Ozark Ecoregional Conservation Assessment; Biodiversity of Missouri	Risk Assessment; WUI maps; Joint Fire Science publications; Fuel Treatment effectiveness reports
Results & Recommendations	Manage fuels; increase use of prescribed burning; S&Gs lacking or not adequate; role of fire in ecosystem should be addressed; adequate monitoring of effects of prescribed fire has not occurred; scale, seasonality, severity, & internal variability need to be considered in prescribed fire prescriptions	Improve prescribed fire objectives; identify & address obstacles to growing season burns

Goal 2.3 Transportation System

	1986-2003	2006-2020
Emphasis	Provide a road system that is safe, affordable, has minimal ecological impacts, and meets immediate and projected long-term public and resource management needs	Provide minimum permanent road access to meet resource mgmt. objectives; provide off-road vehicle use that minimizes resource impacts
Issues	Issues involving access and closure; record keeping inconsistency in definitions over time; effectiveness of closure devices has not been formally monitored or evaluated; records of which actual roads have been closed or obliterated are hard to find; lack of scientific data and research showing the correlation between road mileage and effects on specific wildlife species or soil and water resources in Missouri	ATV trail monitoring minimal
Data collected	Road miles by standard	ATV trails condition; Transportation Analysis Report (TAR)
Publications	Meramec Regional Planning Commission (MRPC) roads analysis report for maintenance level 3 and 4 roads (MRPC 2003)	
Results & Recommendations	Improve the tracking of road activity accomplishments; need to evaluate effectiveness of closure devices forest-wide; density limits should be reevaluated and substantiated	Continue to organize & update global data, file & share with staff, evaluate effects of management on ATV use off approved forest roads/trail areas

Goal 2.4 Timber Management

	1986-2003	2006-2020
Emphasis	Meet wildlife habitat & other desired conditions through silviculture; perpetuate a healthy, well-stocked forest; support local industry & economy	Use timber management to restore or enhance degraded natural communities, sustain healthy & productive forests & reduce hazardous fuels; provide wood products to local industries
Issues	Overstocking; type shift to fast-growing red oaks; oak decline & insect issues increasing; low growth rate; NEPA appeals & bat conflicts; market for small roundwood weak to nonexistent; UEAM vs EAM	Oak decline risk moderate to high on large areas in Forest but effective treatment slowed by capacity and continued lack of market for roundwood
Data collected	FIA 1989, 1999, 2004; CDS/FSVeg; aerial insect/disease detection annually	FIA 2013; CDS/FSVeg; aerial insect/disease detection annually
Publications	Johnson et.al. 1994 Review of Vegetation Management Practices on MTNF	Forest Health EA; Disturbance Recovery EA
Results & Recommendations	Need more flexibility in management area prescriptions; some mgmt. prescriptions not compatible with naturally occurring vegetation (SLP); reconsider realistic ASQ	Develop flexible toolbox approaches to address timely response to oak decline

Goal 2.5 Geology and Minerals Management

	1986-2003	2006-2020
Emphasis	Encourage & facilitate orderly use of mineral resources on NF; conduct mineral operations in environmentally sound manner & integrated with other resources & planning; reclaim lands disturbed for mineral activities to productive uses	Provide for mineral prospecting & development while complementing other resource management objectives
Issues	Public concern with mining & effects from mining	Public concern with mining & effects from mining
Data collected	Revenue from leases/permits; Tech Team conducted several investigations to quantify background physical and chemical characteristics of ground, surface, and spring water and sediment; to assess aquifer and confining unit hydraulic properties; to study background concentrations of trace elements in aquatic biota; and to provide geological mapping	Data in support of NRDA/CERCLA
Publications	Tech Team (USGS)	NRDA/CERCLA

	1986-2003	2006-2020
Results & Recommendations	Need to further clarify the forest-wide standards and guidelines according to Federal mineral categories; Forest Plan standards and guidelines should be integrated with the current lease and permit stipulations	Re-evaluate need for Forest Plan-level monitoring question upon next Forest Plan assessment and revision

Goal 2.7 Range Management

	1986-2003	2006-2020
Emphasis	Respond to projected demand for range forage while complementing other resource objectives, particularly those associated with open land wildlife habitat; emphasize native grasses	Within the capability of sustainable ecosystems, provide range forage on open lands in response to demand; encourage native grass communities on appropriate sites
Issues	No specific direction to monitor implementation, effectiveness, or validation of grazing for managing open-land (glade and woodland) wildlife habitat; grazing in natural communities such as glades; non-native invasive species	No Forest Plan-level monitoring questions in relation to range management
Data collected	AUMs (animal unit months); Acres treated; visual monitoring of grazing use on allotments; little or no quantifiable vegetative data for grasses and herbaceous cover exist from which to gauge improvements in plant diversity. Parker 3-Step (Parker 1954) baseline trend studies have been established on many of the glade allotments but no remeasures; livestock in or near riparian & streams	AUMs; acres treated
Publications	Ozark/Ouachita Highlands Assessment; USDA Agricultural Census	

	1986-2003	2006-2020
Results & Recommendations	Exclude certain natural communities from grazing; emphasize grazing in existing open pasturelands; change prescriptions & S&Gs to restore riparian & targeted ecosystems; detailed monitoring and evaluation plan including indicators of ecosystem sustainability, range health and conducted at reasonable cost & timely manner. Monitoring should include year-end assessments of residual forage to adjust grazing capacities & assessments of effects on recovery and maintenance of native flora to establish grazing capacities on glade and open woodland natural communities	Consider establishing a monitoring protocol for native grass open lands to track species diversity & structure because of grazing pressure; establish desired conditions & minimums for species diversity

Goal 2.8 Recreation Opportunities

	1986-2003	2006-2020
Emphasis	Implement recreation opportunity spectrum (ROS) – provide variety of experiences; most rec sites constructed 1960s and 1970s	Provide a diversity of recreational opportunities through a variety of settings; contribute to economies in socially & environmentally acceptable manner
Issues	Deteriorating facilities	Deferred maintenance backlog
Data collected	Recreation visitor days (RVD) & revenues; 1996 marketing analysis to evaluate customer needs & minimize conflicts; 2001 evaluation of changes since 1996; facility inspections	RVDs; facility inspections; NVUM 2013; 2018 NVUM; next round NVUM 2023.
Publications	Ozark/Ouachita Highlands Assessment; SCORP; County surveys Meramec Regional Planning Commission	NVUM reports
Results & Recommendations	Individual area recommendations made in 1996 – many reaffirmed 2001, but not enough funds to operate all of them; FP amendment #27 created MP 7.1	Continue efforts to reduce maintenance needs by reducing facilities & seeking partners, collaborative opportunities & authorities, or funding opportunities

Goal 2.10 Heritage Resources

	1986-2003	2006-2020
Emphasis	Identify sites, protect & mitigate impacts of mgmt. activities; relocate or defer projects preferred	Identify, protect, manage, & interpret historic properties in the Mark Twain National Forest

	1986-2003	2006-2020
Issues	Funding for surveys; looting & vandalism; may be managing sites that don't meet NR criteria because haven't been evaluated	Looting & vandalism; natural impacts; may be managing sites that don't meet NR criteria because haven't been evaluated
Data collected	Project level archaeological surveys of just over 400,000 acres; limited site evaluation; data in INFRA	Project level archaeological surveys
Publications	Ozark/Ouachita Highlands Assessment; SCORP; County surveys Meramec Regional Planning Commission	Annual Report of Heritage Program Activities as per 2019 Section 106 Programmatic Agreement with SHPO, ACHP, and Tribes
Results & Recommendations	2002 FP amendment to comply w/Federal mandates; Forest has over 6,000 sites identified; need updated Forest Heritage Resource Overview (last one in 1979)	IDIQ and field requirements mandating evaluation at Phase I level wherever possible; aggressive implementation of collaborative, field, and administrative tactics to reduce backlog of "unevaluated" archaeological sites; complete data validation of all archeological GIS layers.

Goal 2.11 Wilderness Opportunities

	1986-2003	2006-2020
Emphasis	Protect wilderness & provide wilderness experience for users	Ensure protection of wilderness resource while complementing user objectives
Issues	Illegal OHV use; no established character or DFC; Hercules Glade & Bell Mountain ecosystems are fire-dependent; demand for outfitter-guide services in wilderness	All 7 designated wildernesses meet minimum stewardship goals
Data collected	RVDs; visitor exit surveys	RVDs; visitor exit surveys
Publications	Ozark/Ouachita Highlands Assessment; National Survey of Recreation and the Environment	
Results & Recommendations	Desired character & DFC need to be established for each wilderness; monitor changes in conditions that are sensitive to internal and external influences; establish fire use plan for wilderness	Continue annual monitoring & target improvement in specific elements; inventory & monitor wilderness character & manage to minimize impacts on character

4.0 MONITORING ACTIVITIES DURING FISCAL YEARS 2015 - 2020

This section presents the specific monitoring questions that were addressed within this report. Section 5 Monitoring Results will present the most recent evaluations performed for all questions, as well as additional data and trends.

Nineteen (19) monitoring questions were addressed during the fiscal year 2015 through fiscal year 2020 (October 1, 2014 through September 30, 2020) monitoring period, and their associated sections have been updated in Section 5.

The following monitoring questions were addressed during the reporting period, and have had their associated evaluations updated in the next section of this report:

Monitoring Question 1 (see section 5.11) To what extent is Forest management affecting water quality? (File Code 2500)

Monitoring Question 2 (see section 5.12) To what extent is Forest management affecting priority watershed condition? (File Code 2500)

Monitoring Question 3 (see section 5.21) Are vegetation management practices moving conditions towards desired natural community type structural characteristics? (File Code 2200)

Monitoring Question 4 (see section 5.22) Are restoration activities increasing plant species richness and native plant cover for woodlands, glades, and forests? (File Code 2200)

Monitoring Question 5 (see section 5.23) To what extent are prescribed fires used to mimic natural processes, maintain/improve vegetative condition and/or restore natural processes and functions to ecosystems? (File Code 5100)

Monitoring Question 6 (see section 5.24) To what extent are hazardous fuels being treated in the Wildland-Urban Interface (WUI) and/or in high-risk areas? (File Code 5100)

Monitoring Question 7 (see section 5.25) To what extent are fuel treatments affecting the successful suppression of wildfires? (File Code 5100)

Monitoring Question 8 (see section 5.26) Are lentic ecosystems providing habitat for fish and other aquatic species? (File Code 2600)

Monitoring Question 9 (see section 5.27) Are lotic ecosystems providing habitat for fish and other aquatic species? (File Code 2600)

Monitoring Question 10 (see section 5.31) To what extent is Forest management contributing to the maintenance and establishment of shortleaf pine and pine-oak woodlands as described in Appendix A? (File Codes 2200 and 2600)

Monitoring Question 11 (see section 5.41) To what extent is Forest management contributing to the conservation of threatened, endangered, and sensitive species and moving toward objectives for their habitat conditions? (File Code 2600)

Monitoring Question 12 (see section 5.51) What is the status and trend of visitor use, visitor satisfaction, and progress toward meeting recreation objectives in the plan? (File Code 2300)

Monitoring Question 13 (see section 5.52) To what extent do Forest recreation facilities and opportunities meet accessibility, health, safety, and maintenance requirements and achieve resource and social objectives? (File Code 2300)

Monitoring Question 14 (see section 5.53) To what extent are management activities meeting Recreation Opportunity Spectrum objectives? (File Code 2300)

Monitoring Question 15 (see section 5.54) How are management activities affecting unauthorized OHV use? (File Codes 2300 and 5300)

Monitoring Question 16 (see section 5.61) How is the occurrence of mortality across the plan area changing on an annual basis? (File Code 2400)

Monitoring Question 17 (see section 5.71) How close are projected outputs and services to actual? (File Code 2400)

Monitoring Question 18 (see section 5.72) What progress has been made towards meeting objectives in the plan? (Primary File Code 1900 – secondary 2200, 2300, 2400, 2500, 2600, 5100)

Monitoring Question 19 (see section 5.81) Are the effects of forest management, including prescriptions, resulting in significant changes to productivity of the land? (File Code 2500)

5.0 MONITORING RESULTS

The last published monitoring evaluation report for the Mark Twain NF was for Fiscal Years 2015 and 2016. This current report builds upon the data and evaluations from that report adding fiscal years 2017 through 2020, creating a “living document” that covers the history of monitoring in the Forest, and all the data and evaluation since the Monitoring Program was updated under the 2012 Planning Rule.

5.1 – Status of select watershed conditions

Monitoring questions 1 & 2 address required monitoring element 36 CFR 219.12(a)(5)(i) “Status of select watershed conditions (FSH 1909.12 32.13a)”.

5.11 - To what extent is Forest management affecting water quality? (File Code 2500)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded the most significant positive findings were that, in general, best management practices are being implemented as required. About 78 percent of the best management practices that were inspected were implemented as planned. The most significant negative findings were occasional instances where best management practices have not been completely successful at preventing soil movement off-site. Most of these are isolated instances that can be corrected with some additional work. Roads and motorized trails, steep slopes and aquatic organism passages are the resource areas with most of these issues.

Monitoring Indicator(s)

Best Management Practice Implementation and Effectiveness Monitoring

Monitoring Frequency

Best management practice monitoring was first implemented on the Mark Twain National Forest in 2013. Annual monitoring is planned. Each year a different set of activities is monitored for compliance with National best management practices.

Background & Driver(s)

Forest Plan goal 1.3 Soils, Watersheds, and Water Quality has several sub-goals; one of which is “Protect the water quality and integrity of the watershed on Forest lands.”

Forest-wide standards and guidelines for protection of water quality during forest management activities can be found on pages 2-3, 2-4, 2-5 of the 2005 Forest Plan. There are also standards and guidelines applicable to specific resource actions throughout the 2005 Forest Plan.

The Federal Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 404 of the Clean Water Act establishes a federal policy for the control of point and nonpoint source pollution. Nonpoint source pollution results from many diffuse sources like land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and groundwaters. Sediment from erosion is the most common nonpoint source pollution that could occur because of land management activities on National Forest System land. The Clean Water Act Section 404 allows exemptions for discharge permits with the applications of best management practices for the following activities: silviculture; harvesting to produce forest products; upland soil and water conservation practices; and for the purpose of construction or maintenance of forest roads.

Compliance with the Clean Water Act by the Mark Twain National Forest to reduce or eliminate nonpoint source pollution is achieved with the implementation of best management practices. Best management practices are established as Forest Plan standards in the 2005 Forest Plan.

The National Best Management Practice Program was rolled out through a letter from the Deputy Chief in the spring of 2012 and distribution of the National Core Best Management Practice Technical Guide began that summer. The National Best Management Practice Program integrates water resource protection into management activities conducted across the landscape. This program documents compliance with the management of nonpoint source pollution and addresses the new planning rule requirement for national best management practices. Best management practice monitoring began nationwide in 2013.

Best management practice monitoring is an interdisciplinary process that includes assessing the effectiveness of the applied best management practice to prevent a nonpoint source pollution such as sediment from entering a stream or waterbody. For example, we construct waterbars on a skid trail after the timber harvesting of a unit is complete. Nationally, the evaluation forms are entered in a database and reports may be generated that compile all information. Locally, the forms and pictures that were taken are stored electronically in the Forest Service NRM database and in the box folder 2500WatershedAirMgmt\BMP_EP.

Water quality data has not been specifically collected within the Forest since the mid-1990s. Water quality monitoring has been conducted sporadically within the Forest since the 1960s when hydrologists were first hired. Before that, USGS set up water quality and water flow monitors at Greer Springs and a few other sites that are no longer operational, so there is limited water quality data from Forest Service monitoring. The USGS gauge at Greer Springs is still in operation and can be looked at on-line. USGS Water Resources Division is the primary source of water quality data for waters that flow through the Mark Twain National Forest (MTNF). They maintain over 50 gauging stations in watersheds that encompass portions of the MTNF. Data from these sites is found in the USGS Water Resources Data – Missouri annual reports or on the USGS web page (www.mo.water.usgs.gov).

Other water quality data is taken by Missouri Stream Teams, Missouri Department of Natural Resources (DNR), Missouri Department of Conservation (MDC), Conservation Federation, and other volunteers. Missouri DNR is the state agency responsible for this data.

Correlating water quality data with effects from resource or public use activities on Mark Twain National Forest System lands is problematic since there are no watersheds which are 100 percent National Forest System lands. Mark Twain National Forest System lands are located within 65 different hydrological unit code (HUC) fifth level watersheds (also known as 10-digit code watersheds). Within these 65 watersheds, National Forest System land ownership comprises from 0.2 percent to 57 percent of the watershed. Only 7

watersheds have more than 40 percent National Forest ownership. There are 32 of the 65 watersheds with less than 10 percent National Forest ownership. Most of our watersheds have a high proportion of private lands and other ownerships where activities take place beyond our control. Therefore, the best management practice effectiveness monitoring is used to answer this monitoring question.

We collect water samples at recreation sites for E.coli testing of drinking water and high public swim use areas (one swimming beach within the Mark Twain National Forest). Missouri DNR keeps that information. Water quality monitoring of streams, rivers, and lakes is done by Missouri DNR as required by the Clean Water Act. Streams that are considered impaired are placed on the 303(d) list and posted on their web site. Within watersheds with National Forest System lands there are streams on the 303(d) list. Issues include atmospheric deposition of mercury (all major streams and lakes have mercury issues), heavy metals associated with lead mining and lead smelters (Salem and Potosi Unit of the Potosi-Fredericktown Ranger Districts), and one stream due to temperature (Fredericktown Unit of the Potosi-Fredericktown Ranger District). There is a statewide fish consumption limitation due to atmospheric deposition of mercury.

Monitoring Indicator 1

Best Management Practice Implementation Monitoring - % National best management practices implemented

Results and Discussion

Best management practice monitoring data is entered into a Natural Resource Manager (NRM) database, and reports can be retrieved from that database. The 2013 evaluations were not scored, but all other years since have been scored and included in the national document to the Environmental Protection Agency (EPA). Data documenting the monitoring trips can be found in the internal box drive folder 2500WatershedAirMgmt\BMP_EP.

Field evaluations are used to monitor best management practice implementation to determine whether appropriate site-specific best management practice prescriptions were planned and implemented as intended. This includes accessing the primary planning document to determine if provisions to protect water, aquatic, and riparian resources were included and if included were they fully implemented. Between 2013 and 2020 there have been a total of 51 field evaluations and the tables below show overall scoring and summary by year.

Table 2. Implementation monitoring field evaluations between 2013 and 2020

Implementation Rating	Total # of Surveys per Rating for Implementation	Percent per Implementation Rating
Fully	33	65
Mostly	12	24
Marginal	4	8
Not	2	4

Table 3. Implementation monitoring field evaluations summary by year

	Fully Implemented	Mostly Implemented	Marginally Implemented	Not Implemented
2013 Number	0	3	0	0
2013 Percent	0%	100%	0%	0%
2014 Number	3	2	0	2
2014 Percent	43%	29%	0%	29%

	Fully Implemented	Mostly Implemented	Marginally Implemented	Not Implemented
2015 Number	1	3	1	0
2015 Percent	20%	60%	20%	0%
2016 Number	5	1	1	0
2016 Percent	71%	14%	14%	0%
2018 Number	12	1	1	0
2018 Percent	86%	7%	7%	0%
2019 Number	5	1	1	0
2019 Percent	71%	14%	14%	0%
2020 Number	6	1	0	0
2020 Percent	86%	14%	0%	0%

In general, best management practice implementation has successfully occurred with 65 percent of the actions rated as fully implemented and 24 percent as mostly implemented (89 percent of the sites evaluated). The six sites rated as marginally- or not-implemented (or 12 percent) had no common or recurring issue. Each location had site specific issues that were different. The table below includes specific findings for each type of action monitored. Overall, the planning documents and on-the-groundwork include the implementation of 2005 Mark Twain Forest Plan and standards and guidelines.

Table 4. Watershed best management practice implementation monitoring by resource

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
AqEco B - Completed Aquatic Ecosystems Improvements							1 - Fully	
Range A - Grazing management	1 - Mostly							
Fire A - Prescribed Fire	1 - Mostly	2 - Fully	1 - Fully	1 - Fully	2 - Fully	1 - Fully	1 - Fully	
Fire B - Wildfire	1 - Mostly			1 - Fully	2 - Fully	1 - Fully		
Recreation A – developed sites for operation and maintenance				1 - Marginal 1- Mostly				Marginal - There are unresolved maintenance needs (erosion issues) and water supply and delivery system maintenance needed. Mostly - Corrected actions needed not taken (is undergoing new site development plan to correct issues)
Recreation C – motorized or non-motorized trail completed construction		1 - Mostly						Provisions did not include locations and spacing of cross

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
								drains (e.g. waterbars)
Recreation D – motorized or non-motorized trail operation or maintenance		1 - Fully	1 - Mostly		1 - Fully 1 - Mostly	1 - Mostly		2015 - No inspections had occurred during previous 12 months at critical times for water quality issues. 2018 - No inspections performed at critical times and trail had to be closed to protect water quality and aquatic resources. 2019 - trail closure was needed and not done.
Recreation E - Motor Vehicle Use Areas		1 - Fully						
Recreation G – constructed/re constructed watercraft launches or to the operation and maintenance of existing launches		No Plan					2 - Fully	2014 - evaluation of existing launch. No site plan or guidance document was used.
Road A- applied during the construction and reconstruction of Forest Service system roads and/or waterbody crossings				1 -Fully				
Road B - Completed Road or Waterbody Crossing Construction or Reconstruction			1 - Marginal		2 - Fully	2 - Fully	1 - Fully	2015 - Decision document included provisions for aquatic organism passage and it was not implemented.

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
Road C - Long-term management and maintenance of Forest Service system roads (maintenance levels 2-5)		1 - Not			1 - Fully 1 - Not			2014 - There is no documented survey, inventory, or condition assessment for the road that addresses potential water quality problems. 2018 - Road management objectives do not accurately reflect existing design and maintenance that occurred did not involve protection water, aquatic, and riparian resources, road is not maintained to standard, and corrective actions were needed and not taken.
Vegetation A – Ground-based skidding and harvesting operations		1 - Mostly	2 - Mostly	2 - Fully	4 - Fully	1 - Fully 1 - Marginal	1 - Mostly 1 - Fully	2014 - Guidance documents did not include location, size, and timing of use for landing and no aerial extent of harvesting operations and transportation system. 2015 - Supplemental erosion control was needed and applied. 2019 - Debris control in stream was not implemented. 2020 - Corrective actions were needed and implemented.

Monitoring Indicator 2

Best Management Practice Effectiveness Monitoring - % National best management practices effective

Results and Discussion

Field evaluations are used to monitor BMP effectiveness to determine if the applied practices met the desired objective(s) for water quality. Questions in the evaluation address soil erosion, chemical spills, or other potential pollutants such as trash. Between 2013 and 2020 there have been a total of 51 field

evaluations. The tables below show overall scoring for effectiveness and a summary by year and effectiveness rating.

Table 5. Effectiveness monitoring field evaluations between 2013 and 2020

Effectiveness Rating	Total # of Surveys with Effectiveness Ratings	Overall Percent Effectiveness
Effective	31	61
Mostly	2	4
Marginal	3	6
Not	15	29

Table 6. Effectiveness monitoring field evaluations summary by year

	Fully Implemented	Mostly Implemented	Marginally Implemented	Not Implemented
2013 Number	2	1	0	0
2013 Percent	67%	33%	0%	0%
2014 Number	3	1	0	4
2014 Percent	38%	13%	0%	50%
2015 Number	3	0	0	2
2015 Percent	60%	0%	0%	40%
2016 Number	3	0	0	4
2016 Percent	43%	0%	0%	57%
2018 Number	10	0	1	3
2018 Percent	71%	0%	7%	21%
2019 Number	5	0	0	2
2019 Percent	71%	0%	0%	29%
2020 Number	5	0	2	0
2020 Percent	71%	0%	29%	0%

In general, 65 percent of the sites evaluated for best management practice implementation were considered effective or mostly effective at preventing pollutants from entering the stream. Best management practice implementation on 18 sites (35 percent) were considered marginal or not effective from preventing soil erosion entering the stream channel. The table below includes the site-specific findings. The most common issue was the lack of cross drains or incorrect cross drain spacing on fire lines, roads, and trails. The table below includes more detailed information.

Table 7. Watershed best management practice effectiveness monitoring by resource

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
AqEco B - Completed Aquatic Ecosystems Improvements							1 - Effective	
Range A - Grazing management	1 - Effective							
Fire A - Prescribed Fire	1 - Effective	1 - Effective 1 - Not	1 - Effective	1 - Not	2 - Effective	1 - Effective	1 - Effective	2013 - Old closed road used as fireline with no cross drains

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
								through the burn unit 2014 and 2016 - Constructed dozer line with no cross drains
Fire B - Wildfire	1 - Marginal			1 - Not	1 - Effective 1 -Not	1 - Effective		2016 - Failed water bars 2018 - Constructed dozer line with no cross drains
Recreation A – developed sites for operation and maintenance				2 - Not				2016 - user created trails lead to stream with no cross drains
Recreation C – motorized or non-motorized trail completed construction		1 - Effective						
Recreation D – motorized or non-motorized trail operation or maintenance.		1 - Not	1- Not		1 - Marginal 1 - Not	1 - Not		2014 - Failed BMPs on steeper slopes 2015 - perennial stream crossing not properly set causing water to flow under culvert and is an AOP barrier. Also portion of trail located within an ephemeral stream channel. 2018 Marginal due to BMP failure as result of a record-breaking storm and flooding event May 2017. 2017 & 2019 Not rating due to poor trail

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
								location and no ability to install cross drains.
Recreation E - Motor Vehicle Use Areas		1 - Mostly						
Recreation G – constructed/re constructed watercraft launches or to the operation and maintenance of existing launches		1 - Not					1 - Effective 1 - Marginal	2014 - No BMPs
Road A- applied during the construction and reconstruction of Forest Service system roads and/or waterbody crossings.				1 - Effective				
Road B - Completed Road or Waterbody Crossing Construction or Reconstruction			1 - Not		2 - Effective	1 - Effective 1- Not	1 - Effective	2015 - Evaluation of newly constructed stream crossing and it was undersized causing streambank instability and continued to be an AOP barrier. 2019 - BMP failure due to a high precipitation event with tornado damage.
Road C - Long-term management and maintenance of Forest Service system roads (maintenance levels 2-5)		1 - Not			1 - Effective 1 -Not			2014 and 2016 - Cross drains not maintained

Resource monitored	2013	2014	2015	2016	2018	2019	2020	Findings
Vegetation A – Ground-based skidding and harvesting operations		1 - Effective	2 - Effective	2 - Effective	4 - Effective	2 - Effective	1 - Effective 1 - Marginal	

In terms of protecting the integrity of the watersheds, our seven years of effectiveness monitoring has shown that 2005 Forest Plan standards and guidelines regarding soil and water best management practices are overall effectively working (preventing sediment from reaching the stream). About 61 percent of the areas inspected showed that implementation of best management practices was 100 percent effective at working well to reduce or eliminate soil movement off-site. There are a few cases where best management practices have not been completely successful. Most of these involve cases where waterbars were not correctly installed, and actions have been taken to correct the future implementation of waterbars in these types of situations. Roads and motorized trails, steep slopes and aquatic organism passages are the resource areas identified most often as having issues.

Overall, water quality in streams and rivers that flow through the Mark Twain National Forest is good and meets state standards for full body immersion (USDA Forest Service 2005, p. 3-225). Surface waters do not meet state drinking water standards without treatment, generally because fecal coliform is present. (USDA Forest Service 2005, p. 3-225). Within the Mark Twain National Forest, most of the streams and lakes on the 303(d) list are due to atmospheric deposition of mercury. Additionally, there are streams on 303(d) list due to heavy metal contamination in the Old and New Lead Belts. These listings are not a result of activities occurring in the National Forest.

During 2013 through 2016 monitoring, the most significant negative findings were that there are occasional instances where best management practices have not been completely successful at preventing soil movement off-site. Most of these are isolated instances that can be corrected with some additional work. Roads and motorized trails, steep slopes and aquatic organism passages are the resource areas with most of these issues.

2018 through 2020 surveys had similar positive and negative findings as the 2013 through 2017 surveys. Weather events contributed to most of the negative findings. There are trends across all the evaluation years. Recreation D motorized and non-motorized trail in almost all cases best management practices have failed, Road C Operation and Maintenance have best management practice placement or location issues, and both Fire A and Fire B have issues when an old road was re-used as a fireline.

2013 – best management practices implemented were effective at preventing soil erosion from reaching the stream network or a waterbody.

2014 – best management practices implemented were effective at preventing soil erosion from reaching the stream network or a waterbody.

- 100% best management practices implemented were effective at preventing soil erosion from reaching the stream network or waterbody on: Devils Horn 5; Ozark Trail reroute; Trail 120; Family Play Area; and Turkey Ridge payment unit 4.
- Prescribed Fire Bennett Road had a constructed fireline along an old, closed road that paralleled along an ephemeral stream, on a steeper slope with rocky soils. No waterbars were constructed and sediment from the fireline (old road) directly deposited into the ephemeral channel. To improve or prevent this situation in the future the group present discussed options of choosing a

new fire line location and other materials that can be used to prevent sediment erosion when waterbars are difficult to construction. Other materials include using rock or logs.

- Chadwick Motorized Trail 120 had major improvements, but some of the improvements on the steep slope section did not hold, and sediment from the trail directly deposited into the stream. Continued maintenance to improve the trail was planned.
- Turner Mill North Boat Ramp in the Eleven Point River is a graveled boat ramp and sediment from the nearby road directly enters the stream down the boat ramp. Long-term future planning is needed at the site.
- National Forest System Road 1623 rills and small ruts forming, and sediment was directly entering an intermittent stream channel at a natural ford crossing. Continued maintenance post timber sale is unfunded and this problem will continue to exist until there is funding for the maintenance on level 2 roads.

2015 –

- 100% best management practices implemented were effective at preventing soil erosion from reaching the stream network or a waterbody on the prescribed fire and vegetation A monitoring trip.
- Chadwick Motorized Trail 119 had a stream crossing constructed on the perennial stream where the culvert is set on top of bedrock, the stream is flowing under the culvert and is an aquatic organism passage barrier. Within the section of trail above the stream crossing, a short segment is in an ephemeral stream channel. Even though it was within the stream course, this is the better location because of the steep slopes with erosive soil. We discussed using a different trail surface than the small gravel and fine mixture that is currently on the trail.
- The stream crossing replacement on Town Branch Road was replaced and on the monitoring trip day was still an aquatic organism passage barrier during low-flow. There are times during high flow the material under the crossing would be flushed out and not be a barrier.

2016 –

- 100% best management practices implemented were effective at preventing soil erosion from reaching the stream network or a waterbody on prescribed fire, Berryman Road, and vegetation A.
- On the Carty wildfire most of the best management practices were effective. One waterbar on a dozer line had failed and sediment had reached the stream. The waterbar had been placed on a steep slope with too far of a distance between waterbars.
- In the Silvermine's Turkey Creek Picnic Area, a set of old steps had been removed for safety reasons. However, this left an unstable, bare soil bank along the stream. The plan was to repair this during maintenance.
- In the Red Bluff Recreation area, there is a failing streambank with user-created trails, so sediment is being directly deposited into the stream. Currently plans to fix this bank are in the planning and design phase.

2017 – No best management practice monitoring checks were completed due to the record-breaking flooding in April/May and the summer/fall western fire season. Planned 2017 monitoring will be completed in Fiscal Year 2018. In April/May 2017, parts of south-central Missouri experienced a 1,000-year rainfall event. This powerful, slow-moving storm system brought torrential rainfall (averaging 10 to 15 inches), causing many problems on roads, trails, and facilities managed by the Mark Twain National Forest.

2018 – Most monitoring was considered to have effective implementation of best management practices. The Tidwell Wildfire, Ozark Trail at McCormack Lake, and Road Operation/Maintenance on FSR 1627 had best management practices that were not effective. As a result, sediment was directly deposited into the stream channel.

- On the Tidwell wildfire one of the firelines was old road located on a steep slope along an ephemeral stream channel. Water control features were not installed on the fireline because the ground is very rocky, and the line is entrenched. This established fireline is used in a prescribed burn unit to manage for wildlife habitat in a walk-in turkey hunting area. During the wildfire it was decided to reuse the established fireline that is located along the property line near a residence. Since this was an inherited fireline the decision was made to re-use it because a new dozer line would have caused additional disturbances. The incident commander managing the fire decided to fall back to existing lines to cause less resource damage to existing resources and to protect the private residence next to the fire. Since the soil is so rocky and difficult to construct waterbars the evaluation team discussed use of trees or logs to act as a water control feature to help disrupt water flow down the fireline. Changes in stream bedload due to sediment from the fireline were noted.
- Monitoring of maintenance on the Ozark Trail at McCormack Lake determined there was trail damage and erosion caused by the April/May 2017 record breaking flood event. Matters were further degraded by user-created detours around the damaged trail. By and large, effectiveness monitoring affirmed the proper use of best management practices to minimize and mitigate adverse effects to soil, water quality, and riparian resources that may result from continued use of the trail. Existing water control features were well designed and located to reduce erosion.
- Consideration should be given to the poor location and steep grade of certain sections of the existing trail. As staffing and funding allow, these sections should be evaluated for realignment to meet U.S. Forest Service Trail Management Objectives (TMO) and improve water quality.
- National Forest System Road 1627 was used during a timber sale. The road did not have properly functioning best management practices, and road condition continued to deteriorate by the April/May 2017 record breaking weather event. The monitoring team included the following recommendations:
 - Improve communication between engineering staff and district staff to prevent problems from lack of best management practices.
 - Include the transportation analysis in the environmental analysis. The Environmental Assessment had no specific information. It was unclear why the road needed reconstruction. Only maintenance was planned for the timber sale contract.
 - Follow the intent of all Forest Service Manuals and Forest Service Handbook direction.
 - There are problems with funding to support all road maintenance needs. As a group re-evaluate the approach to funding how road work will get completed.

2019 – Most monitoring was considered to have effective implementation of best management practices. The evaluation on the Silver Mines trail and National Forest System Road 712 A had best management practices that were not effective. As a result, sediment was directly deposited into the stream channel.

- The monitoring of the Silver Mines trail was to determine the maintenance needed after the April/May 2017 rainfall event, which caused widespread trail erosion and sedimentation in streams. In October/November 2018, the Potosi-Fredericktown Ranger District of the Mark Twain National Forest performed operation and maintenance on Silver Mines Trail (No. 056127). Effectiveness monitoring affirmed the proper use of best management practices to minimize and mitigate adverse effects to soil, water quality, and riparian resources from continued use of the trail. Existing water control features were well designed and located to reduce erosion - as evidenced by the trails current condition, despite above normal precipitation levels during the month of May 2019. The 120' ditch installation is located on a steep portion of an old, entrenched mining road. Sediment travels down the entrenched trail and has led runoff directly into the stream. Waterbars with lead offs cannot be constructed in this section due to hard bedrock on the surface. Re-routing as identified by district or zone staff is likely the only remedy. Overall, the work on the Silver Mines trail was excellent given the legacy issues and limited resources. The creativity of the ditch, re-establishment of the old spur trail, and the rock step checks were particularly impressive.
- National Forest System Road 712A had best management practices built correctly and within the typical spacing for waterbars. However, a significant rain event occurred after project completion, and best management practices failed during the event causing sediment to directly enter in the stream course. Since precipitation amounts during a single storm event caused significant failure, we need to consider creating deeper dips, increase quantity of dips, and larger rock size in the bottom of dips to decrease chances of best management practice failures.

2020 –All evaluations had either effective or marginal effectiveness of all best management practices. Sediment did not enter directly into the stream course. North Fork Boat Ramp and Spearhead Timber Sale and best management practices with rating of marginal effectiveness.

- North Fork Boat Ramp had ruts created by equipment wheel tracks between river and sediment fence. Tracks stopped before reaching streambank. Once area is revegetated this will no longer be an issue.
- East Fork Huzzah project, Spearhead Sale had a rut on the landing produced by the equipment when moving the slash pile to comply with provision CT 6.7# slash disposal measures within the slash disposal zone. This rut resulted in production of a small area of soil movement outside of the landing area. This area appears to be stabilized and is localized in nature. Repairing the rut however would have required more use of machinery and could cause additional problems. An alternative method of erosion control could be to place slash on and around the site with the rut to slow water movement.

Recommendations

Site specific issues discovered during field monitoring trips were dealt with on a case-by-case basis and are being incorporated into future planning and implementation work.

Evaluation of Monitoring Question and Indicator(s)

Best management practice monitoring is a national requirement. We will continue to monitor water quality according to national and regional direction.

References

National BMPs website <https://www.fs.fed.us/biology/watershed/BMP.html>

U.S. Department of Agriculture, Forest Service. 2005. Mark Twain National Forest. Final Environmental Impact Statement. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm8_045273.pdf

USGS Water Resources Division www.mo.water.usgs.gov

Missouri Department of Natural Resources <https://dnr.mo.gov/env/wpp/>

5.12 – To what extent is Forest management affecting priority watershed condition? (File Code 2500)

Last Updated

The Mark Twain National Forest's priority watersheds were initially scored in 2011 or 2012 and re-evaluated in 2021. We also updated the Watershed Action plan in 2021. Maps identifying the watershed conditions and the Watershed Action plans are found on the Watershed Condition Framework website.

We are tracking projects completed but have not revisited if there has been a change in condition class. It is too soon to determine if changes have taken place and there are still active vegetation treatments occurring in the priority watersheds. A more appropriate measure of success will be possible once the current and proposed stream projects have been completed, and the watershed condition class is assessed again.

Monitoring Indicator(s)

Watershed Condition Class Score (composed of 25 individual indicators)

Monitoring Frequency

Each priority watershed is evaluated according to the 25 individual indicators on an as needed basis once treatments have been completed in each watershed. There are three MTNF priority watersheds. In 2021 select watersheds were re-evaluated based on potential changes in condition. Change in condition includes significant storm damage and restoration work that occurred across large portions of individual watersheds, including the three priority watersheds. All other watersheds were evaluated in 2011 and 2012. Watersheds included in the 2021 evaluation are listed below.

Storm Damage: West Fork Black River 110100070103; Middle West Fork Black River 110100070104; Brushy Creek 110100070305; Indian Creek 110100060104

Restoration Work: Widows Creek – Black River 110100070703; Headwaters Cane Creek 110100070901; Middle Hurricane Creek 110100110209; Headwaters Big Barren Creek 110100080606 (Priority Watershed); Big Barren Creek 110100080605 (Priority Watershed); Lower Pike Creek 110100080404; Mill Creek 102902030107 (Priority Watershed)

Background & Driver(s)

In 2011, the Forest Service directed that Forests identify priority watersheds, based upon the criteria established in the Watershed Condition Framework (USDA Forest Service 2011). The Mark Twain identified three HUC-6 (12-digit code) watersheds as priority watersheds. This includes Mill Creek Watershed in the Houston-Rolla-Cedar Creek Ranger District and Upper Big Barren and Big Barren Watershed in the Eleven Point Ranger District. Watershed plans and progress are documented in the 2021 Transition Watershed Restoration Action Plan. Physical location tracking of on the groundwork is reported in Watershed Improvement Tracker (WIT).

Monitoring Indicator 1

Watershed Condition Class Score (composed of 25 individual indicators)

Watershed Condition Indicators

- Water Quality (Impaired waters (303(d)) listed); Water quality problems (not listed))
- Water Quantity (Flow characteristics)
- Aquatic Habitat (Habitat fragmentation; Large woody debris; Channel shape and function)
- Aquatic Biota (Life form presence; Native species; Exotic or aquatic invasive species)
- Riparian/Wetland Vegetation (Vegetation condition)
- Roads and Trails (Open-road density; Road and trail maintenance; Proximity to water; Mass wasting)
- Soils (Soil productivity; Soil erosion; Soil contamination)
- Fire Regime or Wildfire (Fire Regime Condition Class; Wildfire Effects)
- Forest Cover (Loss of forest cover)
- Rangeland Vegetation (Rangeland vegetation condition)
- Terrestrial Invasive Species (Extent and rate of spread)
- Forest Health (Insects and disease; Ozone)

Results and Discussion

The Mark Twain National Forest's priority watersheds were scored in 2011 or 2012 and 11 watersheds were reevaluated in 2021. Maps identifying the watershed conditions are found on the Watershed Condition Framework website. The website was updated with the new evaluation scores.

Recommendations

Watershed projects should continue to be implemented as part of integrated resource projects.

Evaluation of Monitoring Question and Indicator(s)

Priority watershed condition needs to be scored at intervals to assess progress toward meeting 2005 Forest Plan goals and objectives. We should continue to follow national and regional direction for determining watershed health.

References

U.S. Department of Agriculture, Forest Service. 2011. Watershed Condition Framework.
https://www.fs.fed.us/biology/watershed/condition_framework.html

U.S. Department of Agriculture, Forest Service. Watershed Improvement Tracker (WIT).

5.2 - Status of select ecological conditions including key characteristics of the terrestrial and aquatic ecosystems

Monitoring questions 3-9 address required monitoring element 36 CFR 219.12(a)(5)(ii) "The status of select ecological conditions including key characteristics of the terrestrial and aquatic ecosystems (FSH 1909.12 32.13b).

5.21 – Are vegetation management practices moving conditions towards desired natural community type structural characteristics? (File Code 2200)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded plot data has been collected pre-and post-treatment on two landscape scale project areas, Pineknott and Cane Ridge. Both are

primarily shortleaf pine and pine-oak woodland natural communities. A preliminary review of the data has been completed, but the data is still being analyzed. The initial assessment indicates a trend toward meeting some of the structural parameters for open and closed woodland.

Plot data has also been collected pre-treatment on several other landscape scale project areas, including Kaintuck (primarily oak woodland) and the Ava glades ecosystem. Post-treatment data has been collected on the Ava glades, but that data has not yet been analyzed.

Observations of the areas under landscape-scale management for the longest time show that basal area and percent canopy have both decreased, and ground cover has increased, because of management treatments, including timber sales (overstory removal), understory removal, and prescribed fire.

Monitoring Indicator(s)

2005 Forest Plan Appendix A: Table A-1 Parameters for Natural Communities (% canopy, basal area, understory, shrub layer, ground cover)

Table 8. Range of ecological parameters for respective natural communities in management prescriptions 1.1 and 1.2

Natural Community Types	% Canopy	Basal area	Canopy Gap Size	Understory	Aspect, slope, roughness	Shrub layer	Structural age/growth stages per decade	Ground organic layer	% Ground cover	Patch size
Prairie	<10	NA	NA	NA	All aspects; gentle slopes; plains	Sparse	Grassland with few scattered shrubs and trees	Grass, sedge, and forb cover	90-100	10-200 acres
Savanna	10-30	<30	5-20 acres with 2 per 100 acres	Scattered oaks and shrubs	Broad ridges; all aspects; gentle sloping	Dense; mostly scattered oaks and other shrubs	Shrub oak/pine covering 10-25% of area	Grassland, sedge, and forb cover	90-100 grasses dominant	50 to over 1,000 acres
Open Woodland	30-50	30-50	10 acres with 1-3 per 100 acres	Mixed shrubs, early-mid seral	Southwest facing to upper ridges; gentle to steep; gentle plains and hills	Dense; mostly scattered oaks and various shrubs	Shrub oak/pine covering 10-25%; even age stands	Grass, sedge, and forb cover; little accumulated leaf litter	60-80 grasses dominant	10-100 acres
Closed Woodland	50-80	50-90	3 acres with 1-5 per 100 acres	Early-mid seral trees	Some upper ridges to base of north-facing slopes; gentle to steep; hills and breaks	Sparse; mostly scattered oak and various shrubs	Shrub oak/pine in 5-10% of area; even age stands	Shallow leaf litter; mixed grasses, sedges, and herbs	80-100	100 to over 1,000 acres
Upland Forest	80-100	80-100	1% per year	Shade tolerant shrubs and small trees	Generally north-facing slopes; steep to very steep; hills and breaks	Sparse; scattered; vines present	Oak/mixed species of variable age; small, isolated gaps 1-5 acres	Moderately deep leaf litter	50-70	10-100 acres
Bottomland Forest	80-100	80-100	1% per year	Shade tolerant shrubs and small trees	North-facing slopes; very steep or broad-level floodplains; hills and breaks	Sparse; vines present	Multi-layered; uneven age; few gaps	Deep leaf litter; ephemeral herbs	50-70	10-500 acres

Natural Community Types	% Canopy	Basal area	Canopy Gap Size	Understory	Aspect, slope, roughness	Shrub layer	Structural age/growth stages per decade	Ground organic layer	% Ground cover	Patch size
Fen	<10	NA	NA	NA	Toe slopes; ravines and floodplains	Dense to sparse or none; variable	Vary from shrub thickets to open herb/sedge meadows	Shallow marly to deep muck	90-100	<100 sq. ft. to 15 acres
All glade types	<10	NA	NA	Small shrubs and trees restricted to rock outcrops and borders	Generally southwest-facing but all aspects on igneous and White River; steep to very steep; hills and breaks	Variable	Primarily grass or mixed herb cover with scattered shrubs	Sparse to dense cover of grasses; mineral soil often exposed	30-90 grasses dominant	½ to 300 acres

Monitoring Frequency

Annual

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 1 Promote Ecosystem Health and Sustainability and Goal 1.1 Terrestrial Natural Communities, which says “Maintain, enhance, or restore site-appropriate natural communities, including the full range of vegetation composition and structural conditions.” The 2005 Forest Plan contains tables 1.1 and 1.2 displaying the amount of community types desired in management prescription areas 1.1 and 1.2 respectively (USDA Forest Service 2005, p. 1-2).

The 2005 Forest Plan emphasizes restoration and maintenance of sustainable and healthy natural communities. The percent of area in varying community types as compared to the natural capacity of the landscape is a good indication of whether we are moving toward achievement of those desired conditions stated in the 2005 Forest Plan.

2005 Forest Plan table A-1 (displayed in table 8) parameters were determined during the development of the 2005 Forest Plan. All the parameters except patch size are measured or estimated during plot data measurement for forest inventory and analysis (FIA) and floristic quality index (FQI) plots.

Monitoring Indicator 1

2005 Forest Plan Table A-1 parameters (displayed in table 8)

Results and Discussion

Plot data has been collected pre- and post-treatment on two landscape scale project areas, Pineknott and Cane Ridge. Both are primarily shortleaf pine and pine-oak woodland natural communities. Recent data shows that basal area reduction has occurred. Currently basal area on a landscape-scale is still too high to fall within the parameters for “Open woodland” according to 2005 Forest Plan Table A-1 (displayed in table 8). The continued assessment indicates a trend toward meeting some of the structural parameters for open and closed woodland.

Observations of the areas under landscape-scale management for the longest time show basal area and percent canopy have both decreased, and ground cover has increased, because of management treatments, including timber sales (overstory removal), understory removal, and prescribed burning. Continued reentry with prescribed fire is a necessity or a reversal of the trend will occur with trees per acre in these landscapes increasing rapidly.

If overall ground cover and species richness are occurring on the restoration landscapes yet overall basal areas remain on the high end of desired range, a re-evaluation of 2005 Forest Plan Table A-1 may need to take place. This table with its different natural community types and ecological parameters was created at the infancy of the practice of natural community management and years of data collection may support a change in the ranges for some community types.

Under an agreement with NatureCite, a summary analysis of vegetation monitoring plots of data collected from 2000 to 2017 was completed for the Pineknott and Cane Ridge sites. This included 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). All treatment plots showed an increase in native cover since thinning and prescribed fire activities began. Burn only and thin and burn treatments had an increase in richness from 2000 to 2014 for the Pineknott site with slight increases in Mean C (mean average of conservative species present) and a decline in 2005 and then an increase in 2015 for thin and burn sites. The Cane Ridge site showed an increase in native cover across all treatment sites and a decrease in species richness. None of these changes were statistically significant. Plot-by-plot comparisons will be needed to better understand the behavior of floristic quality across these sites. Evaluation of this monitoring effort has identified shortcomings in our monitoring efforts at the landscape level and has resulted in the development of the Community Health Index (CHI) as described in the following section.



Photo 1. Historic photo (May 1942) - National Forest shaded pasture; Houston Ranger District



Photo 2. Upland woodland in forest condition (no treatment). Overstocked with substantial development of suppressed and shade-tolerant trees. Pineknot project area circa 2010; Doniphan Ranger District



Photo 3. Upland Woodland in forest condition (no treatment). Overstocked with substantial development of suppressed and shade-tolerant trees. Cherokee Pass project area circa 2019; Potosi/Fredericktown Ranger District.



Photo 4. Upland woodland in initial stages of restoration. Maintenance phase following harvest, non-commercial mechanical treatment (chainsaw felling), and two burn cycles. PineKnot project area circa 2015; Doniphan Ranger District.

Recommendations

We have gathered grid plot data (including floristic quality index (FQI)) since 2005 as a replacement for annual stand exams that were discontinued. FQI data is entered into the FS Veg database. In addition, data is collected in The Nature Conservancy (TNC) plots centered on specific natural communities, such as Pineknot. These plots gather primarily understory and ground flora data, including Brown's transects (fuel). Data from TNC plots is also entered into the FS Veg database.

FIA data has been gathered in National Forest for several decades. It is stored in the national FIA database, which is accessible by the public for standard reports and basic data analysis.

Analysis of data gathered has been limited to scattered, informal efforts by individuals interested in a specific issue or topic. We have a large amount of data that needs to be evaluated prior to starting Forest Plan revision. The sooner the data is analyzed, the better information we have about how well our current management is achieving objectives; or if we need to adjust in how or when we conduct management activities.

Evaluation of Monitoring Question and Indicator(s)

We are just now starting to get enough information to determine if changes occurring are moving toward the desired future conditions. We need to continue to evaluate the available information to see if it is

telling us what we need to know to assess future management decisions. Until then, we will not know if this monitoring question or indicators need to be changed or adjusted.

References

U.S. Department of Agriculture, Forest Service. 2005. Mark Twain National Forest, Forest Plan.
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm8_045308.pdf

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Inventory and Analysis (FIA).

5.22 – Are restoration activities increasing plant species richness and native plant cover on woodlands, glades, and forests? (File Code 2200)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded data has been collected long enough for some areas to see changes in native species richness and cover. Pineknot (open pine woodland), Cane Ridge (open pine woodland), and Ava Glades (glade) have each had at least three remeasures of plot data. However, we must be cautious in interpreting this data. Plot locations were established for the purpose of monitoring, not for rigorous scientific research. It is difficult to be confident that the results are a statistically significant representation of differences because of management actions or lack thereof. In addition, three years of data spread over a period of 10 years is a blink of the eye in ecological time. It may seem long enough in human time, but it normally takes decades or longer for ecological changes to manifest. What we can determine from the data is whether it appears that our management is moving toward the objectives of the 2005 Forest Plan. This indeed, appears to be the case. This type of data collection needs to be continued long-term if it is to be helpful in determining whether changes are taking place.

Monitoring Indicator(s)

Change in native species richness and cover

Monitoring Frequency

Annual

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 1 Promote Ecosystem Health and Sustainability and Goal 1.1 Terrestrial Natural Communities, which says “Maintain, enhance, or restore site-appropriate natural communities, including the full range of vegetation composition and structural conditions.” The 2005 Forest Plan contains tables 1.1 and 1.2 displaying the amount of community types desired in Management Prescription areas 1.1 and 1.2 respectively (USDA Forest Service 2005, p. 1-2).

Ground cover is a vital component of natural communities. The number of species present and their distribution over an area is a good indication of how healthy the system is and if it is functioning in a sustainable way. To monitor changes in native species richness and cover, we use the floristic quality index (FQI), including mean coefficient value, native index, and number of species per plot. FQI is based on repeated sampling of vegetation in randomized plots (typically fifty 1/4 square meter quadrats) along permanent line transects. Fixed plots are sampled on a 5- to 10-year schedule and the data is compared to determine changes.

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 each 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). FQI has conclusively been shown to have very limited usefulness in predicting a site's floristic quality and biological integrity. 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.

Threshold or range for species richness:

1. Mean coefficient (C) value for species per quadrant: Less than 5 are poor; more than 5 is better; 7.5 is best.
2. Mean native species for each plot: 1 to 3 is poor; 3 to 8 is fair; 8 to 15 is good, greater than 15 is high integrity (desired condition) for woodlands.
3. Native Index equals mean values of all species collected in each quadrat divided by the square root of total number of species. Poor is less than 25; fair (still degraded) 25 to 40; high integrity is 40 to 65.

Table 9. Expected relative changes in key groundcover indicators for woodland natural communities in MP 1.1 or 1.2, assuming implementation of prescribed activities as scheduled

	Year 1 Baseline (no treatment)	Year 3 Following burn	Year 5 Following thinning	Year 10 Following 2 more burns	Year 20 following 3 more burns	Year 30 following 2 more burns	Optimal range
#species/plot	1-3	3-5	5-7	8-10	10-12	12-14	10-17
Mean C	1.7	2.2	3.5	5.8	6.4	7.2	>7.5
Native Index	6.0	7.5	10.5	14.5	16.8	20.4	25
% Cover	<5%	20-30%	30-40%	50-60%	60-80%	70-90%	>90%

Monitoring Indicator 1

Change in native species richness and cover

Results and Discussion

Pineknott – Open Pine Woodland

Pineknott project area contains 100 plot locations (settings). These plots were established in 2000 and were re-measured in 2001, 2005, 2010 and 2014. In 2019, we had a data analysis of Pineknott and Cane Ridge vegetation monitoring plots under a Challenge Cost Share Agreement (18-CS-11090500-033) with NatureCite, which has been a partner for many years in the collection and analysis of floristic data.

The Pineknott and Cane Ridge project area falls within the Missouri Pine-Oak Woodland Project area, a Collaborative Forest Landscape Scale Restoration Project which started in 2012 and will be completed in 2026. This project area has received extensive amounts of restoration thinning, various types of silviculture treatments, timber harvest and prescribed fire. Prior to 2012, the Pineknott project area had received extensive pine thinning and prescribed fire treatments as part of the 2003 Pineknott Restoration Project. The established fixed vegetation plots are stratified by their treatment regimes, no treatment, thinning only, prescribed burning and a combination of both thinning and burning. The following is a summary of the general trends of the herbaceous communities.

Pineknott Treatments (comparing Burn Only, Thin Only, Thin and Burn, and No Treatment): The Thin Only treatment showed no significant change over time in native Mean C and there was only a slight (non-significant) increase in. The Burn Only treatment increased in richness from 164 plant species in 2000 to 246 species by 2014. 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). This combined change in Mean C was not statistically meaningful. In the Thin and Burn treatment, richness and native FQI increased significantly. While not statistically meaningful, Mean C appears to have slightly declined after 2001 but rebounded slightly in 2014 (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.

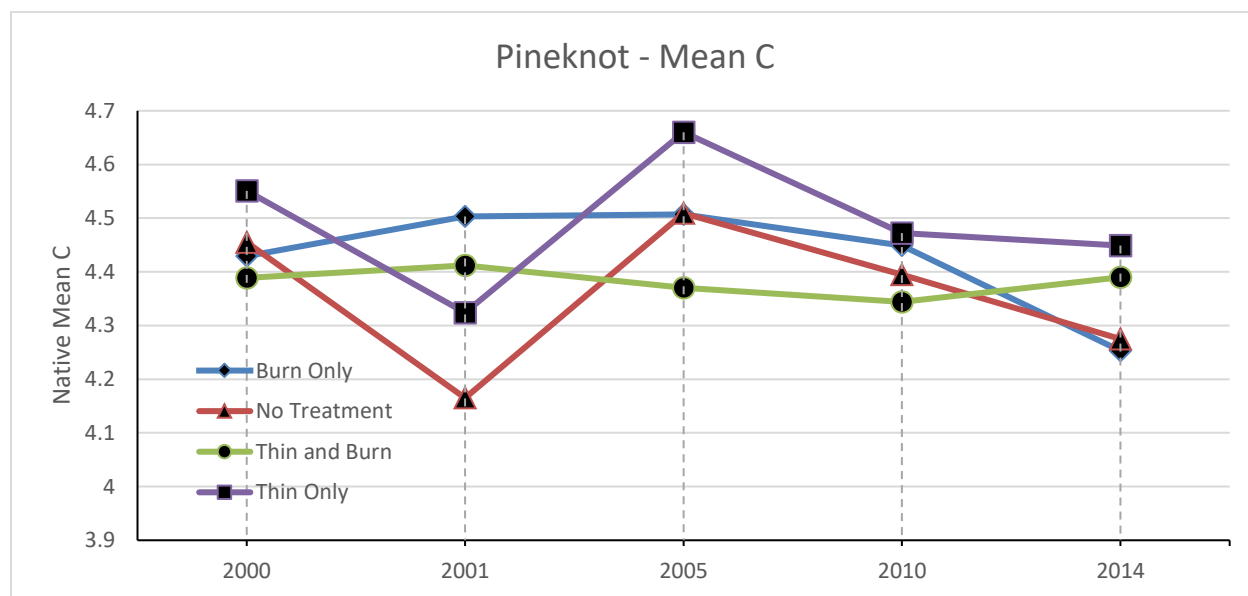


Figure 2. Pineknott changes over time in native Mean C for each treatment regime¹

¹None of these changes were statistically meaningful: No Treatment (n=5 plots); Thin Only; Burn Only (n=34 plots), and Thin and Burn (n=54 plots). 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.

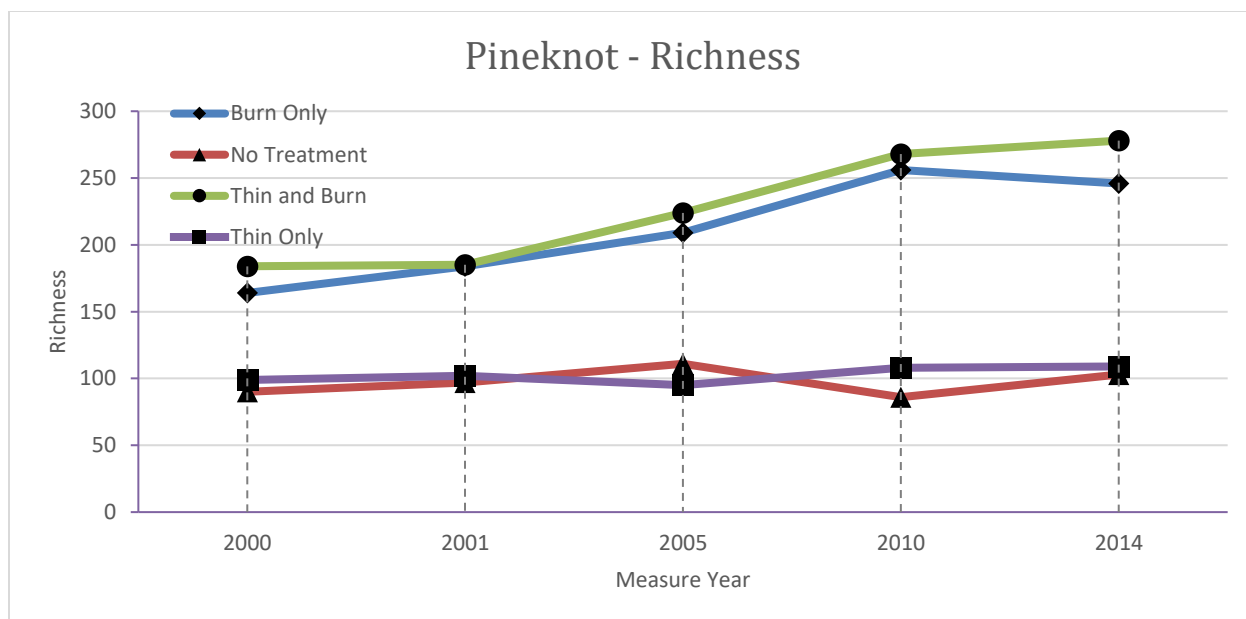


Figure 3. Change over time in richness for each treatment regime²

²(No Treatment [n=5 plots]; Thin Only [n=7 plots]; Burn Only [n=34 plots]; and Thin and Burn [n=54 plots]). 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).

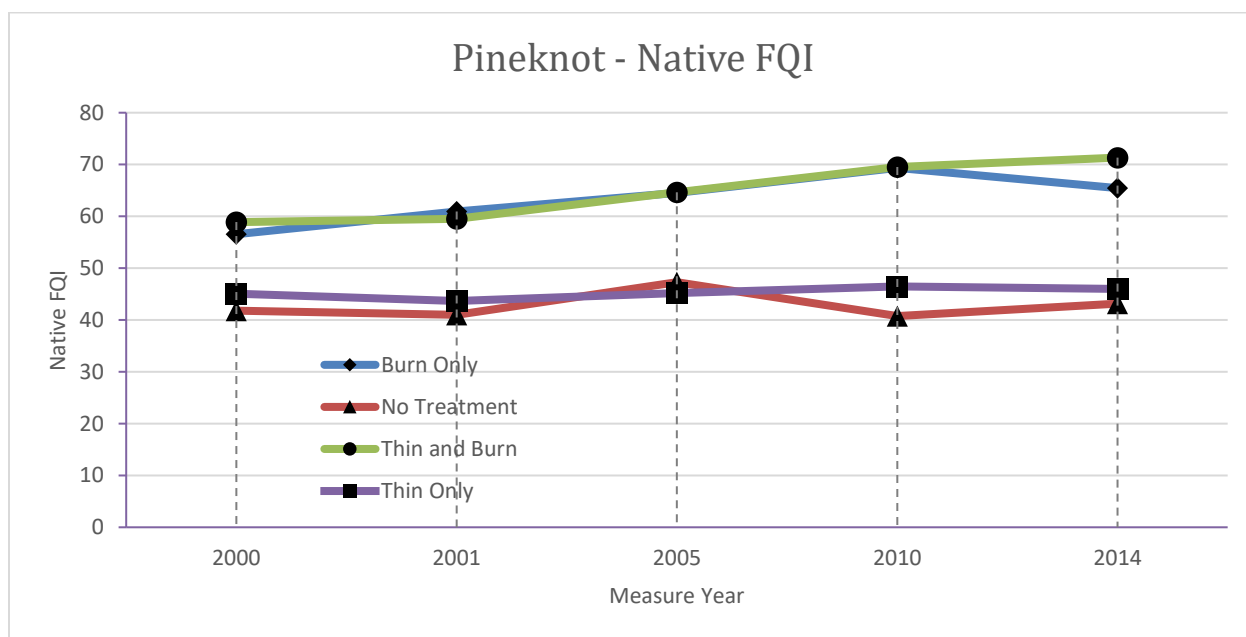


Figure 4. Change over time in native FQI for each treatment regime³

³(No Treatment [n=5 plots]; Thin Only [n=7 plots]; Burn Only [n=34 plots]; and Thin and Burn [n=54 plots]). 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. 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.

Cane Ridge Treatments (comparing Burn Only, Thin Only, Thin and Burn, and No Treatment):

Cane Ridge has 31 and were sampled in 2009, 2012 and 2015. FQA monitoring plots: 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. Richness for Burn Only suggests an increase from 105 plant species in 2009 to 134 species (132 native; 2 exotic) by 2015. Native Mean C for Burn Only suggests an increase each year. 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.

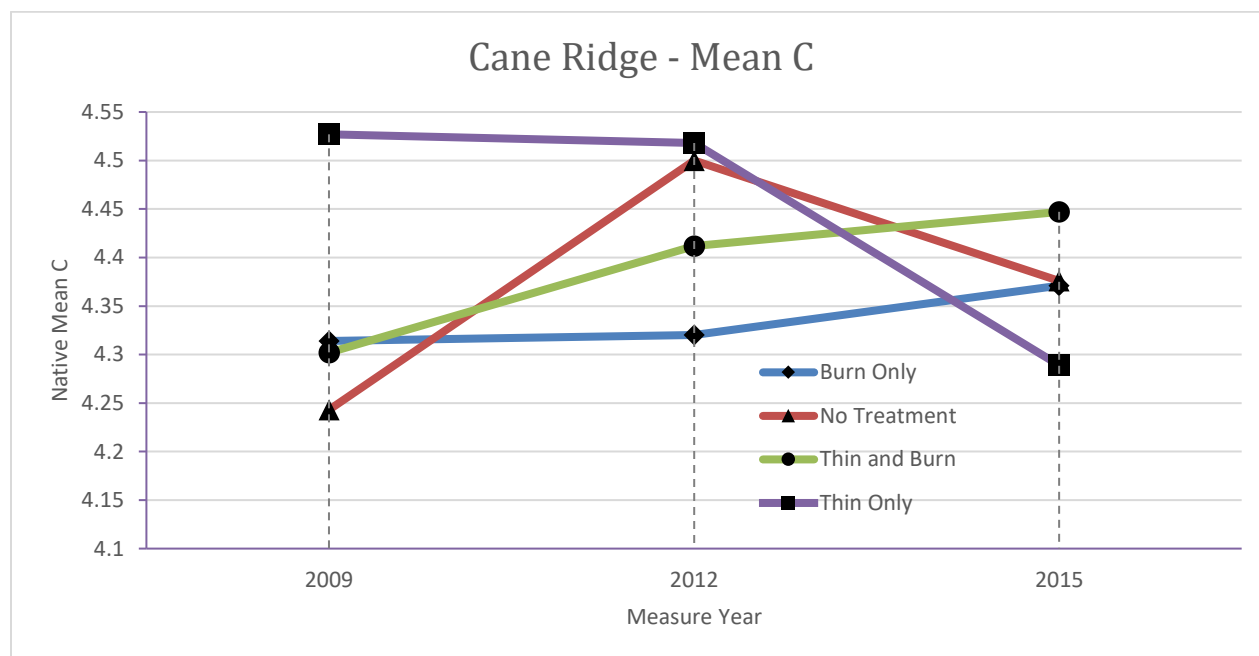


Figure 5. Change over time in native Mean C for each treatment regime⁴

⁴No Treatment [n=4 plots]; Thin Only [n=3 plots]; Burn Only [n=6 plots]; and Thin and Burn [n=15 plots].

Linear regression shows a significant increase in Mean C from 2009 to 2015. 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. 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 regarding their starting conditions and the details of applied management.

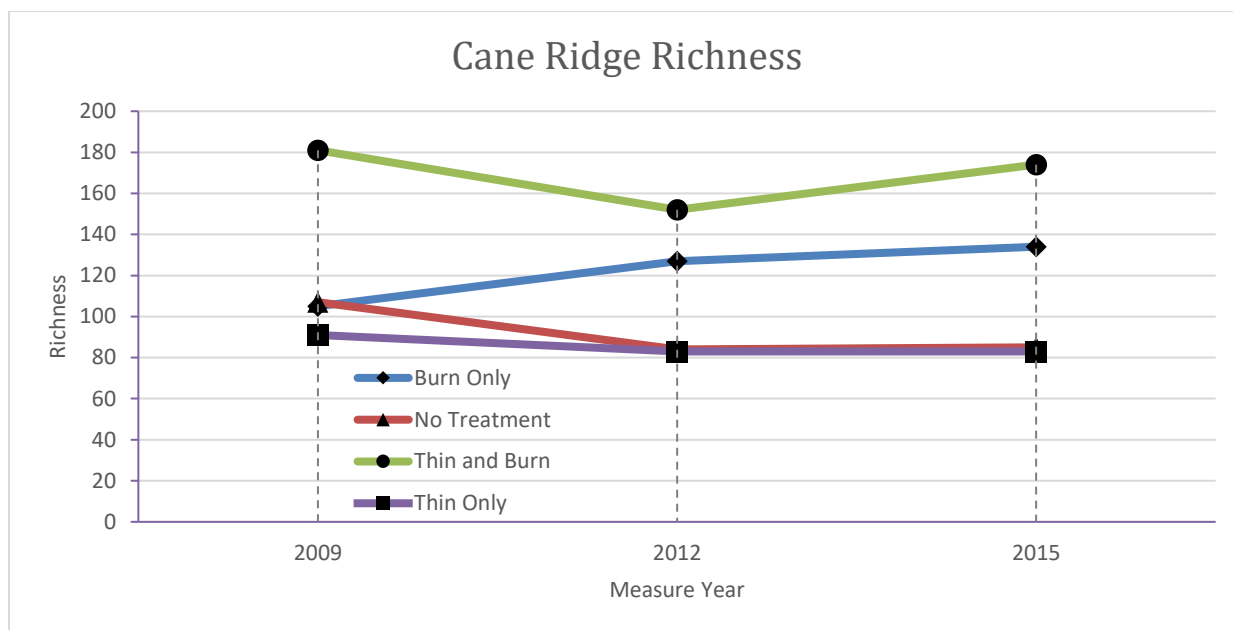


Figure 6. Change over time in richness for each treatment regime⁵

⁵No Treatment [n=4 plots], Thin Only [n=3 plots], Burn Only [n=6 plots], and Thin and Burn [n=15 plots]. 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).

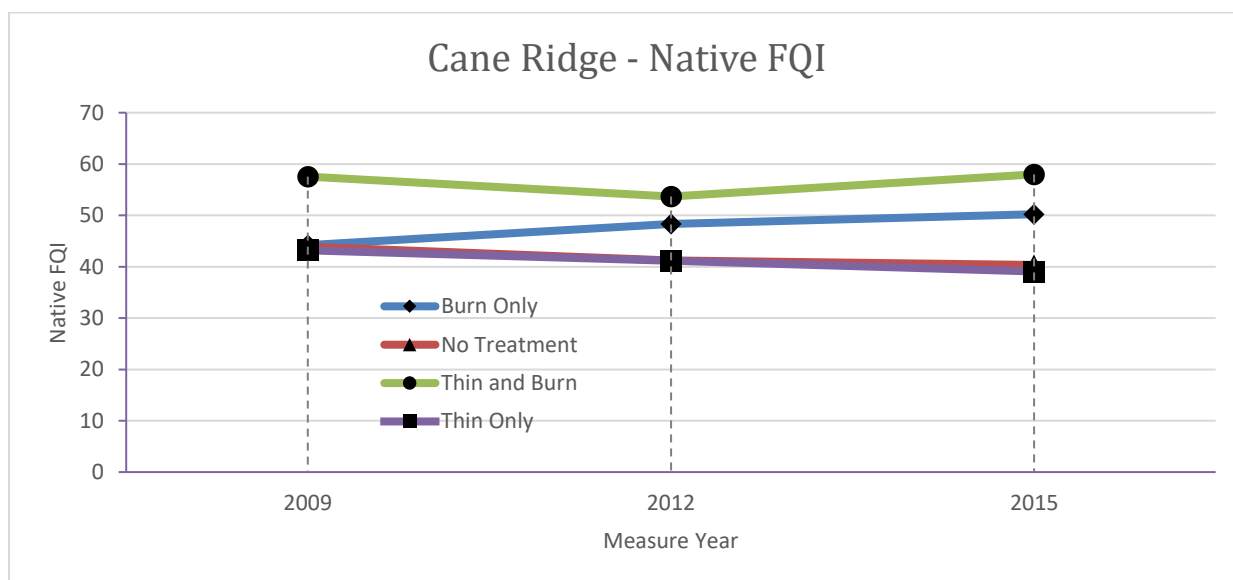


Figure 7. Change over time in native FQI for each treatment regime⁶

⁶No Treatment [n=4 plots], Thin Only [n=3 plots], Burn Only [n=6 plots], and Thin and Burn [n=15 plots]. 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).

Issues with Monitoring Design: 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”. 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 Relative Importance Values (RIV) 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.

Conclusion: 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 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. 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, additional data collection, and 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.

Ava Dolomite Glade Communities

In 2020, the Mark Twain National Forest contracted data analysis of Ava Glade vegetation monitoring plots under a Challenge Cost Share Agreement (20-CS-11090500-041) with NatureCite, which has been a partner for many years in the collection and analysis of floristic data. The following is a summary of information contained in the *Ava Ranger District Floristic Quality Assessment Report 2020*. Seventy-five plots were established in 2006 and data were collected in 2006, 2011, and 2017. This summary below provides an interpretation of the ecological condition and trajectory of the dolomite glade and woodland communities as indicated by their floristic quality.

Because canopy density can affect ecological processes in glades, following a slightly modified interpretation of the Mark Twain National Forest’s classification of open and closed glades, we also grouped glade plots into open and closed categories using aerial images from Google Earth (2020). In this context, open glades refer to a plot with an overstory canopy approximately less than 50 percent, and closed glades refer to a plot with an overstory canopy approximately greater than 50 percent. This resulted in 27 plots being categorized as an open glade and 19 plots categorized as a closed glade. Woodlands were not analyzed by this category. Plots grouped into burn frequency and canopy density categories can be viewed in the table.

Table 10. Community data classification summary

Community Type*	Burn Frequency by 2017	Number of Plots	Plot Identity
Open Glade	0 – 2 (low)	8	1, 2, 5, 6, 12, 13, 14, 15, (18)
Open Glade	4 – 6 (high)	19	16, 19, 20, 21, 23, 25, 29, 33, 37, 39, 40, 41, 42, 43, 52, 55, 56, 58, 61
Closed Glade	0-2 (Low)	6	3, 15, (17), 65, 73, 74, 75
Closed Glade	4-6 (high)	12	30, 38, 46, 47, 48, 50, 51, 53, 54, 57, 62, 63
Woodland	0-2 (low)	17	4, 7, 8, 9, 10, 11, 22, 24, 44, 64, 66, 67, 68, 69, 70, 71, 72
Closed Glade	4-6 (high)	12	26, 27, 28, 31, 32, 34, 35, 36, 45, 49, 59, 60

*Open glade refers to glades with little to no overstory canopy and closed glade refers to a significant overstory canopy. Low burn frequency refers to plots that were unburned or burned up to two times, and plots identified as high burn frequency were burned four to six times.

Because differences in management corresponded to geographically clustered plots and because these clustered plots demonstrated similar data trends, the plot data were also grouped and analyzed by each of these “units”. For example, plots centrally located off Glade Top Trail (plots 30-49) experienced higher burn frequencies than plots located near the property boundary south and west of Hwy 160 (plots 64-75). Illustration of each unit can be viewed in figure 8.

Based upon these groupings, a total of 44 glades and 29 woodland plots were identified in the dataset. These plots were also divided into seven units for analysis, and two categories (low and high frequency) of burning. These groups were subject to inherent overlap.

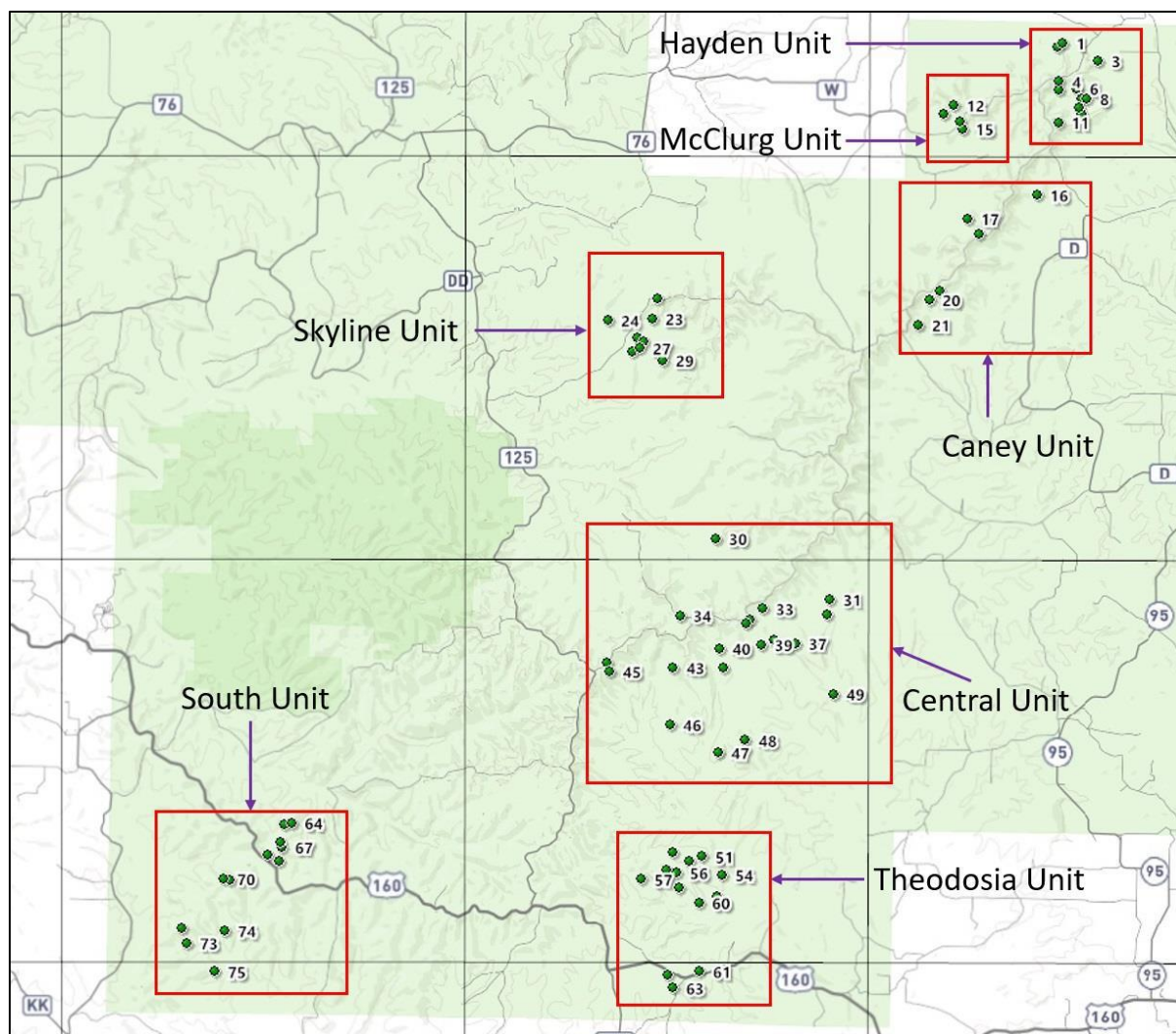


Figure 8. Ava Ranger District plot locations and their corresponding units. Only portions of the plot numbers are represented in the figure.

Limitations: Glade plots 17 and 18 were outliers and were excluded from the analysis. Unlike other plots because they were densely covered with immature woody vegetation, and it was uncertain whether they were formerly glade or woodland in character. Their inclusion would have artificially obscured the direction and relative stability of the other plots and thereby misinformed the analysis.

Although this project focuses on interpretations of floristic quality regarding management history, some management activities, such as timber harvest, thinning, livestock grazing, etcetera, are not fully characterized and documented. These past land use activities, in some cases, have influenced the state of natural communities at Ava Ranger District and should, at some point, be integrated into the experimental design planning process and analysis. Prescribed burns, however, were accurately documented and most burns occurred during the sample period. We found these parameters to be the most relevant and informative for characterizing floristic quality trends.

Glade Plots: The table shows the categories into which the plot data were sorted for analysis. These categories represented natural relationships in the plot-by-plot data analysis over the 2006 to 2017 study

period. The categorization of data into units provided a geographical relationship between plots that corresponded to management histories and consistent range variations of the variables in the analysis.

All Plots Combined: Because of variations in legacy, management, geography, and the intact nature of the plots in the study over the study period, an analysis of all the plots combined provides little information. When all glade plots are analyzed together, we find that Native Mean C and Shannon diversity did not change significantly over the sampling period. Plot native richness decreased significantly from 71 species to 67. Plot native richness did not correlate to Native Mean C, but native richness at the quadrat scale (quadrat richness) strongly correlated with Native Mean C. This is a matter of two scales of perception. At the plot scale the richer plots do not have a higher chance of having quality species than the less rich plots. However, at the quadrat scale, plots with more species per quadrat are likely to have higher quality species. This relationship is likely due to differences in heterogeneity. Some plots have many species in the plots, but each quadrat only catches a fraction of them compared to other plots which have the same number of species more equally distributed between quadrats. Put another way, the quadrats of some plots have fewer species but a higher proportion of them are unique to each quadrat compared to others which have more species per quadrat, but the quadrats have many of the same species. A close inspection of the data revealed that this correlation was not related to closed or open glade conditions or amount of burning.

Table 11. Glade plots: average values of 2017 FQA results and their average differences between 2006 and 2017 (gain vs loss) by category. Calculated differences of FQA values in the table with a negative value refer to an overall decline from 2006 to 2017.

Data Category	Burn Frequency	Native Mean C by 2017	Change in Native Mean C (06-17)	Native Richness by 2017	Change in Richness (06-17)	Average Richness by 2017	Change in Average Richness (06-17)	Relative Woody Cover by 2017	Change in Relative Woody Cover (06-17)	Relative Forb Cover by 2017	Change in Relative Forb Cover (06-17)
Total Plots for Site	0-6	5.05	0.10	67.80	-3.36	8.74	-0.61	10.08	-7.60	30.03	-5.54
Open Glade	0-6	5.20	0.16	66.73	-1.92	10.06	-0.32	5.54	-5.23	31.27	-8.09
Closed Glade	0-6	4.83	0.02	69.33	-5.44	6.85	-1.04	16.63	-11.03	28.24	-1.85
Low Burn Frequency	0-2	5.22	-0.05	69.23	2.92	8.95	0.08	8.01	-7.93	30.32	-1.07
High Burn Frequency	4-6	4.98	0.16	67.19	-6.00	8.66	-0.65	10.94	-8.66	29.91	-4.35
Hayden Unit	0-2	5.37	0.00	65.40	5.80	10.41	0.22	2.94	-4.14	34.10	-9.99
Caney Unit	4-6	5.54	0.25	62.50	6.25	12.24	1.66	2.38	-0.60	31.36	-13.59
Central Unit	4-6	4.99	0.21	64.25	-10.83	7.91	-1.48	8.73	-9.85	26.41	-2.36
McClurg Unit	0-2	5.17	-0.01	73.25	1.25	8.43	-0.98	10.12	-2.46	27.28	-16.57
Skyline Unit	4-6	5.29	0.33	79.00	-1.33	11.45	0.15	6.19	-6.67	34.73	0.63
South Unit	0-2	5.09	-0.14	70.00	1.00	7.64	-1.03	12.25	-8.87	28.62	1.79
Theodosia Unit	4-6	4.70	0.04	68.75	-6.42	7.51	-0.78	17.20	-10.66	31.71	-4.49

Open Glades and Closed Glades: Open glades had higher Native Mean C and native richness (5.2 and 69 respectively) than closed glades (4.8 and 66, respectively) throughout the study. Open glades increased in Native Mean C across the study period from 5.0 to 5.2 while richness did not change. Closed glades did not increase in Native Mean C across the study period, but native richness declined from 75 to 69 species per plots. Open glades also had more species per quadrat than closed glades (average of 10 versus 7). Relative woody cover declined in both open and closed glades but decreased more in closed glades regardless of fire frequency.

Burning Frequency: Low vs. High: The low frequency category includes Hayden Unit, McClurg Unit, and South Unit. These plots were burned zero to two times. The high frequency category includes the Caney, Central, Skyline, and Theodosia units which burned between four and six times over the sample period. The low frequency plots had a Native Mean C of 5.22 and the high frequency plots had a Native Mean C of 5.0 at the end of the sampling period in 2017. There was a slight increase in Native Mean C for the high frequency plots while that of the low frequency plots did not change. Native richness for the high frequency plots dropped an average of six species while the low frequency gained an average of three.

Currently, the data demonstrate no significant difference between the relative woody cover of high and low frequency plots at the end of the study period, but both high and low frequency plots demonstrate a significantly lower cover when comparing 2017 to 2006. This demonstrates that both high and low frequency plots lost woody cover regardless of fire frequency which suggest that the loss in woody cover was not attributable to fire frequency. In fact, the high and low frequency plots become more similar in woody cover over the study period than they were in 2006.

While these results run contrary to other studies (Miller et al. 2017) and conventional thought about the role of fire in this landscape, it is likely that the high-quality condition of the glade communities in the study area and their subsequent ecological resiliency was high enough that change really should not have been expected. Different results might occur in restorations of low-quality sites, but, as the rest of this report attests, the study area is already an intact high-quality system. The insignificant to slight increases in quality variables are a positive sign that management is maintaining the system integrity and the perceived urgency of fire, or frequent fire may not be as dire as once thought.

Glade Results by Unit

Caney Unit: The three plots in this unit have been burned four or five times. This area includes plots around the Caney fire tower and Caney Lookout. The glades here are of superior condition in terms of their open character and high Native Mean C value. Species that are indicative of high-quality glades that are rare and scattered across most of the study area are common in these plots. These plots also have more remnant mollisols than other units which directly corresponds to the intact quality of the vegetation. This also suggests that the other units have witnessed more overgrazing or destructive fires than the Caney Unit. Plot 17 is included here due to its location only. Floristically it is far removed from the quality of the remaining plots. Plots 17 and 18 have had intensive management attempts to push them in ecological directions that are quite ambitious, and the resulting ecological expressions have been chaotic. Given their outlying character, plots 17 and 18 were not included in this analysis.

The Native Mean C, native richness of plots, and native richness of the quadrats has increased since 2006 in this unit. From 2006 to 2017 Native Mean C increased 0.24 points to 5.54, which is the highest Mean C of all the units in the study area. These plots are the best examples of reference conditions for the glade communities in the study area and likely in the region.

Central Unit: The 12 plots in this unit have been burned five or six times. They are a mix of high-quality remnants and moderately disturbed- and altered-state glades. Several of the glades show signs of historic aerial broad-leaf herbicide application. The soils are also thinner which is likely due to historic overgrazing and destructive fire. The roads that traverse this unit allow for convenient access and prescribed burning but also may serve as entryways for invasive species.

Over the course of the study, native richness at the plot and quadrat scale has declined while the Native Mean C has increased 0.21 points to 4.99. While this is the second lowest Native Mean C in the study area, these units had the highest potential for recovery. Further, any number over 4.3 is considered high-quality natural remnant vegetation. Increases in Mean C often occur as lower C-value species (more weedy species) decline and higher C-value species recolonize. This is a case where decreased richness is a good thing and is a good sign that management is not impeding the ecological complexity and trajectory of the system.

The primary management goal in this unit should be to continue to bring Mean C up to the levels expressed by the Caney, Hayden, and Skyline units. Given the low forb richness, especially on the glades with suspected historic aerial herbicide spraying, assisted migration (manually moving seed from high quality glades to lower quality glades) is highly recommended. However, utmost care and consideration of the source and sowing of that seed is highly recommended to honor the natural character and structure of the sites. Monitoring this process would be highly informative and would provide much needed insight into species recruitment and recruitment limitation.

Hayden Unit: This unit is in the northeastern portion of the study area. Plots in this unit had been burned twice as of 2017. The floristic quality of its glades remains very high (5.37 as of 2017) and did not change significantly from 2006 to 2017. As with units with higher fire frequencies, woody cover in the plots has declined in the Hayden unit. As with other units, there was a small loss in plot richness and a slight increase in quadrat-level richness likely due to declines in weedy species as the system stabilizes and matures.

This unit contains the old Hayden Bald Natural Area that was delisted from Missouri Natural Areas roster in 2010. The old natural area was a square surrounded by private land. It and the surrounding private land had become colonized by Eastern red cedar likely sometime in the mid-1900s (Miller et al. 2017). In the 1980s the Eastern red cedar on Hayden Bald was removed, but it was not removed from surrounding private land. Today, and despite never having burned, Hayden Bald remains free of Eastern red cedar. This is a testament to the impervious nature of stabilized systems in terms of colonization by weedy species.

McClurg Unit: Of the four plots in this unit, three have been burned once and one was unburned since burning has been recorded by MTNF. All but one of the glades had cedar removed in the 1980s or 1990s (based on aerial images). These plots occur on the northwest end of the study area near the small community of McClurg and are bisected by the Glade Top Trail road. These plots were the most stable in terms of exhibiting little change in Mean C, plot richness, quadrat richness, and woody cover. The Native Mean C of the unit was 5.17 in 2017, which puts it on the lower-middle range for the area.

Skyline Unit: This unit occurs on the west-central portion of the study area and along Skyline Road. Only three plots occur in this unit. Two were burned six times and one was burned five times since burns were recorded by MTNF. These glades are of excellent quality with a Native Mean C of 5.29. This is an increase of 0.33 from 2006 to 2017. Plot richness, quadrat richness, and woody cover did not change significantly over this period.

South Unit: This unit occurs south of highway 160, except for plot 65, on the south side of the study area. This area is more dissected and woodier than most other units with more isolated glade openings and more closed glades transitioning to woodland complexes. This unit has had no prescribed fire over the study period. Because of its woodland influence and likely historical negative impacts from grazing and the misapplication of fire it has a lower Mean C of 5.09, which is still very high and encouraging. Over the sampling period both plot and quadrat richness were stable and woody cover decreased.

Theodosia Unit: This unit contains 12 plots of which about half were closed glades and half were open glades. These plots are rugged and difficult to access. Nearly all the plots in the unit have been burned six times over the study area. The plots show signs of more historical damage than the other units and that damage is reflected in its Mean C of 4.7, which makes it the lowest quality unit. However, anything above 4.3 is considered high-quality, so though it is on the low end for the study area, it still holds high ecological integrity. From 2006 to 2017 plot richness decreased a little, as it did in other units, and quadrat richness also declined. Some of the plots have witnessed recent clearing of woody vegetation and what appears to have been extreme fire behavior. These may have stalled more advanced stages of ecological recovery and stability.

Ava Woodlands: Table 12 shows the state of the woodlands in 2017 and changes between 2006 and 2017. By 2017, the average Native Mean C for all woodland plots was 4.47, which is not significantly different than its score of 4.45 in 2006. Change in floristic quality for woodland plots across the entire site was as stable as that of the glade plots, yet woodlands consistently scored lower Native Mean C values than glades. This is expected since woodlands have fewer habitat specialist species. When the data was analyzed by burn frequency (low and high burn categories), they showed no measurable change in floristic quality over time. Hayden, a low burn frequency unit, scored the highest Native Mean C (4.66) among woodland units. Skyline and Central, both high burn frequency units, scored second and third highest in Native Mean C with a 4.54 and 4.45, respectively. Plots represented in these three units (Hayden, Skyline, Central) either met or exceeded the average Native Mean C for the entire site and appear to symbolize exceptional high quality natural woodlands.

The South and Skyline units showed slight decreases in Mean C from 2006 to 2017. These declines could possibly be explained by unrelated processes. For the Skyline unit, two of the five plots (#26 & #27) were thinned in 2016 which could have triggered a flush of annual and short-lived perennial plants likely driving Native Mean C down and richness up (Table 12). The Skyline plots also expressed slight losses in conservative taxa with C-value ranges 7-10. Whereas in the South unit, a low burn frequency unit with the lowest average number of species ($n=32$), the lowest relative forb cover (10.3 percent), and the highest relative woody cover (75.02 percent) among all woodland units, quality may have declined from dense canopy and high leaf litter accumulation.

Table 12. Woodland plots: average values of 2017 FQA results and the averaged differences between 2006 and 2017 (gain vs loss) by category. Calculated differences of FQA values in the table with a negative value refer to an overall decline from 2006 to 2017.

Data Category	Burn Frequency	Native Mean C by 2017	Change in Native Mean C (06-17)	Native Richness by 2017	Change in Richness (06-17)	Richness by 2017	Change in Average Richness (06-17)	Relative Woody Cover by 2017	Change in Relative Woody Cover (06-17)	Relative Forb Cover by 2017	Change in Relative Forb Cover (06-17)
Total Plots for Site	0-6	4.47	0.02	52.45	-5.69	3.35	-0.52	49.45	-11.48	27.44	8.20
Low Burn Frequency	0-2	4.46	0.00	44.06	-5.88	2.52	-0.41	60.36	-1.93	21.84	3.40
High Burn Frequency	4-6	4.50	0.05	64.33	-5.42	4.53	-0.67	34.00	-25.02	35.38	15.00
Hayden Unit	0-2	4.66	0.08	62.83	-10.00	3.59	-1.08	43.79	4.10	32.37	0.02
Skyline Unit	(0) 4-6	4.54	-0.05	51.40	3.00	3.06	0.73	43.42	-28.22	29.44	15.69
Central Unit	4-6	4.45	0.06	65.00	-11.38	5.07	-1.27	33.59	-19.44	40.25	17.06
Theodosia Unit	4-6	4.36	0.00	55.50	-4.50	3.18	-0.64	42.67	-16.04	24.98	2.06
South Unit	0-2	4.35	-0.02	32.00	-2.50	1.69	-0.09	75.02	-3.62	10.31	2.33

As shown in the table, for all woodland plots combined, the average native richness by 2017 was 52.5 species. This is an average loss of 5.69 species per plot since 2006. Woodland plots that have fewer species may be susceptible to lower floristic quality scores than plots with more species, however, the overall total loss in species and the changes in Native Mean C were minimal. That is to say, the contributing loss in species for woodland plots may not result in significant floristic quality declines and may likely be natural fluctuations in community assembly. It is also possible for a site to lose lower quality species as stabilization occurs, so species loss is not always correlated with negative impacts to a natural community.

Also shown in the table, when the plot data is sorted into low and high frequency burn categories, both demonstrate a decline in approximately six species between 2006 and 2017. Floristic quality remains relatively unchanged over this period. The two units that lost the most species, Hayden and Central, represent a low burn frequency unit and a high burn frequency unit. Therefore, the loss of richness is unlikely due to fire frequency. Because Native Mean C is relatively unchanged despite losses in richness, the losses in richness are likely due to natural and normal successional processes and are not reason for alarm. That said, an investigation into the cause of these losses would be highly informative.

Table 12 also demonstrates that from 2006 to 2017, the average relative cover of woody species in all the plots combined went down by 11.5 percent and forb cover went up 8.2 percent by 2017. However, these trends were much more pronounced when the data were categorized by fire frequency. For relative woody cover, low frequency plots witnessed a decrease of two percent and high frequency plots witness a decrease in 25 percent. For relative cover of forbs, low frequency plots demonstrated an increase of 3 percent and high frequency plots demonstrated an increase of 15 percent.

Similar trends emerged when viewing burn frequency by units as did with the plots grouped into low and high burn frequency categories. For example, relative woody cover goes down more in units with high burn frequency (Skyline, Central, Theodosia) than low burn frequency units (South & Hayden). Changes in woody cover were significantly different from 2006 to 2017 for Skyline, Central, and marginally so for Theodosia. The marginal difference for Theodosia was likely because of its small sample size of two plots. The most substantial loss of woody cover was Skyline (-28.2 percent), but this result may largely be weighted by two plots having been thinned in 2016. Central and Theodosia also lost high percentages of woody cover (Theodosia= -16 percent | Central= -19 percent). South also declined (-3 percent) but Haden slightly increased (+4.1 percent). The average relative forb cover increased or stayed the same for all units. Skyline and Central had the highest increase in forb cover, each with about 16 percent, while forb cover gains for other units ranged from 0.02 percent up to 2 percent.

Conclusion: The results of this analysis indicate that the plant communities in the study area are quite stable. The changes that have occurred over the study area during the period from 2006 to 2017 appear to have increased ecological integrity and functionality. This is largely due to the relative intactness of these systems, in the sense that most of the area does not appear to have witnessed past degrees of ecological damage too extensive for recovery. In the glades, woody cover is declining regardless of fire frequency. The woodlands, however, do show decreases in woody cover with more frequent fire, though woody cover is decreasing even with little to no fire. Although fire appears to have accelerated the decline of woody cover in woodlands, burning has had no demonstrable influence on species richness, floristic quality, or diversity indices for glade and woodland communities. This is an interesting and unexpected result that shows how stable and self-assembling intact systems can be even with infrequent fire. Though this may seem antithetical to conventional views about the role of fire in these landscapes, these data fit reports of modeled mean fire return intervals as high as 8 or more years (Guyette et al. 2012) for the area and are well in line with characterizations of the intact historic landscape.

Low burn frequency glades and woodlands had the highest Native Mean C and have stayed relatively stable over the sample period compared to more frequently burned plots. Closed glades have lower Native Mean C and higher richness than open glades, but they are stable and improving. They are not losing sensitive or emblematic glade species and not being colonized by woody species. This could mean there is no real rush to open them up with thinning or extreme fire behavior. It may also mean that opening them up can be a slow, non-impactful, and progressive process that more appropriately corresponds to the rates of immigration of conservative flora. This is especially true considering all glade and woodland categories have decreased in woody cover, even the sites without fire or with limited fire. Interestingly, the glade plots seem to be converging into a stable average woody cover regardless of fire treatment or how open or closed they started. The difference is the speed at which they converge. Open glades and low burn frequency glades are decreasing in woody cover the least, but they are decreasing. This speaks volumes about the stable trajectories of these high-quality systems.

The woodlands naturally have slightly lower Native Mean C values due to the general lack of specialist plant species as compared to the glades. However, the Native Mean C values of the woodlands are quite high and very much demonstrative of a high-quality remnant system. It is important to also understand that the woodlands are dominated by immature trees resulting from wholesale timber removal from the middle of the 19th century to the middle of the twentieth century. As such, these are systems that have not

reached their fully functional structural expressions and thus have not achieved their full species compositional structure and function. All signs indicate that time is the only missing variable.

Ava Glade Monitoring – Community Health Index Summary

In 2021, 16 Bald Knob Dolomite Glade units were sampled utilizing new Community Health Index (CHI) methodology at the following sites: 4 at Theodosia, 3 at Central, 3 at Skyline, 2 at Caney, 2 at Hayden, and 2 at McClurg (see figure 9).

The natural community health index (CHI) is a methodology tiered to a Terrestrial Ecological Unit Inventory to assess and monitor the health or ecological integrity groups of like ecological site types based on four components:

1. Landscape Context

Factors include the size of the natural community and the percent of the surrounding landscape in native vegetation. This component accounts for 10 percent of the total CHI score.

2. Vegetation Characteristics

Example characteristics accounted for by CHI protocol, depending on community type:

- Eastern redcedar canopy cover
- Percent canopy cover of native deciduous trees
- Percent cover of native shrubs
- Percent cover of native warm-season grasses and native forbs
- Number of indicator matrix (Conservation Coefficient values [c-values] 4-6) and high conservation value (c-values 7-10) plant species present.*
- Estimated abundance of characteristic matrix and high conservation value plant species across the unit.*

*60% of the total CHI score is based on the diversity and abundance of matrix and conservative plant species. Vegetation, and specifically floristic quality, influence or are indicative of most ecological functions, including habitat for other taxonomic groups. Additionally, plants are the most easily and practically measured variables of natural communities.

3. Animal Presence (optional category)

Animals are difficult to sample rapidly and require an additional technical skillset, especially herptiles and invertebrates. However, glade CHI protocol includes presence of tarantulas and scorpions and number of characteristic reptiles, amphibian, and bird species observed. The animal component makes up 10% of the score.

4. Disturbance Factors

Disturbance metrics are negative points and consider invasive species, feral hog use, and human impact (such as evidence of illegal herptile collection, root digging, or off-road vehicles).

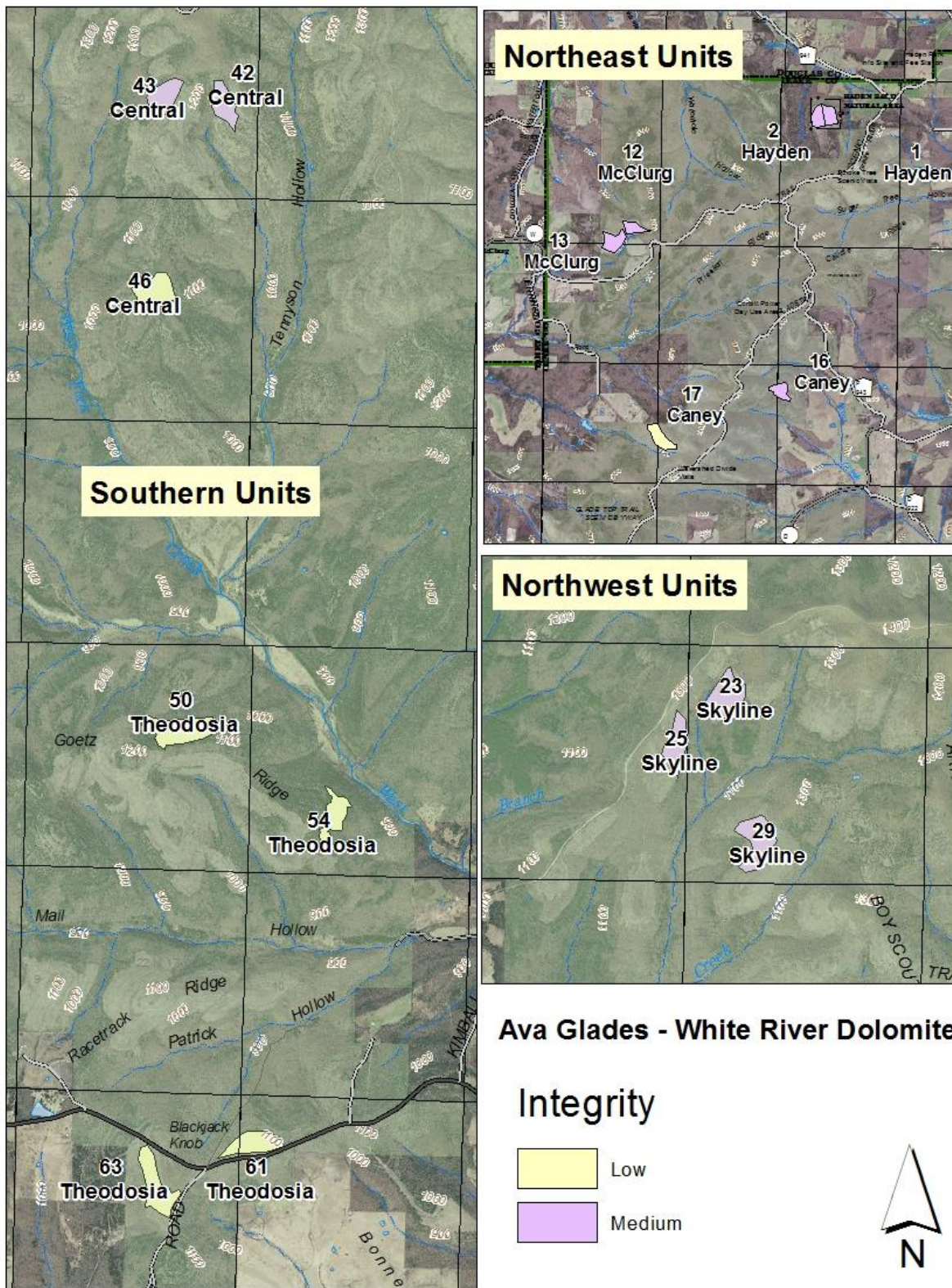


Figure 9. Map of the Northeast, Northwest, and Southern CHI Units within the Ava Glades.

Total Score: Total CHI scores add subtotals from each of the four components. Total scores can be tracked through time as management occurs and can be compared to CHI scores of reference sites.

A summary table of CHI scores for all units can be found in table 13 and detailed scores for each unit can be found in table 14. Ranking integrity (high, medium, low) was calculated based on all dolomite glade units sampled in southern Missouri, including glades outside the White River Hills subsection (n = 64). Sites scored as high would be considered to approaching or at reference conditions as described for the appropriate ecological site description(s). In this case, reference conditions are described in the Bald Knob Dolomite Glade ecological site description. Few sites have the land use history and continuity of ecological processes to reach the reference condition. Medium ranked sites are those that with sustained ecological restoration attain a decent degree of ecological functioning. Low score sites are either those sites that have received little to no ecological restoration or because of past degrading land uses (such as overgrazing), even with ecological restoration, this may be the best they can achieve, at least in the short term. Within Ava glades, ten units ranked as ‘functioning’, six ranked as ‘departing’, and zero as ‘reference’. CHI scores correlate to the following integrities:

Low (departed) < 49
Medium (functioning) = 49-83
High (reference) > 83

Analysis: We compared total CHI scores to two individual CHI sub-metrics: percent cover of eastern redcedar and matrix and conservative plant species scores. There was a strong correlation between cedar cover and total CHI score. The two lowest ranking CHI units had over 50 percent cedar cover whereas all units ranked as ‘medium’ had 0 to 10 percent cedar cover (Table 14). Additionally, there was a strong positive relationship between matrix and conservative plant species scores and total CHI scores.

We further considered the relationship between mean conservatism coefficients (c-values) of flora and total CHI scores. Broadly, higher c-values were associated with ‘medium’ ranking units while units with low mean c-values were ranked as ‘low’ in CHI protocol. It is important to note that this analysis was minimal and management history and initial condition was not considered.

Table 13. 2020 - 2021 CHI summary table for Ava White River Dolomite Glades

Average CHI Score	53.1
# of Units in Medium Ecological Condition	10
# of Units in Low Ecological Condition	6
Highest Scoring Unit	Unit 1 (Hayden)
Lowest Scoring Unit	Unit 50 (Theodosia)

Table 14. Scores for CHI units within the Ava Glades

Site Name	Unit ID	Acres	FQA Mean C	% Cedar Cover	CHI Matrix and Conservative Plant Species Score	Total CHI Score	Integrity
Theodosia	50	19.4	4.537	> 50%	22	28.25	Low
Theodosia	54	11.46	4.629	> 50%	23.5	30.75	Low
Central	46	13.73	4.644	11-25%	32	38.75	Low
Theodosia	63	16.46	3.958	0-10%	33.25	38.75	Low
Caney	17	17.58	4.741	0-10%	38.5	44.75	Low
Theodosia	61	12.81	4.492	0-10%	43.5	48.5	Low
Skyline	25	10.35	5.316	0-10%	50.5	57.5	Medium
Central	42	10.39	5.309	11-25%	52.5	58.5	Medium
Skyline	23	14.22	4.872	0-10%	53	60	Medium
Central	43	10.29	5.139	0-10%	54	61	Medium
Caney	16	10.38	5.623	0-10%	56	61.5	Medium
McClurg	12	10.05	5.341	0-10%	56.5	62	Medium
Hayden	2	10.7	5.472	0-10%	57.5	63	Medium
Skyline	29	15.11	5.667	0-10%	57.5	64.5	Medium
McClurg	13	15.34	5.091	0-10%	59.5	65.5	Medium
Hayden	1	10.58	5.456	0-10%	59	66.25	Medium

This table includes Floristic Quality Assessment (FQA), mean coefficient of conservatism values (Mean C) and total Floristic Quality Index (FQI) scores for vegetation within the CHI units (data for these metrics collected by the Institute for Botanical Training). Other information includes percent canopy cover of eastern redcedar (% cedar cover), characteristic matrix and conservative plant species scores, total CHI score, and CHI integrity ranking.

Recommendations

Monitoring Recommendations

As the monitoring summaries of the Florist Quality Assessment Reports for Pineknot and Cane Ridge disclose, a different approach in their use and interpretation is needed, as well as a change in plot design. The following are recommendations to changes to the fixed FQA plot specifications in the future.

- Reduce the number of quadrats from 50 to 30 on each radial arm and discontinue sampling the overstory tree plots. This would reduce the size of the plots and reduce the amount of variation in site quality. It will also reduce cost in sampling.
- Evaluate each plot and discontinue sampling plots that are negatively influenced by roads, trails, utility rights-of-way and other human disturbances. Discontinue sampling plots that cross different ecological sites.
- Complete a gap analysis and add additional plots in under-represented communities or structural vegetation conditions, where deemed necessary.
- For each FQA plot location, complete a community health index (CHI) assessment for the site (stand).
- Document each ecological site description for each FQA plot.
- Complete a plot-by-plot analysis for Pineknot and Cane Ridge project areas.

The recommendations above will improve monitoring efficiencies and reducing monitoring cost, while adopting a monitoring approach that is more flexible and available to all areas while being more holistic and meaningful to land managers.

Given the cost, time, and complexities of the Floristic Quality Vegetation plots, we are recommending that this effort be augmented with a rapid assessment such as Community Health Index. We are currently collaborating on the development of a rapid assessment with Missouri Department of Conservation and NatureServe. This process will provide a wider understanding of how management activities will or will not improve ecosystem function and integrity, as well as identify areas that would benefit from ecological restoration activities. This will provide a monitoring protocol to be applied to an adaptive management approach to natural community restoration. In addition, cooperative development and utilization of this monitoring effort will provide more comprehensive results both inside and outside Mark Twain National Forest boundaries, within shared landscapes.

A natural community health index (CHI) is a methodology to assess and coarsely monitor the health or ecological integrity of terrestrial natural community types based on four components:

- Landscape context and size of the natural community
- Composition of the plant and animal species
- Structure of vegetation and biomass
- Invasive species

For this assessment, vegetation structure and composition are the most heavily weighted factor (accounting for 75 percent of the possible score) in a community health index because:

- Vegetation influences most natural community functions.
- Vegetation structure and composition provides habitat for other taxonomic groups.
- Vegetation is the primary vector of energy flow through an ecosystem.
- Strong correlations exist between vegetation and soils.
- Plants are the most easily and practically measured variables of natural communities.
- Vegetation integrates spatially and temporally variable natural and management induced disturbances.

In addition, the concepts of floristic quality indices are integrated into this process by utilizing the assigned coefficients of conservatism (Thomas and Ladd 2015) to measure the quality of vegetative communities across the defined assessment area. A plant species list has been developed for Ozark woodland containing 80 species that range from moderate (C values 4 to 6) to highly conservative species (C values 7 to 10). The 4 to 6 value species represent the characteristic species that signify a good quality remnant or restored site, while the additive 7 to 10 value species represent highly functioning and near reference quality conditions.

Landscape context (especially the size of the natural community occurrence) and animal taxa (birds, mammals, invertebrates, reptiles) information would account for 15 percent and 10 percent, respectively, of the possible score in a terrestrial community health index model.

The following table represents community health index sampling units that were completed in 2020 and 2021 as part of the development of the methodology. This test sampling only considers vegetation structure and composition.

Table 15. Community Health Index Sampling Completed in 2020 and 2021

Unit ID	Community Type	Management Regime	BA	% Canopy Cover	% Native grass cover:	% Native forb cover:	Mean C	Relative Score (total score / 90)	Ranking
8	Pine Woodland	Thin, Burn	77	60	10-25%	26-50%	5.70	64.11	Medium
11	Pine Woodland	Thin, Burn	89	61	10-25%	26-50%	5.83	62.44	Medium
12	Pine Woodland	Thin, Burn	70	55	26-50%	26-50%	5.98	72.33	High
13	Pine Woodland	Thin, Burn	91	45	10-25%	26-50%	5.83	58.61	Medium
15	Pine Woodland	No Treatment	142	78	<10%	<10%	5.56	31.89	Low
21	Pine Woodland	Thin, Burn	72	67	<10%	<10%	5.70	36.83	Low
22	Pine Woodland	Thin, Burn	118	71	10-25%	10-25%	5.90	56.83	Medium
23	Pine Woodland	Thin, Burn	148	74	<10%	<10%	5.41	26.72	Low
24	Pine Woodland	Thin, Burn	86	82	<10%	<10%	5.72	31.72	Low
25	Pine Woodland	Thin, Burn	88	95	<10%	10-25%	5.74	40.83	Low
26	Pine Woodland	Thin, Burn	89	63	10-25%	26-50%	5.66	60.22	Medium
27	Pine Woodland	Thin, Burn	75	91	<10%	10-25%	5.71	30.61	Low
28	Pine Woodland	Thin, Burn	85	95	<10%	10-25%	5.65	38.83	Low
29	Pine Woodland	Thin, Burn	80	83	<10%	10-25%	5.63	37.39	Low
30	Pine Woodland	Thin, Burn	98	82	NA	NA	5.58	32.06	Low

Unit ID	Community Type	Management Regime	BA	% Canopy Cover	% Native grass cover:	% Native forb cover:	Mean C	Relative Score (total score / 90)	Ranking
31	Pine Woodland	Thin, Burn	115	75	NA	NA	5.58	36.50	Low
32	Pine Woodland	Thin, Burn	69	88	NA	NA	5.88	50.22	Medium
33	Pine Woodland	Burn	107	93	NA	NA	5.86	61.89	Medium
34	Pine Woodland	Thin, Burn	73	45	NA	NA	5.79	52.11	Medium
35	Pine Woodland	Thin, Burn	108	68	NA	NA	5.76	48.00	Medium
1	Dolomite Glade	Burn	NA	NA	51-75%	51-75%	6.53	48.89	Low
1	Dolomite Glade	Cedar Removal	NA	NA	26-50%	26-50%	6.51	71.67	Medium
2	Dolomite Glade	Cedar Removal	NA	NA	51-75%	26-50%	6.32	70.00	Medium
3	Dolomite Glade	Cedar Removal, Burn	NA	NA	26-50%	26-50%	6.24	69.72	Medium
5	Dolomite Glade	No Treatment	NA	NA	0-25%	0-25%	6.67	37.22	Low
6	Dolomite Glade	No Treatment	NA	NA	0-25%	26-50%	5.77	24.44	Low
7	Dolomite Glade	No Treatment	NA	NA	0-25%	0-25%	6.26	28.33	Low
12	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	26-50%	6.29	68.89	Medium
13	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	26-50%	6.26	72.78	Medium
16	Dolomite Glade	Burn	NA	NA	51-75%	26-50%	6.26	68.33	Medium
17	Dolomite Glade	Cedar Removal, Burn	NA	NA	26-50%	26-50%	6.44	49.72	Low
23	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	26-50%	6.22	66.67	Medium
25	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	0-25%	6.35	63.89	Medium
29	Dolomite Glade	Burn	NA	NA	51-75%	26-50%	6.45	71.67	Medium
42	Dolomite Glade	Burn	NA	NA	51-75%	26-50%	6.36	65.00	Medium
43	Dolomite Glade	Burn	NA	NA	51-75%	26-50%	6.61	67.78	Medium
46	Dolomite Glade	Burn	NA	NA	26-50%	0-25%	5.92	43.06	Low

Unit ID	Community Type	Management Regime	BA	% Canopy Cover	% Native grass cover:	% Native forb cover:	Mean C	Relative Score (total score / 90)	Ranking
50	Dolomite Glade	Burn	NA	NA	0-25%	0-25%	6.00	31.39	Low
54	Dolomite Glade	Burn	NA	NA	26-50%	0-25%	6.10	33.06	Low
61	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	26-50%	6.10	53.89	Low
63	Dolomite Glade	Cedar Removal, Burn	NA	NA	51-75%	26-50%	6.00	43.06	Low

This process will allow for us to better address the Forest Plan monitoring questions 5.21 and 5.22.

This process will also allow us to assess more acres without having to wait for funding for expensive re-measures of existing fixed vegetation plots that are limited in their number and locations. Since this is a more focused rapid assessment with a narrowly defined set of parameters, silviculturist, wildlife biologist and fire personnel will be able to conduct these assessments while gaining on-the-ground knowledge of areas they have or will be managing. These monitoring protocols could be scaled up to include a landscape level, such as Ava's White River Hill Glade Communities or could be scaled down to the individual stand to better understand management questions by the local management decision maker and be more adaptive with management decisions.

In addition, the Mark Twain National Forest is currently developing a Terrestrial Ecosystem Unit Inventory with Ecological Site Descriptions. Each site description will have a fully quantified reference condition which can be used as a desired condition in which to compare responses to restoration activities. This will also compliment the community health index process by allowing us to match reference sites to ecological landscape types where community health index assessment is being conducted.

Evaluation of Monitoring Question and Indicator(s)

Annual changes in species richness and cover are not very meaningful on a biological time scale. Trends in species richness and ground cover would be more accurate in helping us understand if our management was achieving the objectives set in the 2005 Forest Plan. FQA fixed plot data should continue to be collected as funds permit and as needed as management activities are completed. Community health index assessments should be completed at specific project areas, primarily in management prescriptions 1.1 and 1.2, both during the planning phase and after completion of vegetation treatments.

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U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

5.23 – To what extent are prescribed fires used to mimic natural processes, maintain, or improve vegetative conditions or restore natural processes and functions to ecosystems? (File Code 5100)

Last Updated

This question was included in the 2015-2016 Mark Twain National Forest monitoring evaluation report as part of goal 2.2 Prescribed Fire, Fuels, and Wildland Fire Management.

The conclusion for this question was that in 2015 and 2016, 90 percent of prescribed fire acres were in management prescriptions (MP) 1.1, 1.2, 8.1 and 5.1, with most of those acres in management prescriptions 1.1.

Monitoring Indicator(s)

Acres of prescribed burn completed in management prescriptions 1.1, 1.2, 8.1 and 5.1

Monitoring Frequency

Annually

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2.2 Prescribed Fire, Fuels, and Wildland Fire Management to “Re-establish the role of fire in the natural communities of the Ozarks by emulating the historic fire regime.” and restore Fire Regime Condition Class 2 or 3 to Condition Class 1. It also corresponds to objective 2.2b “Use prescribed fire to reduce hazardous fuels and improve Fire Regime Condition Class on 45,000-acres or more per year.”

Management prescriptions 1.1 and 1.2 emphasize the restoration of natural communities; management prescription 8.1 includes special areas with specific management needs; and management prescription 5.1 is wilderness where the natural characteristics are unimpaired. The number of acres of prescribed fire applied in these areas is indicative of successful efforts to emulate the historic fire regime and improve Fire Regime Condition Classes, since fire has been a source of natural disturbance in the Ozark landscape for centuries, if not millennia. While the use of prescribed fire is not the sole disturbance source and cannot, in most cases, by itself restore natural conditions, it is a vital component of restoration and maintenance of many natural communities.

Monitoring Indicator 1

Acres of prescribed fire completed in Management Prescriptions 1.1, 1.2, 8.1 and 5.1

Results and Discussion

In 2015 and 2016, 90 percent of prescribed fire acres were in management prescriptions 1.1, 1.2, 8.1 and 5.1, with most of those acres in management prescription 1.1 (based on the data from FACTS fuel summary report). From 2017 through 2020, most prescribed fire acres were concentrated in management prescription 1.1 and 1.2 restoration areas as illustrated in figure 10 (based on the data from FACTS).

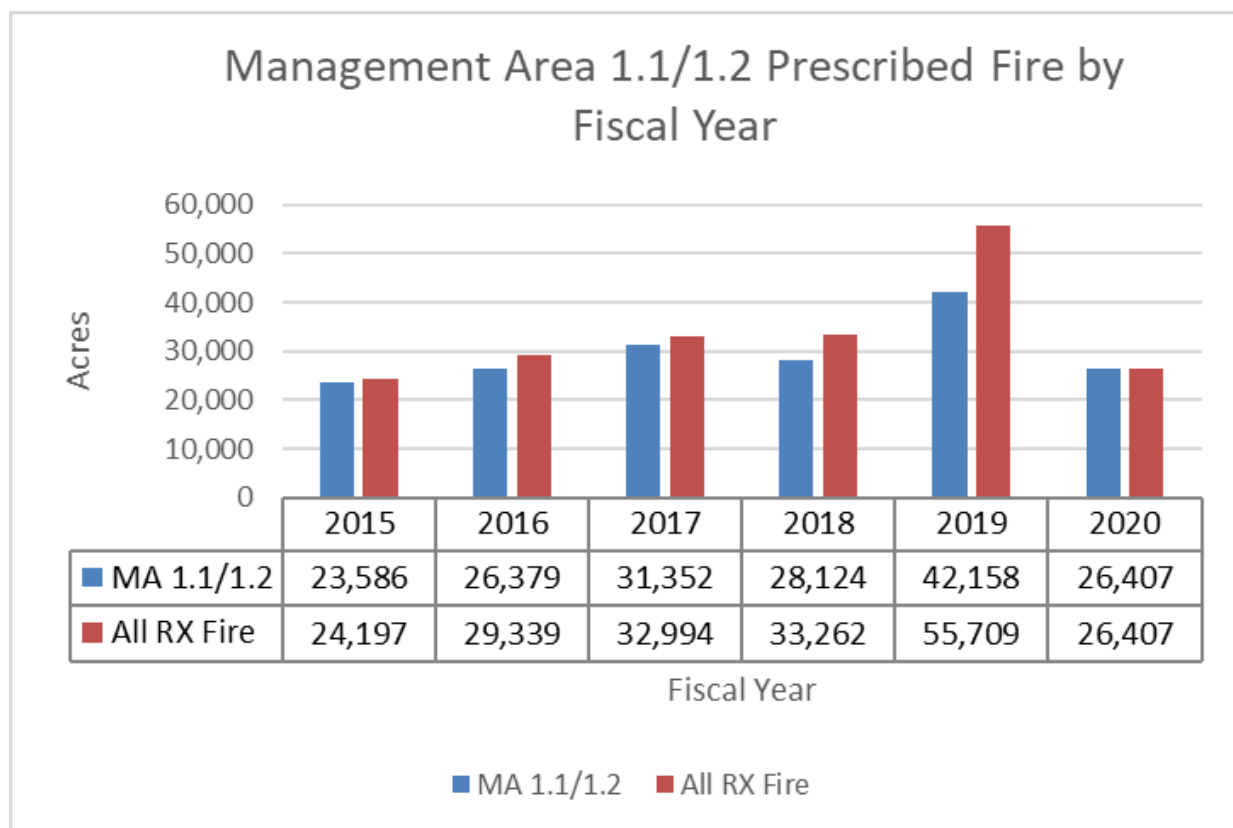


Figure 10. Prescribed Fire by Fiscal Year

We have increased the proportion of prescribed fire acres in these management prescriptions over the past six years. Most acres treated with prescribed fire in these management prescriptions are either areas which have been treated with prescribed fire multiple times or have been placed on a schedule for repeated prescribed fire treatments in future years, to replicate the natural fire regime.

See also monitoring results for questions 3, 4, 10 and 11 regarding changes to vegetation and biodiversity following management treatments, including prescribed fire.

Recommendations

We should continue to evaluate fire effects on prescribed fire areas; and make changes to fire intensity, season, or interval as needed to continue movement toward 2005 Forest Plan objectives found in appendix A, table A-1 Range of Ecological Parameters for respective natural communities in management prescriptions 1.1 and 1.2. Vegetation plot data and floristic quality data will be other indicators to measure the change.

Evaluation of Monitoring Question and Indicator(s)

There are no recommendations for change in this monitoring question or indicator(s).

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

5.24 – To what extent are hazardous fuels being treated in the Wildland-Urban Interface (WUI) or in high-risk areas? (File Code 5100)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded the 10-year average for hazardous fuel treatments within wildland-urban interface or high-risk areas was 21,487 acres per year.

Monitoring Indicator(s)

Analyzing the actual prescribed fire and mechanical treatment acreage completed in contrast with wildland-urban interface areas, and high-risk areas designated in 2005 Forest Plan FEIS appendix G – Fire Risk Assessment.

Monitoring Frequency

Annually

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2.2 Prescribed Fire, Fuels, and Wildland Fire Management to “Reduce hazardous fuels” and “Reduce wildland fire risk to communities.” It also corresponds to objective 2.2b “Use prescribed fire to reduce hazardous fuels and improve Fire Regime Condition Class on 45,000 acres or more per year.” and objective 2.2c “Treat those fuels that pose moderate to high risk to communities or community infrastructure and threatened and endangered species that are at risk.”

The number of acres treated with prescribed fire within areas identified as high risk or as Wildland-Urban Interface (or intermix) areas gives some indication of progress toward reducing risks to people and natural resources from wildland fire.

Monitoring Indicator 1

Acres treated for hazardous fuels reduction in wildland-urban interface and acres treated for hazardous fuel reduction in high-risk areas designated in 2005 Forest Plan’s FEIS appendix G – Fire Risk Assessment.

Results and Discussion

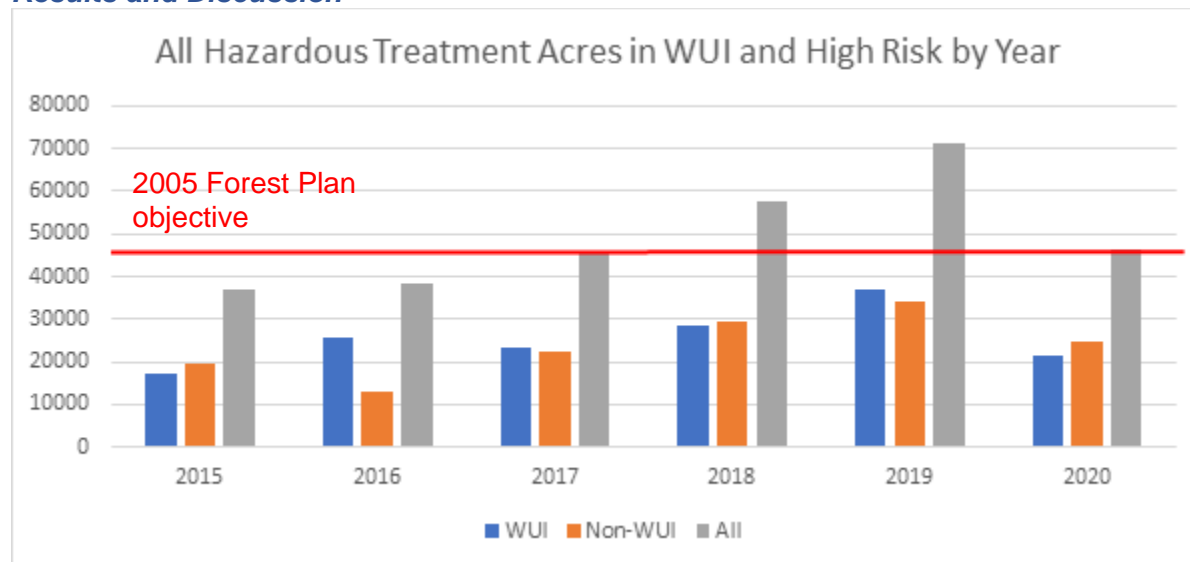


Figure 11. Hazardous Fuels Treatment Acres by Fiscal Year

In 2015, 17,320 acres within wildland-urban interface areas and high-risk areas were treated for hazardous fuels. In 2016, 25,654 acres were treated. The 10-year average for hazardous fuel treatments within wildland-urban interface areas or high-risk areas is 25,500 acres per year. Figure 11 displays acres treated by year in wildland-urban interface areas compared to non-wildland-urban interface areas (FACTS Fuels-All Summary Report I). The category of “all” represents the sum of treatments across both types of areas for a given year. Over the past several years, we have been trending upward in acres treated in wildland-urban interface areas. This upward trend could be attributed to the increase in urban-rural areas interface areas adjacent to National Forest System lands.

See the response to question 7 in section 5.25 for assessment of the effectiveness of these treatments.

Recommendations

We should consider conducting an updated risk assessment and make sure all units are using the most up-to-date wildland-urban interface areas geographic information system layer when planning projects. The current Fire Risk Assessment is based on data from 2005, and there is a need to assess current conditions for change in risk.

Evaluation of Monitoring Question and Indicator(s)

There are no recommendations for change in this monitoring question or indicator(s).

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

5.25 – To what extent are fuel treatments affecting the successful suppression of wildfires? (File Code 5100)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded only two wildfires burned into hazardous fuel treated areas and the pre-existing control lines for those treatment areas helped to keep containment acres small on both wildfires.

Monitoring Indicator(s)

Number of wildfires burned into fuel treatment units AND number of those with fire suppression or behavior impacts; OR percent of wildfires which burn into fuel treatment units where suppression or fire behavior changed due to fuel treatment.

Monitoring Frequency

Annually

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2.2 Prescribed Fire, Fuels, and Wildland Fire Management to reduce hazardous fuels and reduce wildland fire risk to communities.

The primary purpose of hazardous fuel treatments on National Forest System lands is to reduce the spread, intensity, and impacts of wildfire on people and natural resources. This in turn should reduce funds required for wildfire suppression and restoration of fire-damaged resources.

The monitoring indicators are designed to determine how many wildfires burned into treatment areas and how many of those incursions resulted in a reduction of spread, intensity, or effects. The Fuel Treatment

Effectiveness Database is the primary source for this information. The Fuel Treatment Effectiveness Database contains fire and fuels data and site observations collected by firefighters and fire supervisors of the wildfire event after it is controlled. As of 2018, the database had been populated with information from the agency's data warehouse for wildfires and treatments. The FACTS database is another source for determining spatially when wildfires burn into previously treated areas.

Monitoring Indicator 1

Number of wildfires burned into fuel treatment units AND number of those with fire suppression or fire behavior impacts.

Monitoring Indicator 2

Percent of wildfires which burn into fuel treatment units where suppression or fire behavior changed due to fuel treatment.

Results and Discussion

Only two wildfires burned into treated hazardous fuel reduced areas in 2015. Pre-existing control lines for those treatment areas helped to keep containment acres small on both wildfires. No wildfires burned into treated areas in 2016. From 2017 through 2020, the database of record shows that 79 wildfires either started in or burned into a fuel reduction unit that been subject to prescribed fire or mechanical treatment. Overall, 68 percent of the treatment units exhibited a reduction or change in fire behavior, and 88 percent of the treatment units helped with control of the wildfires (see figures 12 through 15).

FTEM Missouri State Summary

Summary Created: 2/19/2021, 9:01:48 AM
User Name: Bennie Terrell

Summary of 2017 Missouri Fuel Treatment Effectiveness on Wildfires													
Number and Percentage of Treatments Tested By Wildfire													
Agency	Fire	Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire		Total Records	Total Number of Fires
		No		Yes		No		Yes					
		#	%	#	%	#	%	#	%	#	%		
USFS	Knotwell	0	0	1	100	0	0	1	100	1	100	1	
	Mill Creek	0	0	1	100	0	0	1	100	1	100	1	
	Big Creek	0	0	2	100	0	0	2	100	2	100	2	
	Weight Scales	0	0	1	100	0	0	1	100	1	100	1	
	Dog	0	0	1	100	0	0	1	100	1	100	1	
	Ironside	0	0	1	100	0	0	1	100	1	100	1	
	Tidwell	0	0	1	100	0	0	1	100	1	100	1	
	Pear Tree	0	0	1	100	0	0	1	100	1	100	1	
	Combs	0	0	2	100	0	0	2	100	2	100	2	
	Western Star	0	0	1	100	0	0	1	100	1	100	1	
	Tidwell 2	0	0	1	100	0	0	1	100	1	100	1	
	Poison Hollow	0	0	4	100	0	0	4	100	4	100	4	
	Oak Grove	0	0	2	100	0	0	2	100	2	100	2	
	Potato	1	33	2	67	0	0	3	100	3	100	3	
	Prong Creek	0	0	1	100	0	0	1	100	1	100	1	
	Fairview 2	0	0	1	100	0	0	1	100	1	100	1	
	Pear Tree 2	0	0	1	100	0	0	1	100	1	100	1	
	Total	1	4	24	96	0	0	25	100	25	100	25	17

*Choosing "The fire did not enter the treatment" for the "Did the fire behavior change as a result of the treatment" required question, counts as a "No" in the "Treatments that changed fire behavior" column.

Figure 12. Summary of 2017 Missouri Fuel Treatment Effectiveness on Wildfires

FTEM Missouri State Summary

Summary Created: 2/19/2021, 8:57:57 AM
User Name: Bennie Terrell

Summary of 2018 Missouri Fuel Treatment Effectiveness on Wildfires													
Number and Percentage of Treatments Tested By Wildfire													
Agency	Fire	Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire		Total Records	Total Number of Fires
		No		Yes		No		Yes					
		#	%	#	%	#	%	#	%	#	%		
USFS	Barn	1	100	0	0	1	100	0	0	0	0	1	
	Devreaux	5	71	2	29	0	0	7	100	7	100	7	
	Red Bluff	2	100	0	0	0	0	2	100	2	100	2	
	Willie Lee	0	0	1	100	0	0	1	100	1	100	1	
	Hurricane	0	0	2	100	0	0	2	100	2	100	2	
	Top Trail	0	0	1	100	0	0	1	100	1	100	1	
	KK	1	100	0	0	0	0	1	100	1	100	1	
	Pinnacle	0	0	1	100	0	0	1	100	1	100	1	
	Rock Creek	1	100	0	0	1	100	0	0	0	0	1	
	940	1	100	0	0	1	100	0	0	0	0	1	
	Rozell	0	0	3	100	0	0	3	100	3	100	3	
	Haynes	1	100	0	0	0	0	1	100	1	100	1	
	Wildcat	3	100	0	0	3	100	0	0	0	0	3	
	Elm Springs	0	0	1	100	0	0	1	100	1	100	1	
	Parks	3	100	0	0	0	0	3	100	3	100	3	
	Yankee	2	100	0	0	0	0	2	100	2	100	2	
	Kaintuck	0	0	2	100	0	0	2	100	2	100	2	
	Powerline	2	100	0	0	0	0	2	100	2	100	2	
	Wiley	0	0	2	100	0	0	2	100	2	100	2	
	Big Hollow	0	0	3	100	0	0	3	100	3	100	3	
	Wedge	0	0	1	100	0	0	1	100	1	100	1	
	Roby Lake	0	0	3	100	0	0	3	100	3	100	3	
	Black Jack	0	0	1	100	0	0	1	100	1	100	1	
	Dawn	0	0	2	100	0	0	2	100	2	100	2	
	Carman	0	0	3	100	0	0	3	100	3	100	3	
	Cave Branch	0	0	3	100	0	0	3	100	3	100	3	
	Bug Smasher	0	0	1	100	0	0	1	100	1	100	1	
	Bunker South	0	0	1	100	0	0	1	100	1	100	1	
	Nichols Lake 2	2	66	1	34	2	66	1	34	1	33	3	
	Wolf Creek	0	0	1	100	0	0	1	100	1	100	1	
	Twin Pond Road	1	100	0	0	1	100	0	0	0	0	1	
	Tidwell	0	0	1	100	0	0	1	100	1	100	1	
	Total	25	41	36	59	9	15	52	85	52	85	61	32

*Choosing "The fire did not enter the treatment" for the "Did the fire behavior change as a result of the treatment" required question, counts as a "No" in the "Treatments that changed fire behavior" column.

Figure 13. Summary of 2018 Missouri Fuel Treatment Effectiveness on Wildfires

FTEM Missouri State Summary

Summary Created: 2/19/2021, 8:58:50 AM
User Name: Bennie Terrell

Summary of 2019 Missouri Fuel Treatment Effectiveness on Wildfires													
Number and Percentage of Treatments Tested By Wildfire													
Agency	Fire	Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire		Total Records	Total Number of Fires
		No		Yes		No		Yes					
		#	%	#	%	#	%	#	%	#	%		
USFS	Kitchen	0	0	1	100	0	0	1	100	1	100	1	
	Patrick	1	100	0	0	0	0	1	100	1	100	1	
	Horse Trough Hollow	11	100	0	0	0	0	11	100	11	100	11	
	Terrill Hollow	2	100	0	0	0	0	2	100	2	100	2	
	Fairview	0	0	1	100	0	0	1	100	1	100	1	
	Johnson Mountain	0	0	3	100	0	0	3	100	3	100	3	
	McClurg	0	0	1	100	0	0	1	100	1	100	1	
	Highway 99	7	100	0	0	7	100	0	0	0	0	7	
	Wet Fork	3	100	0	0	0	0	3	100	3	100	3	
	Little Pond	1	100	0	0	0	0	1	100	1	100	1	
	Skyline	0	0	1	100	0	0	1	100	1	100	1	
	Tidwell	0	0	1	100	0	0	1	100	1	100	1	
	Ridge	0	0	1	100	0	0	1	100	1	100	1	
	Brushy Hollow	1	100	0	0	1	100	0	0	0	0	1	
	Total	26	74	9	26	8	23	27	77	27	77	35	14

*Choosing "The fire did not enter the treatment" for the "Did the fire behavior change as a result of the treatment" required question, counts as a "No" in the "Treatments that changed fire behavior" column.

Figure 14. Summary of 2019 Missouri Fuel Treatment Effectiveness on Wildfires

FTEM Missouri State Summary

Summary Created: 2/19/2021, 9:00:40 AM
User Name: Bennie Terrell

Summary of 2020 Missouri Fuel Treatment Effectiveness on Wildfires													
Number and Percentage of Treatments Tested By Wildfire													
Agency	Fire	Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire		Total Records	Total Number of Fires
		No		Yes		No		Yes					
		#	%	#	%	#	%	#	%	#	%		
USFS	Scroggins Ridge	0	0	2	100	0	0	2	100	2	100	2	
	Merriam Cemetery	0	0	2	100	0	0	2	100	2	100	2	
	Tram	2	100	0	0	2	100	0	0	0	0	2	
	Hog Cliff	1	100	0	0	1	100	0	0	0	0	1	
	Clayton	0	0	1	100	0	0	1	100	1	100	1	
	Possum	2	100	0	0	2	100	0	0	0	0	2	
	Big Hollow	0	0	10	100	0	0	10	100	10	100	10	
	Snider	1	100	0	0	1	100	0	0	0	0	1	
	Daylight	1	100	0	0	1	100	0	0	0	0	1	
	Terrill Hollow	0	0	2	100	0	0	2	100	2	100	2	
	26	0	0	2	100	0	0	2	100	2	100	2	
	Jackson	0	0	1	100	0	0	1	100	1	100	1	
	Horse	0	0	1	100	0	0	1	100	1	100	1	
	Little Boulder	0	0	1	100	0	0	1	100	1	100	1	
	Harmony Church	0	0	1	100	0	0	1	100	1	100	1	
	Willie	0	0	32	100	0	0	32	100	32	100	32	
	Total	7	11	55	89	7	11	55	89	55	89	62	16

*Choosing "The fire did not enter the treatment" for the "Did the fire behavior change as a result of the treatment" required question, counts as a "No" in the "Treatments that changed fire behavior" column.

Figure 15. Summary of 2020 Missouri Fuel Treatment Effectiveness on Wildfires

Recommendations

There are no changes to management recommended.

Evaluation of Monitoring Question and Indicator(s)

There are no recommendations for change in this monitoring question or indicator(s).

References

U.S. Department of Agriculture, Forest Service. Fuel Treatment Effectiveness database.
https://iftdss.firenet.gov/landing_page/

5.26 – Are lentic ecosystems providing habitat for fish and other aquatic species? (File Code 2600)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded Ripley Lake increased in the catch per unit effort (CPUE), however Palmer Lake has shifted to a smaller size class of largemouth bass. Management of aquatic vegetation, along with improvements in bank fishing accessibility and improving the gravel boat ramp could increase use at Palmer Lake. The control of

aquatic vegetation on many National Forest System lakes is necessary to promote balanced fish populations. In general, we purchase the aquatic herbicides and Missouri Department of Conservation treats the lakes. Some lakes are drawn down to kill aquatic vegetation. Most of the lakes in the Mark Twain National Forest need an updated lake management plan.

Monitoring Indicator(s)

Number of lakes stocked; Number of vernal pools constructed

Monitoring Frequency

Annual

Background & Driver(s)

This question addresses required monitoring element 36 CFR 219.12(a)(5)(ii) “The status of select ecological conditions including key characteristics of the terrestrial and aquatic ecosystems (FSH 1909.12 32.13b).

Missouri Department of Conservation is responsible for management of species in Missouri, and they have conducted most fish and aquatic species surveys in the state, including waters within the Mark Twain National Forest. They also stock several Mark Twain National Forest small lakes and ponds with channel catfish to encourage public fishing. MDC also helps us manage aquatic nuisance plants that invade various lakes using aquatic herbicides or lake drawdowns. Management results and recommendations are provided to us annually.

The 2005 Forest Plan goal 1.4 Wildlife and Aquatic Habitat says regarding aquatic habitat, “Restore and manage natural communities as the primary means of providing quality terrestrial, karst, and aquatic wildlife and rare plant habitat.”

Standards and guidelines for constructed waterholes is found on page 2-14 of the 2005 Forest Plan. Waterhole construction is to be only where natural or constructed water sources are limited or lacking; and managing or rehabilitating existing waterholes is a priority over constructing new ones.

Number of lakes stocked annually is determined by review of the annual MDC report. Number of vernal pools constructed is submitted to the forest wildlife biologist by district biologists during annual accomplishment reporting.

Monitoring Indicator 1

Number of lakes stocked

Results and Discussion

In 2015 eleven (11) lakes were stocked; in 2016 twelve (12) lakes and ponds were stocked; in 2017 eighteen (18) lakes and ponds were stocked; in 2018 fifteen (15) lakes and ponds were stocked; in 2019, twenty (20) lakes and ponds were stocked. As of January 28, 2021, the annual report for 2020 hadn’t been received from MDC. Lakes were predominantly stocked with channel catfish, but occasionally one is stocked with hybrid sunfish. Stocking is intended to improve fishing opportunities and catch success at these lakes. Fish population surveys are conducted at various lakes periodically, and the control of aquatic vegetation on many National Forest System lakes is necessary to promote balanced fish populations. In general, we purchase aquatic herbicides, and MDC treats the lakes. Some lakes are drawn down to kill aquatic vegetation. Most of the lakes in the Mark Twain National Forest need an updated lake management plan.

In 2015, Ripley Lake and Palmer Lake were surveyed by MDC. Surveys at Ripley Lake documented an increase in the Catch Per Unit Effort (CPUE) of largemouth bass, bluegill, and redear sunfish since the last survey in 2013. Annual aquatic vegetation control at Ripley Lake is necessary to balance fish populations. Other species present in the lake include channel catfish and green sunfish. Survey efforts at Palmer Lake documented that bluegill and redear sunfish populations remain steady. Largemouth bass populations shifted to a smaller size class since the last survey. Fishing at these lakes should be good based on these survey results. Management of aquatic vegetation, along with improvements in bank fishing accessibility and improving the gravel boat ramp could increase use of this lake.

In 2016, fish population surveys were conducted at Logger's Lake and Timberline Lake. At Logger's Lake, the surveys documented an increase in largemouth bass catch per unit effort. There was also a shift to larger size classes. The catch per unit effort of bluegill decreased and the catch per unit effort of redear sunfish increased. MDC noted that the "overall fish numbers are fair but have declined since 2013." The reason for the decline is difficult to determine, but possible reasons include survey equipment power not being adequate or aquatic vegetation interference. Logger's Lake is drawn down annually to help control aquatic vegetation. Fish numbers (catch per unit effort of largemouth bass and bluegill) was less than half of 2013 numbers. The aquatic vegetation present in the lake makes it difficult to effectively capture fish, therefore, controlling the vegetation is necessary to balance fish populations.

In 2017, electrofishing surveys were conducted on three Mark Twain National Forest lakes. Aquatic herbicides were utilized on three lakes to treat 3.5 acres, and an annual lake drawdown occurred on one lake within the five Mark Twain National Forest Districts. Aquatic vegetation densities were monitored at four additional lakes. Structures were placed at two lakes to improve fish habitat, work was done at a dam and spillway to address erosion caused by flooding, and copper sulfate was applied at one lake. A survey was conducted at Pinewoods Lake in 2017. When compared to the 2014 sample, largemouth bass and bluegill numbers have drastically decreased. It is difficult to draw any conclusions as the poor sample could be a result of excessive vegetation interfering with sampling, sampling inefficiencies due to low water conductivity, or effects of wide water temperature fluctuations. However, enough redear sunfish were collected to indicate a good fishery, which is very popular with anglers, especially during the spring spawning time. Numbers of nine inch and larger fish make this a good lake for those who want to catch Master Angler-sized fish. Howell Lake was surveyed as well, but timing of the survey was less than ideal due to early temperature rise and equipment malfunction. From the overall limited catch observed, it appears that the size structure in Howell Lake continues to move towards a balanced fishery. Beaver Lake received two surveys, one using hoop nets to assess the channel catfish population, and the other using backpack shockers to assess the largemouth bass and bluegill populations. The channel catfish population size structure (53 percent greater than 16 inches) met the management goal. Our channel catfish surveys (2011, 2014, and 2017) have shown that Beaver Lake can produce quality sized fish, but the densities are lower than desired. Although electrofishing efficiency was poor at the conductivity level during the survey, the largemouth bass catch rate (57 per hour) and population size structure (percent of bass greater than 15 inches equals 7) were like previous years. Bluegill were captured at a much lower rate (57 per hour) than the historical rates. The bluegill population size structure is excellent with 15 percent of the fish captured greater 8 inches.

In 2018, electrofishing surveys were conducted on four Mark Twain National Forest lakes. Aquatic herbicides were utilized on three lakes to treat 7 acres, and an annual lake drawdown occurred on one lake within the five Mark Twain National Forest Districts. Aquatic vegetation densities were monitored at five additional lakes. Palmer Lake was surveyed, and trends since 2012 suggest that the overall fish population continues to be variable and poor. Until aquatic vegetation is managed in Palmer Lake (estimated 46 percent of lake surface covered in 2015), the fish population will suffer. A fish population sample (electrofishing) was conducted in May 2018 at Fourche Lake. Results indicate there are plenty of harvestable largemouth bass which exhibited good body condition and appeared healthy. However, the

lake's forage base are sunfish, mainly consisting of bluegill and redear, and both populations are low densities. This is concerning as there are no definitive answers as to why the decline. Results of the 2018 Ripley Lake sample confirmed the decline of the lake's fishery. A fertilization program was recommended as the process promotes primary productivity (phytoplankton and zooplankton), resulting in better fish populations. Ripley Lake was part of a fertilization study from 1989 until 2004. During that time, fish populations seemed to be thriving. It was recommended to begin fertilizing in April 2019.

In 2019, electrofishing surveys were conducted on three lakes within the Mark Twain National Forest. Aquatic herbicides were utilized on two lakes to treat 6.3 acres, and an annual lake drawdown occurred on one lake within the five Mark Twain National Forest Districts. Aquatic vegetation densities were monitored at four additional lakes. Trees were planted around one lake shoreline and debris was removed from one in-lake overflow structure.

Monitoring Indicator 2

Number of vernal pools constructed

Results and Discussion

In 2015 seven (7) vernal pools were constructed; in 2016, twenty-five (25) vernal pools were constructed; in 2017, seven (7) vernal pools were constructed; in 2018, eleven (11) vernal pools were constructed; in 2019, thirty-one (31) vernal pools were constructed; and in 2020, five (5) vernal pools were constructed.

Vernal Pool Construction

Some of the pools were created in upland settings to provide diversity on the landscape. Others were created because of wetland restoration, which was part of a bigger picture connecting riparian habitats in a historically braided stream habitat.

Fourteen of the vernal pools constructed in 2017 and 2018 occurred in an area acquired from Doe Run Mining Company. The land had historically been used for agricultural purposes. About half of the vernal pools were constructed in runoff areas to slow erosion and sedimentation, increase water holding capacity, and allow slower absorption of water into the ground. About half of the total are functioning ideally. The others either don't hold water or hold water for a shorter period due to the high gravel component of the soil. This is not necessarily viewed as a negative result as it increases the diversity of water levels, and thus the diversity of plants and animal using those areas.

Five of the vernal pools constructed in 2019 were in the Potosi-Fredericktown Ranger District. The remaining thirty-one constructed in 2019 took place in the Poplar Bluff Ranger District in a former grazing allotment within a floodplain along the Black River. This area had been grazed for 30+ years. Work was conducted under close coordination with the Natural Resources Conservation Service, which provided a plethora of knowledge and guidance.

Historically, all the pools in a floodplain produced an amazing diversity of water levels, which in turn served an extremely large number of species—both plant (vascular and non-vascular) and animal (vertebrate and invertebrate). For those areas of wetland restoration, existing topography was used as a template and guideline to establish or enhance depressions, which were once (and still are in many cases) part of an old, braided channel system. The present-day depressions are varying depths depending on the age (older channels will be shallower) and agricultural influence. Both deposition (which has accelerated due to clearing, agriculture, road building, and so on) and farming have greatly reduced the diversity, depth, and function of present-day ephemeral pools. Farming had a tremendous effect on floodplain pools. The purpose for vernal pool construction was to provide that diversity that once occurred along this area of the Black River. This restoration process reverses the sedimentation and human-induced leveling

of natural topographic features. In the summer of 2020, native wetland flora was planted along the edges of the vernal pools.

Vernal Pool Surveys

Missouri Western State University, in partnership with Forest Service, conducted a 5-year survey of vernal pools from 2012-2015. While four years is too short a time to make any statistically valid conclusions about species population trends, the study did document species presence and differing uses of pools.

In the 2013 study season, 12 amphibian species used these pools for breeding, consisting of 9 species of anurans and 3 species of salamanders. This is three more species than were documented in the 2012 season. The ponds are diverse in morphology, depth, hydroperiod, and surrounding vegetation. Therefore, not surprisingly, they are also variable in how amphibians use them for breeding sites. For example, at least eight species were documented using pond 16, a more permanent upland pool with little canopy cover, and only one species in pond 6, a lowland (river bottom) pond on the edge of the forest and bluff that dries each year (Mills 2013).

The most numerous species encountered in 2013 was American toad tadpoles (*Anaxyrus americanus*), which reached over 1,000 in pool 2 and over 300 in pools 12 and 17. Spring peepers (*Pseudacris crucifer*) and spotted salamanders (*Ambystoma maculatum*) were each documented using 11 pools, making them the most common species encountered. Spring peepers were heard calling in virtually every pool that held water in the early spring. The least common species were the marble salamander (*Ambystoma opacum*) and the cricket frog (*Acris blanchardi*), found only in pool 16 and pool 12, respectively. It is interesting to note that one species, the chorus frog (*Pseudacris triseriata*), has been heard calling, but the investigators have yet to collect tadpoles. Overall, more species have been documented using the lowland pools (fig. 16) than upland pools (Mills 2013).

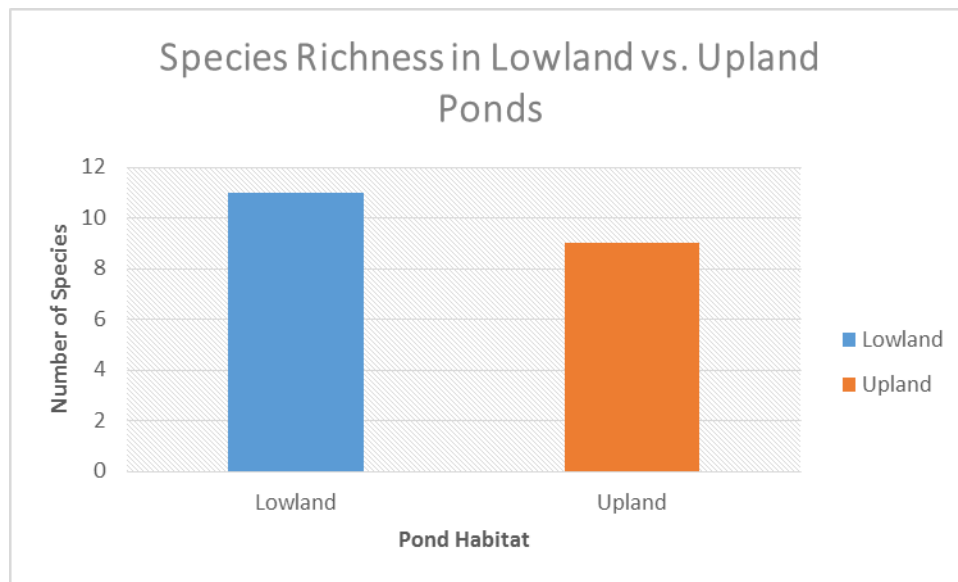


Figure 16. More species have been documented in the lowland (ponds 1-11) compared to upland (ponds 12-17) sites.

In 2015, 10 species were detected using 5 survey techniques. Two species were detected in 2015 that had not been detected in the 2013-2014 field season; but 3 species were detected in the 2013-2014 field

season that were not detected in 2015. So, in the two field seasons, 13 species were found to be using the vernal pools.

No formal surveys of vernal pools took place between 2017 and 2020. However, informal empirical data noted use of the 2019 Black River vernal pools by frogs and toads (presence of tadpoles), along with use by raccoons, opossums, and great blue herons within the first year. As expected, some pools hold water for a longer period, compared to others, depending on the soil structure. Areas with a higher gravel or sand content allow water to move into the water table faster. This adds to the diversity of species using the pools as it ensures various water levels in different locations in a set time.

Recommendations

It would be useful to have specific research on the impacts of fish stocking in lakes in the Mark Twain National Forest related to public use and satisfaction. Occasionally there is feedback from anglers regarding lack of fish in lakes and ponds, and many of those areas receive a large amount of pressure. In addition, information regarding the use of vernal pools by amphibians and changes in their populations would be useful, particularly given that many have been constructed the last several years. The study done by Missouri Western State University should be continued and expanded to look at additional factors in amphibian use of the vernal pools.

Evaluation of Monitoring Question and Indicator(s)

A better indicator for this question would provide information on selected fish and aquatic species population trends in lakes and changes to amphibian populations in areas where the pools are created. To answer this question an increase in funding and staff may be necessary.

References

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U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

5.27 – Are lotic ecosystems providing habitat for fish and other aquatic organisms? (File Code 2600)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded with monitoring of one stream project that affected one mile of the North Fork of the White River. Project implementation began in 2016, however a major rain event in 2017 caused damage to the North Fork Boat Ramp project that was still in-progress. This caused a redesign of the facilities and work resumed in 2018. All the large wood structures remained intact. The first log structure downstream of the boat ramp was buried in floodplain debris but was partially visible upon inspection. The remaining three large wood structures were visible. Some logs from the structure had floated downstream while new logs from the flood were collected.

Monitoring Indicator(s)

Number of stream miles enhanced (AOP barriers removed, streams cleaned-up, large woody debris projects, etc.)

Monitoring Frequency

Annual

Background & Driver(s)

This question addresses required monitoring element 36 CFR 219.12(a)(5)(ii) “The status of select ecological conditions including key characteristics of the terrestrial and aquatic ecosystems (FSH 1909.12 32.13b).

The 2005 Forest Plan has goals and objectives for streams in both the Soils, Watersheds, and Water Quality section, and the Wildlife and Aquatic Habitat section. In addition, there are standards and guidelines for streams in both Watershed and Wildlife sections of chapter 2.

Under goal 1.3 Soils, Watersheds, and Water Quality, “Maintain healthy, sustainable, and diverse natural communities” and “Establish and maintain riparian management and watercourse protection zones to: Maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components of the riparian corridor.” Standards and guidelines for rivers and riparian protection are found on pages 2-3, 2-4, 2-5 of the 2005 Forest Plan.

Under goal 1.4 Wildlife and Aquatic Habitat “Restore and manage natural communities as the primary means of providing quality terrestrial, karst, and aquatic wildlife and rare plant habitat.” Standards and guidelines for streams and rivers are found on pages 2-10 and 2-11 of the 2005 Forest Plan.

Monitoring Indicator 1

Number of stream miles enhanced

Results and Discussion

The only stream project for 2015 and 2016 was the North Fork large woody material project, North Fork of the White River. Funding for this project was allocated in 2016, and the project continued into 2017. Riparian planting occurred in 2017, but a historical flood event washed the trees away. This project affected one mile of the river. The large woody material project was a component of a larger project to redesign the boat ramp and day-use area of the North Fork developed recreation site.

The developed recreation site was impacting an altered stream channel and associated aquatic habitat. Erosion of the existing boat launch site and adjacent stream banks contributes to altering stream morphology and is a source of sedimentation into the river during flood events. During rainstorm events or flash floods, the river flow quickly increases, and the existing gravel load is remobilized and transported downstream. Much of the North Fork Day Use Area is subject to flooding at least every few years.

The large woody material project was designed to reduce erosion, store gravel and sediment so it does not travel downstream, armor the banks, and stabilize the existing gravel bars. Activities associated with this project are:

- Place large wood structures in or along the river corridor to correct stream conditions and to store gravel and sediment. Structures will also improve Ozark hellbender habitat and reduce gravel build-up by storing it on bars.
- Vegetation plantings and other methods for stabilizing and rehabilitating portions of the gravel bar within and adjacent to the existing access and next to large wood structures to provide shade and cover.



Photo 5. Large wood structure during construction. It is the placement of the log with root wad placed perpendicular to the bank on top of the logs that were placed parallel to the bank. The log is buried into the bank so only a small portion of the log and root wad are exposed.



Photo 6. Newly completed large wood structure.



Photo 7. Newly completed large wood structure.

Four large wood structures were constructed in October 2016 and anchored in January 2017. Missouri State University (MSU), through a participating agreement, is monitoring stream morphology changes. In April and May of 2017, a record-breaking flood event occurred on the North Fork of the White River where the water depth was 50 feet. At the time of the event, only the large wood structures had been built and a partially built road to access the new boat ramp. The damage from the flood at this site caused the highway bridge to be washed out and damaged the streambanks in the new boat ramp area and the old boat ramp area. This caused a redesign of the facilities and work resumed in September 2018. All the large wood structures remained intact. The first log structure downstream of the boat ramp was buried in flood plain debris. The remaining three large wood structures were visible. Some logs from the structure had floated downstream while new logs from the flood were collected. General findings of the study have been provided.

- Pre-flood August 2016 survey results: 101 large wood pieces with 4 to 25 pieces per 100 meters. Post-flood wood survey results: 210 large wood pieces with 4 to 55 pieces per 100 meters.
- River shifted to other side of valley wall against the bluff. Channel is no longer along the steep eroding banks.

Two stream improvement projects were completed, Barney Creek streambank stabilization and replacement of Brickey Slab Road stream crossing. Both projects are part of a larger network of projects in Huzzah Creek Watershed occurring on National Forest System lands in partnership for work on private lands.

Barney Creek is a tributary to Huzzah Creek and was completed in September of 2019. This project was in partnership with The Nature Conservancy, Missouri Chapter. Three separate locations of stream bank were reconstructed and stabilized using large wood bio-engineering techniques. At each location the streambanks were unstable due to past management actions relating to farming. Each bank was six feet or more tall causing increased soil erosion of the floodplain. There was no vegetative cover or trees to provide shade and cover. There was also no pool and riffle sequence to provide the various types of aquatic habitat conditions needed in a small order stream.

Post-project monitoring shows all three sites have remained stable and pools developed under the structures. Fish can be observed in these locations; prior to these structures there were no visible fish swimming in these sections. Small trees were planted along the banks and most survived the first year.

Brickey Slab stream crossing is located on Crawford County Road 726 (Westover Road) and this project was in partnership with Crawford County. The new low water crossing increases motorist safety by decreasing the frequency and duration of over-topping during flood events, increases safety for recreational use, decreases trespassing on private land, allows aquatic species to migrate upstream, and improves stream channel conditions.

Recommendations

Continue to monitor all sites to ensure sites are still stable post-flood and desired vegetation is growing along streambanks and in the riparian areas.

Evaluation of Monitoring Question and Indicator(s)

Continue to monitor the effectiveness and impacts of these actions over time (examples include annually or after major flooding events) to determine if the project is effective. The use of in-stream large wood structures is tied to habitat needs of certain species. Habitat stability is the indicator that is applicable.

References

U.S. Department of Agriculture, Forest Service. Watershed Improvement Tracker (WIT).

Monitoring Indicator 2

Aquatic Species Monitoring

Streams in the Mark Twain National Forest provide habitat for many native and desired non-native fish (trout) and mussel species. Monitoring those populations and their habitats is important because many of these are species of concern in the state or Regional Forester Sensitive Species (RFSS). Most of the smaller streams have not had fish community surveys since the 1930s or 1940s. The Missouri Department of Conservation collects fish population data on most of the larger rivers in the Mark Twain National Forest. Many of those streams are managed for warm or cold-water sport fishing. We have also developed an Interagency Agreement with the U.S. Fish and Wildlife Service's Fish and Wildlife Habitat Conservation Office to complete fish and mussel surveys on various smaller streams in the Mark Twain National Forest (2012 to present). We also have a challenge cost-share with Missouri Department of Conservation to survey and augment populations of Eastern hellbender (the Missouri Distinct Population was listed as endangered in March of 2021) and Ozark hellbender (an endangered species).

In 2012, we surveyed Big Barren and Little Barren Creeks. There was limited fish population data from 1941, 1971, and 1994 at small sites on these streams. Twenty fish species were identified during those surveys. In 2012, comprehensive fish community surveys were completed, and 45 fish species were identified, including the same 20 found in previous surveys. One RFSS species, Ozark Shiner, was captured during this survey. All the species located in the stream are native and typically found in similar tributary streams of the Current River. Many mussel beds were located during the fish survey. Further studies of mussels in Big Barren Creek were done in 2013. Seven species of mussels plus one non-native invasive species was found to occupy this stream. Three of the mussels are RFSS (Ouachita kidneyshell, purple lilliput, and slippershell).

USFWS conducted fish surveys in five streams in 2013: Noblett, Spring, Little Indian, Middle Indian, and Indian Creeks. The survey detected 39 species from a total of 14 sampling sites. Eight of the 39 species were newly detected, and seven species that were documented from previous surveys were not detected

(records from 1982-1996). Several habitat management recommendations were provided in the U.S. Fish and Wildlife Service report.

U.S. Fish and Wildlife Service surveyed four streams in 2014: Big Brushy, Middle Brushy, Cane, and Mud Creeks. Historical fish or mussel data was not available for Big Brushy and Middle Brushy Creek. Historical sampling records from 1932, 1941, 1992 and 1999 were available for Cane Creek. That data indicated the presence of 52 fish species and 18 native mussel species. Fish were sampled on Mud Creek previously in 1991: 26 species were found; no mussel survey records were found. Overall, the stream sites surveyed appeared to support a diverse assemblage of fish species, although species assemblages may have changed from historical records. Several recommendations for habitat management were provided for these streams.

Several streams were surveyed in 2015 and 2016. The Eleven Point River Blue and White Ribbon Trout areas continue to be stocked with approximately 20,000 to 25,000 rainbow trout. These trout areas continue to be very popular with anglers. Warm-water sport fish, such as smallmouth bass and shadow bass, also continue to be present in numbers sufficient to provide a quality fishing experience.

Missouri Department of Conservation conducted fish or habitat surveys on Mill Creek, Spring Creek, and Stone Mill Spring branch in 2016. Mill Creek is a Blue-Ribbon Trout Area. The trout fishery in Mill Creek is resilient and there were four-year classes of trout present. Missouri Department of Conservation monitored the physical habitat of Spring Creek by walking the creek. No increased bank stabilization was noted. Stone Mill Spring branch is cooperatively managed by Forest Service, Missouri Department of Conservation, and Fort Leonard Wood. The stream is stocked with rainbow trout for the winter fish-for-fun season, the annual kids' trout derby, and regular fishing season. The area and the fishing events continue to be popular with the public.

In 2016, Missouri Department of Conservation sampled game fish on portions of Courtois Creek and Huzzah Creek. The smallmouth bass and rock bass fishery in both systems remains excellent. A smaller population of largemouth bass persists in these streams and provide harvestable size bass for anglers.

U.S. Fish and Wildlife Service sampled the fish community in James Branch below Lost Lake in 2016, before the railroad trestle that acted as a dam was lowered and eventually failed in the following years. Historic sampling records identified 13 fish species occurring in James Branch. Seventeen (17) fish species were detected in the stream in 2016. No non-native invasive fish species or species of conservation concern were detected. Most species collected in the mainstream and tributary are intolerant to water turbidity, sedimentation and require permanent flow. Sites sampled had an index of biotic integrity of 29 which results in a stream classification of "impaired." However, there were species present that indicate excessive sedimentation was not a problem (Brooke 2016). Surveys should be repeated to determine the effects of the "dam" failure on this fish community.

In 2016, we conducted mussel surveys on Huzzah Creek. A regional forester sensitive specie mussel, Northern brokenray, was observed at five sites.

In 2017 two fish surveys were conducted by the U.S. Fish and Wildlife Service. Twelvemile Creek and its headwater streams were surveyed in September 2017 near Cherokee Pass. Sampling efforts resulted in a total of 3,314 fish and 175 crayfish representing a total of 32 and 4 species, respectively. This number represents 71 percent of the species that have been captured in the watershed during previous sampling efforts. Big Creek Crayfish (*Faxonius peruncus*; n=51) was captured during sampling efforts (Henderson et al. n.d.). Big Creek Crayfish is currently being considered by the U.S. Fish and Wildlife Service as a proposed threatened species with proposed critical habitat. It was determined Twelvemile Creek and its tributary (Peter's Creek) suffer from relatively little impairment. Cedar Bottom Creek, which was the

smallest of the streams sampled, was the least diverse, and was mostly dominated by a single species. (Henderson et al. 2017). Several recommendations for habitat management were provided to the Mark Twain National Forest for these streams.

In October of 2017, Tenmile and Hurricane Creek were surveyed. A total of 3,887 fish were captured from four sampling locations. No historical data exists for Hurricane or Tenmile Creeks, but previous sampling in the vicinity of the study sites yielded a total of 74 unique fish species. In comparison, in this survey a total of 38 unique fish species were observed, one of which was not represented in the list of species previously captured from the watershed. Eighty-seven individual crayfish representing three different species were also collected during the surveys. No Missouri species of conservation concern were detected during sampling (MDC 2018). With one exception it was found that the headwater areas of Hurricane Creek and Tenmile Creek displayed characteristics associated with high habitat quality. The one exception was a 12-culvert concrete slab crossing on Hurricane Creek. Scour associated with the downstream side of this crossing has created a barrier to aquatic organism passage. Indicators of high habitat quality included vegetated riparian buffers, hydrologically connected floodplains, abundant woody debris, which provides habitat for fish and other aquatic organisms, and cobble channels (Rouda et al. 2017).

Fish community and habitat and aquatic macroinvertebrate sampling were conducted on the East Fork of Bull Creek near Chadwick in 2017. The fish and habitat sampling encompassed a 260-meter reach of stream, and a total of 13 fish species were observed. Multiple habitat variables were measured. Data for this site was provided in the 2018 fisheries annual report.

The Eleven Point River Blue Ribbon Trout Area was sampled in 2017 prior to fall trout stocking to monitor and assess structure and body condition of stocked and wild rainbow trout populations. Body condition and population size of wild trout was like previous years. Stocking occurred in the spring and fall with 8,000 (6,400 pounds) fish. Stocked fish averaged 12 inches in length and 0.8 pounds. The White Ribbon Trout Area downstream of Turner's Mill Access continues to be a very popular put-and-take fishery with anglers. In 2017, approximately 16,000 rainbow trout greater than 10 inches were stocked throughout the year. In addition, approximately 35 lunker rainbow trout averaging over 21-inches and approximately 4-pounds were stocked here.

Lotic, warm-water sportfish sampling focused on two sections of the Eleven Point River in 2017: Thomasville to Cane Bluff and the Narrows to the Arkansas state line. Catch rates were lower than previous years, possibly a result of spring historic flooding. Higher smallmouth bass catch rates were observed in the upper river site compared to the lower river, but a larger size structure existed in the lower river site. Largemouth bass and shadow bass (goggle-eye) were also regularly captured in both warm-water samples and likely to be a part of an angler's creel.

Additional Eleven Point River activities in 2017 included assistance with Ozark hellbender nest box surveys and stocking efforts through Missouri Department of Conservation and the St. Louis Zoo, as well as assistance with cold-water crayfish research to determine distribution and population density to inform federal protection efforts.

The Little Piney River was stocked with a total of 2,100 rainbow trout averaging 12 inches. In addition, 12 retired broodstock-sized fish were stocked during 2017. In addition, a trash clean-up occurred in the Mill Creek watershed, organized, and conducted by the Mill Creek Watershed Coalition. In Spring Creek, a sample of the wild rainbow trout population was completed for 2017 but was lower than desired. The number of downed trees, which created superior fish habitat, did not allow for a boat to be used for sampling, and the pools were very deep for a backpack shocker, but a great effort was made to find fish. Only a handful of trout were captured in a one-mile sample, but three-year classes were represented. Also,

anglers are still reporting catching fish upwards of 20 inches upstream of National Forest System lands on private property. This upper three-mile stretch significantly impacts the wild rainbow trout population of this creek. Lastly, Mill Spring Branch was stocked with approximately 5,000 rainbow trout for the regular fishing season. Local anglers continue to provide positive comments on the winter fish-for-fun season.

Wadable streams in the Courtois watershed were sampled to evaluate stream health in summer 2017. The EPA's Environmental Monitoring and Assessment Protocols were used to assess fish and invertebrate communities in randomly chosen streams throughout the watershed. Sites on both the mainstem Courtois and smaller tributaries were sampled and analyzed, but no results were included in any annual reports received to date. Also, Huzzah Creek's game fish populations were surveyed in fall of 2016. Smallmouth bass greater than or equal to 7 inches were captured at a rate of 21 fish per hour. Of the smallmouth bass captured that were greater than or equal to 7 inches in length, 18 percent exceeded the harvestable length of 12 inches and 6 percent were greater than or equal to 15 inches in length. Huzzah Creek continues to support an excellent smallmouth bass fishery, as these numbers are in line with past sample sizes and numbers. Rock bass greater than or equal to 4 inches were captured at a rate of 21 fish per hour. Of the rock bass captured that were this size, 6 percent exceeded the harvestable length of 8 inches. Again, these numbers are like past samples and indicate that a good quality rock bass fishery exists. Largemouth bass greater than or equal to 8 inches were captured at a rate of 2 fish per hour, and 31 percent of those fish exceeded the harvestable length of 12 inches. As with other Ozark streams, largemouth bass remain not as numerous as smallmouth bass, but they do increase the chances of anglers catching a harvestable size bass.

The Eleven Point River Blue Ribbon Trout Area was sampled in September of 2018 prior to fall stocking to monitor and assess structure, population size, and body condition of stocked and wild rainbow trout populations. Body condition and population size of wild trout was like previous years. Stocking occurred in the spring and fall with 8,000 (6,400 pounds) fish stocked. Stocked fish length and weight averaged 12 inches long and 0.8 pounds, respectively. The White Ribbon Trout Area downstream of Turner's Mill Access, continues to be a very popular put-and-take rainbow trout fishery with anglers. In 2018, approximately 16,000 fish greater than 10 inches were stocked here throughout the year. In addition, approximately 46 lunker rainbow trout, averaging over 21 inches and approximately 4 pounds, were stocked into this reach.

Lotic, warm-water sportfish sampling was focused on two sections of the Eleven Point River in 2018: Cane Bluff to Greer Access and Riverton to the Narrows Access. This sampling is designed to track smallmouth bass population trends and changes in size structure through time and space in the special management area. In both sample areas, smallmouth bass exhibited a larger size structure than previous samples, with 21 percent of fish collected exceeding the 15-inch minimum length limit. However, catch rates from the upper river were lower than previous years while the lower river's rates were like previous year's values. Largemouth bass and shadow bass (goggle-eye) were also consistently captured from both warm-water samples and likely to be a part of an angler's creel. Multiple walleyes exceeding 5 pounds were collected, which confirms the lower river supports a small population of large fish. Also, approximately 20,000 walleye fingerlings (2-inch average length) were stocked below the Narrows Access as part of the 4-year walleye stocking rotation ongoing in southern Ozark streams.

Additional Eleven Point River activities in 2018 included assistance with Ozark hellbender nest box surveys and stocking efforts through Missouri Department of Conservation and the St. Louis Zoo, coordination of fall warm-water sportfish sampling to assist with a University of Missouri - Columbia smallmouth bass research project, and a couple qualitative mussel surveys with Missouri Department of Conservation's Resource Science Division downstream of the Riverton Access.

A mussel survey was conducted in 2018 in the Current River to document use near two recreation sites, Deer Leap and Float Camp Recreation Areas. Approximately two river miles were surveyed. Five areas had suitable mussel habitat characteristics and were searched for freshwater mussels. Of these, living freshwater mussels were found at one site. This site is a swift, deep run along a bluff line that provides a stable stream bottom along the outside the river bend (from the shoreline to the toe of the bank). The area appears to support a low density of mussels as only two living individuals were found, both Arkansas Brokenray (*Lampsilis reeviana*) mussels. There was no evidence of mussel occupancy (either dead or alive) at any of the other four sites. A suggestion was made in the report to explore other more suitable mussel habitat to determine if it supports the Flat Floater mussel and other species (Drews et al. 2018).

The Little Piney River was stocked with a total of 2,100 rainbow trout averaging 12 inches in 2018. Also, 15 “lunkers” (retired broodstock) were stocked through the Milldam Hollow allotment. Furthermore, a sample of wild rainbow trout was conducted around the Lane Springs Recreation Area in 2018. The disastrous flooding of 2017 did not have the impact on Little Piney’s trout population as it has on other streams in the area. Rainbow trout between 5 and 20 inches were sampled with big year classes found at the 6, 9, 12 and 15-inch ranges. This continues to be the best wild trout population in the area.

Mill Creek’s Blue Ribbon Trout Area was sampled during 2018 on Bohigian Conservation Area. The flood of 2017 has taken a toll on the wild rainbow trout population of Mill Creek. Rainbow trout were found in small numbers with 4-year classes of fish. Fish in the 8-inch range dominated the sample. However, this small size population is not uncommon for this stretch of water and will rebound with more consistent water years.

In 2018, feral hogs looked to be a detriment to the streambanks of Spring Creek during the heart of the summer as the cold summer waters and good native vegetation seem to attract hogs to this area. A sample of the wild rainbow trout population will be completed in 2019. Hopefully the great population upstream of National Forest System lands on private land will help re-populate the publicly fishable water.

During 2018, approximately 5,000 rainbow trout were stocked by Missouri Department of Conservation in Stone Mill Spring Branch for the regular fishing season of March 1 to October 31, the winter fish-for-fun season and the Annual Kid’s Trout Derby. Local anglers continue to provide positive comments on the winter fish-for-fun season.

In 2019, fish surveys were conducted in a section of Big Barren Creek in Ripley County and a section of Cowards Hollow Creek in Carter County. The Big Barren survey was necessary due to a planned bridge replacement. Results of that survey yielded 530 fish comprised of 12 species. No crayfish species were collected or observed. The only species of conservation concern observed was one Southern Cavefish (*Typhlichthys subterraneus*). The cavefish was found dead and floating down the stream. It is likely that the species was washed from a nearby spring during recent rain events as cavefish rarely venture into open streams. Therefore, it should not be considered relative to this bridge replacement but rather as an overall concern for the sensitivity of karst topography and species found in this area (Finley 2019). Recommendations were made regarding demolition of the bridge.

Results of the Cowards Hollow Creek survey yielded 286 fish comprising of 14 fish species in the upper and lower sections combined, plus the Spothand Crayfish (*Orconectes punctimanus*) (Finley 2019). Recommendations were made to improve the health of the lower section of the creek.

Also in 2019, seven streams were sampled within the Black, Current, and Meramec River drainages. This resulted in the collection 3,296 individual fish comprised of 31 species and one hybrid. Mill Creek had a Simpson’s Diversity Index value of 0.88, the highest among the streams sampled. Little Creek had a Simpson’s Diversity Index value of 0.49, the lowest among the streams sampled. Bee Fork Creek had the

highest species richness with 28 species collected, seven of which were unique to this stream. Barren Fork Creek had the lowest species richness with eight species. No species of conservation concern were observed (Henderson et al. 2020). Several management recommendations were made.

Lastly in 2019, surveys were conducted by Mark Twain National Forest biologists in the West Fork of Big Creek and Big Paddy Creek, respectively. Thirteen species consisting of 151 individuals were documented in Big Creek, and 138 individuals of 32 species were documented in Big Paddy Creek. No RFSS or species of conservation concern were documented.

A status report concerning the “Extirpation Status of the Longnose Darter, (*Percina nasuta*) in the Upper White River Drainage” was compiled in July of 2020 with surveys conducted between June 2018 and July 2019. Longnose Darters (S1, State Endangered) are one of the rarest fish in Missouri and are of conservation concern throughout their range. They were petitioned for listing under the Federal Endangered Species Act in 2010 with a decision to be made in 2021. Twenty sites were sampled in major White River tributaries and within Table Rock reservoir. This area encompasses the Ava/Cassville/Willow Springs Ranger District. Although nine darter species were observed, no Longnose Darter were seen at any site. Sampling efforts in the upper White River drainage, combined with analysis of collection records over the past eighty years, provide further evidence of the absence of Longnose Darter in the upper White River drainage in Missouri. The probability that the Longnose Darter remains extant in the Missouri portion of the upper White River drainage is low given the scope of targeted sampling efforts, repeated surveys over time using multiple sampling methods, and the success at collecting all other darter species known in the study area (Wright, et al. 2020).

Recommendations

Considering results of the most recent aquatic surveys, it appears the aquatic environment is continuing to decline. Diversity appears to be down and the potential loss of a species in the upper White River watershed is concerning. For those reasons we should not only continue to partner with Missouri Department of Conservation and U.S. Fish and Wildlife Service to conduct fish and mussel surveys across the Mark Twain National Forest, but potentially increase efforts to gather additional baseline data in streams lacking that information.

Evaluation of Monitoring Question and Indicator(s)

Fish and mussel population and habitat surveys can provide information on stream health and for restoration needs.

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5.3 - Status of focal species to assess the ecological conditions required under 219.9

Monitoring question 10 addresses required monitoring element 36 CFR 219.12(a)(5)(iii) “The status of focal species to assess the ecological conditions required under 219.9.” (FSH 1909.12 32.13c)

5.31 - To what extent is Forest management contributing to the maintenance and establishment of shortleaf pine and pine-oak woodlands? (File Codes 2200 and 2600)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded densities of Eastern wood pewee and pine warblers were positively related to prescribed fire activity. Eastern wood-pewee and pine warbler were more abundant in areas with more prescribed burns in the 10-years prior. Similarly, these two species had positive relationships with the amount of area that had been burned within one

kilometer of the detection point. These two species did not appear to benefit greatly from pine thinning, but the addition of prescribed fire resulted in species benefits.

Monitoring Indicator(s)

Abundance of Eastern wood-pewee and pine warbler in CFLR project area and nest success for Eastern wood-pewee and pine warbler in CFLR project area

Monitoring Frequency

Diurnal bird surveys were conducted at 151 FQI points and 100 additional grid points within the cooperative forest landscape restoration (CFLR) project areas. This monitoring took place from 2013 through 2015. Nests were searched for and monitored between April and mid-August of 2014 and 2015. Objectives were to 1) determine changes in abundance in response to restoration activities in the CFLR project areas and 2) determine relationships between bird abundance and vegetation structure and composition in the Mark Twain National Forest. Restoration activities included prescribed fire and thinning. Species monitored were Acadian flycatcher, black-and-white warbler, blue-winged warbler, Eastern towhee, Eastern wood-pewee, Kentucky warbler, ovenbird, pine warbler, prairie warbler, red-headed woodpecker, summer tanager, white-eyed vireo, wood thrush, worm-eating warbler, and yellow-breasted chat. Data were collected and evaluated by Northern Research personnel and University of Missouri students. Northern Research provided a summary report each year after data was collected. All reports are on file at the Mark Twain National Forest's Supervisor's Office in Rolla, Missouri.

Background & Driver(s)

This question addresses required monitoring element 36 CFR 219.12(a)(5)(iii) "The status of focal species to assess the ecological conditions required under 219.9 (FSH 1909.12 32.13c).

This question is tied to 2005 Forest Plan goal 1.4 Wildlife and Aquatic Habitat; more specifically "Provide the range of natural habitats necessary to support populations of existing native plant and animal species" and "Restore and manage natural communities as the primary means of providing quality terrestrial, karst, and aquatic wildlife and rare plant habitat."

Eastern wood-pewee and pine warbler were selected as indicators for pine woodlands in cooperation with Northern Research Station, who has been doing bird research in the National Forest for decades. Pine warblers depend heavily on the presence of pine and pine-associated vegetation to meet their life requirements. They are rarely seen away from pines as they nest, forage, and sing in pine trees. They will also eat pine seeds in addition to other fruits, seeds, and insects. Eastern wood-pewee is a bird of clearings and forest edges which nests primarily in deciduous trees. Their presence indicates the type of structural characteristic that is typical of open pine or pine-oak woodlands. If both species are thriving within the CFLR project area, that is a very strong indicator that the shortleaf pine and pine-oak ecological community is healthy and contains the diversity and abundance of pine-related vegetation species to support native animals associated with this community type. Number of birds over time (abundance) and breeding success (nest success) are biologically sound methods for determining population trends to answer these indicators.

In 2012, the Mark Twain National Forest and Northern Research partnered to begin conducting point counts and assessing nest success of Eastern wood peewee and pine warbler, among other species, within the CFLR project areas to provide information that will answer these two indicators. Initial data was collected in 2013. A final thesis was completed by Melissa Roach, University of Missouri – Columbia.

Monitoring Indicator 1

Abundance of eastern wood-pewee and pine warbler in CFLR project area

Results

Overall, densities of Eastern wood pewee and pine warblers were positively related to prescribed fire activity. Eastern wood-pewee and pine warbler were more abundant in areas with more prescribed burns in the 10-years prior. Similarly, these two species had positive relationships with the amount of area that had been burned within one kilometer of the detection point. These two species did not appear to benefit greatly from pine thinning, but the addition of prescribed fire resulted in species benefits.

Discussion

Detection probabilities and densities varied greatly by species but were generally consistent with previous studies examining bird response to management treatment (Thompson et al. 1992, Clawson et al. 2002, Gram et al. 2003, Wallendorf et al. 2007, Reidy et al. 2014).

Pine warbler had some of the highest densities of all species detected. This species was positively related to point-level canopy cover and negatively to thinning. This suggested an unlikely preference for forested and subsequently, non-restored areas. However, examining the other covariates in its top model reveal it has strong preferences for areas with fewer deciduous trees and more frequent, larger burns. Pine-savanna/woodland restoration should have obvious positive responses from pine warbler as they are a true pine specialist; they only place their nests in mature evergreen trees. Their seemingly contradictory relationship with canopy cover and thinning reflects their natural history as a canopy-nesting species that requires a moderate amount of tree density.

Eastern wood-pewee showed lower densities in areas with lower sapling density. It is an aerial forager, sallying from perches to catch insects in the air (McCarty 1996, Frei et al. 2015). Its negative relationship with sapling density, in addition to its positive trend with saw timber density, could be an indication that it prefers open woodlands with large trees for perches and nest sites but open understories to catch prey more easily.

The extent or frequency of fire generally had a greater impact on density than thinning, which could reflect activity intensity. Prescribed fire was implemented over a greater area than thinning in this study because it is a cost-efficient way to reduce understory and mid-story density and create canopy gaps.

Overall, Eastern wood pewee and pine warbler demonstrated a strong relationship to at least one management covariate. This demonstrates the impact that management choices have on species abundance by directly affecting habitat structure.

Of all species monitored in the CFLR areas, neither the pine warbler nor Eastern wood pewee had truly negative relationships with pine restoration. Restoration also created conditions beneficial to woodland generalists such as Eastern wood-pewees while still retaining certain mature forest species. Monitoring in these areas indicated that the mix of current restoration activities provided habitat for a diverse array of species that covered multiple guilds and species of regional and range-wide concern.

Monitoring Indicator 2

Nest success of eastern wood-pewee and pine warbler in CFLR project area

Results

Six species were monitored for nest success, including the Eastern wood-pewee and pine warbler. These are considered sub-canopy to high canopy nesters. Reproductive success was negatively related to mean canopy cover for Eastern wood-pewee, and this species was also negatively associated with sapling density indicating its preference for a more open forest. Eastern wood-pewee daily survival rate (DSR) was negatively related to mean canopy cover. Pine warbler daily survival rate was positively related to sapling density. Eastern wood-pewee had the highest daily survival rate (0.969) of the six focal species

consistent with other studies reporting survival rates of 0.978 (Kendrick et al. 2013) and 0.974 (Knutson et al. 2004). These two canopy-nesting species had no direct relationships with management activities but had clear relationships with vegetation variables that are affected by management. For instance, Eastern wood-pewee nest success was negatively related to mean canopy cover demonstrating higher survival rates in areas with fewer trees due to selective tree thinning and prescribed fire.

This information represents only two years of nest monitoring. Although results cautiously indicate these species are benefiting from pine-savanna and woodland management activities, it will take several more years of data collection to be able to provide solid results.

Discussion

Positive relationships directly and indirectly with management activities shows that pine-savanna and woodland restoration in Missouri is providing quality breeding habitat for both early-successional species and woodland generalists, although data gathered is limited.

We only have two years of data for these two species, which is not enough to accurately assess what it tells us about the success of pine woodland management. Several more years of data are needed to establish a trend that is statistically meaningful.

Pine restoration benefits the pine warbler by shifting the ratio of hardwood to evergreen trees but also opens the understory potentially affecting foraging strategy or nest success.

Recommendations

Forest Service and Northern Research are confident that these two species are good indicators for the health and sustainability of pine woodland communities. Continued data collection will help establish statistically meaningful long-term trends. Cane Ridge East and West projects are currently being implemented, and future management activities will occur for many years. Monitoring may continue but extent will be dependent on funding and personnel availability.

Evaluation of Monitoring Question and Indicator(s)

Once enough data has been collected to provide meaningful results, we will re-evaluate this monitoring indicator and question to determine if changes are needed.

Additional species may be needed for Forest Plan revision to represent other natural communities in the Mark Twain National Forest.

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5.4 - Status of select set of the ecological conditions required under 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern

Monitoring question 11 addresses required monitoring element 36 CFR 219.12 (a)(5)(iv) “The status of select set of the ecological conditions required under 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.”

5.41 – To what extent is Forest management contributing to the conservation of threatened, endangered, and sensitive species and moving toward objectives for their habitat conditions? (File Code 2600)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded we met the objective for old growth in management prescriptions 2.1 and 6.2; minimally met the objective for shrub/grass/forb/regeneration across all management prescriptions; and exceeded the objective for the proportion of native grassland.

We also met the objective to “provide specialized habitats that are a healthy, functioning part of the larger landscape and require no special protection or additional management considerations”.

There is no shortage of snags of all sizes in the Mark Twain National Forest, primarily due to oak decline, wildfire, early and late frosts, ice storms and windstorms. Numbers of species vary annually, but data

shows trends downward, primarily due to the decimation of bat species by white-nose syndrome, which was identified as present in Missouri in 2011. Regardless of how much summer habitat is available, or what the quality of the habitat is, bats continue to die from white-nose syndrome. We have taken steps to reduce the spread, but with limited success so far.

Monitoring Indicator(s)

Acres of key successional habitats provided (open lands, regeneration, etc.); Specialized habitats (caves, fens, seeps, springs, cliffs, rock outcrops, wetlands, etc.) being protected, maintained, and restored; Summer roosting habitats for bats (snags); Bat caves gated; other TES recovery work completed.

Monitoring Frequency

Each of the indicators is monitored annually, but the evaluation of the extent of Mark Twain National Forest contribution to conservation of species and achieving habitat conditions is a longer-term assessment. Comparison of annual accomplishments to 2005 Forest Plan objectives over the last decade is a more appropriate time scale to assess success of our efforts.

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 1.4 Wildlife and Aquatic Habitat; specifically, “Support recovery of Federal and State listed species, protection and management of habitat for regionally listed species, and protection and management of habitat for other identified species of concern” and “Provide specialized habitats that are a healthy, functioning part of the larger landscape and require no special protection or additional management considerations. Provide specialized habitat components (such as standing dead trees, cavity and den trees, downed woody material, temporary pools, ephemeral springs and seeps) across the landscape in amounts and types commensurate with the natural communities in which they occur.”

In addition, pages 2-6 through 2-10 of the 2005 Forest Plan displays the numerous standards and guidelines which address creating and maintaining adequate amounts of various habitat types and conditions.

Acres of key successional stages provided is determined through annual review of the FACTS database and FS Veg information for activities occurring in these habitat types, and acres that meet the definition of each of the special habitat types.

District biologists field check a certain number of specialized habitats each year. The reports are on file with the Forest Wildlife Biologist in the Supervisor’s Office.

Summer roosting habitat for bats (snags) is determined by a query of the FIA database.

The number of bat caves gated is usually low and is easy to determine from district biologist contacts and a review of the wildlife budget expenditures.

Monitoring Indicator 1

Acres of key successional habitats provided (open lands, regeneration, etc.)

Results and Discussion

There are standards and guidelines for three key habitat components in Chapter 2 of the 2005 Forest Plan (old growth; grasslands; shrub/grass/forb). Implementation monitoring to assure that these standards and guidelines are being applied is done by field trips and review of FACTS, FS Veg, and NRIS data sets.

Table 16. Key Habitat Components Present on MTNF (Acres)

Management Prescription	Old Growth: 2.1	Old Growth: 6.1	Old Growth: 6.2	Shrub-Grass-Forb-Regeneration*: 2.1	Shrub-Grass-Forb-Regeneration*: 6.1	Shrub-Grass-Forb-Regeneration*: 6.2	Grassland
Objective	53,592-100,485 Acres	11,040-14,720 Acres	15,712-23,568 Acres	53,592-80,388 Acres	736-3,680 Acres	9,820-19,640 Acres	55% native
2015/16	58,779	8,169	20,149	Shrub-Grass-Forb-Regeneration* for 2.1 + 6.1 + 6.2 = 69,390 + glade acres			80%

*64,148 minimum acres; 103,708 maximum acres

As this table shows regarding old growth, we met the objective in management prescriptions 2.1 and 6.2 but have not met the objective for management prescription 6.1. Regarding shrub/grass/forb/regeneration, objective has been minimally met across all management prescriptions. The objective for native grassland has been exceeded.

Monitoring Indicator 2

Specialized habitats (caves, fens, seeps, springs, cliffs, rock outcrops, wetlands, etc.) being protected, maintained, and restored

Results and Discussion

The 2005 Forest Plan contains several wildlife objectives in chapter 1 under goal 14 that discusses special habitats. From 2015 through 2020, 92 specialized habitats were inspected, and those inspections were documented and are on file in the Supervisor's Office. In general, specialized habitats were being managed and protected according to the 2005 Forest Plan standards and guidelines.

Table 17. Specialized Habitats Inspected from 2015 through 2020

	Sinkhole	Cave	Fen	Spring	Glade	Riparian
2017	1	12	2	0	0	1
2018	4	21	4	2	20	1
2019	4	9	1	1	1	0
2020	8	6	2	3	3	2

Between 2017 through 2020, notable threats have not changed to specialized habitats. Off-highway vehicle use, invasive plants and hogs, woody encroachment, and road runoff are a continued cause of concern. Heavy visitation, user created trails and trash are also continued issues. Other items noted were need for prescribed fires, removal of woody vegetation encroachment into fens, and vandalism to cave gates and signs. A need exists for additional boulders in riparian and glade areas for road, trail, and parking closures. Severe flooding in 2017 caused significant damage to riparian habitat (rivers and streams). Clean up efforts on roadways and recreation areas were completed. Some issues were easily and quickly resolved, while others require long-term monitoring, law enforcement assistance, or continued vegetation management.



Photo 8. North Fork Boat Ramp during 2017 flood



Photo 9. North Fork Boat Ramp construction after 2017 flood

At Kneibert Spring, Forest Protection Officers gave five tickets to off-highway vehicle users on March 18, 2017. Additional tickets were issued in 2018. The word spread that we will not tolerate illegal use in this area. Access routes have been blocked using boulders, berms, trees, and such, and vegetation is re-establishing. Carsonite posts with “No motor vehicles allowed” stickers are replaced as needed at the end of this road, and access points are regularly monitored with cameras. This has deterred continued illegal off-highway vehicle use in the area.

While continued vigilance is needed to ensure the health and sustainability of these habitats, the information gathered shows that we are meeting the objective to “Provide specialized habitats that are a healthy, functioning part of the larger landscape and require no special protection or additional management considerations.”

Monitoring Indicator 3

Summer roosting habitats for bats (snags)

Results and Discussion

The 2005 Forest Plan has several standards and guidelines which address snags and summer bat roosting habitat, for both males and maternity colonies. While the standards and guidelines apply specifically to listed or sensitive bats, providing a continuous supply of snags well-distributed across the landscape, will also provide roosting opportunities for other bat species.

For 2011 through 2016, FIA estimated a total of 20,082,786 snags present across the Mark Twain National Forest. This current period analyzing availability of roosts indicates that the number of snags has

decreased over the time since the 2005 Forest Plan was signed and implementation started. However, there is no shortage of snags of all sizes across the Mark Twain National Forest, primarily due to oak decline, wildfire, early and late frosts, ice storms, and windstorms. Different species of bats require different roost niches, thus even a fire-scarred tree with a small crevice (non-reproductive Indiana bats have been documented using this), or a live tree with a dead limb (Northern long-eared bats have been documented using this), can provide roost habitat for bats. Those types of microhabitats are not captured in the snag data.

Results of bat mist netting show that bats of nine different species continue to use the area for summer habitat. Numbers of species vary annually, but the last few years of mist-netting data show that trends for all are decreasing, some more drastically than others. Northern long-eared bats haven't been captured since 2016, and Indiana bat capture success drastically declined, with none captured in 2019 or 2020 at historic maternity colonies. Regarding cave-dwelling bats, this is primarily due to the presence of white-nose syndrome, which was identified in Missouri in 2011. Populations of tree-roosting bats are declining because of wind turbines. Regardless of how much summer habitat is available, or what the quality of that habitat is, bats continue to die from white-nose syndrome and wind turbine collisions. We have taken steps to reduce the spread of white-nose syndrome, but with limited success so far.

The EVALIDator Program, v. 1.8.0.01, was used to query snags on the Mark Twain National Forest. For 2017 through 2019, FIA estimated a total of 7,289,199 snags present across the Mark Twain National Forest. This is about 11 snags per acre. This is a decline of approximately two snags per acres compared to the previous six years. Due to COVID, data for year 2020 was not available.

Monitoring Indicator 4

Bat caves gated

Results and Discussion

One cave was gated in 2015, and two caves were gated in 2016. Other cave gates were inspected, and some instances of vandalism to gates were discovered and repaired.

During 2017 through 2020, three cave entrances and one mine entrance was constructed. Other cave gates were inspected, and some instances of vandalism to gates were discovered and repaired. Though this curbs the spread of white-nose syndrome from human interaction, species are still in decline. Cave Research Foundation has been an integral part in monitoring cave gate breaches and repairs and biological surveys, and this partnership should be continued.



Photo 10. Fence gate at Butler Hollow Cave

In caves that have been gated, population counts have shown species declining, due to the presence of white-nosed syndrome. Gating to limit human entry into caves is particularly important since white-nose syndrome was discovered in bats using the Mark Twain National Forest. While it cannot be proven that white-nose syndrome has been slowed or stopped by cave gating, it is important that we do whatever has a chance of being successful, which includes limiting human access to caves with vulnerable bat species.

Continued partnership with the Cave Research Foundation is vital to successful achievement of this indicator.

Monitoring Indicator 5

Other TES Recovery Actions Implemented

Results and Discussion

In 2013, we partnered with Iron County to pave the gravel road and provide proper drainage adjacent to Barton Fen, a Hine's emerald dragonfly critical habitat unit. We were granted a Wings Across the America's Dragonfly Conservation Award for this project.

We continue to partner with Missouri Department of Conservation to monitor and augment populations of Eastern and Ozark hellbenders. Egg collections were taken from the Big Piney for Eastern hellbenders and from the Current and Eleven Point Rivers for Ozark hellbenders. Three nest boxes were being used in the Current, four in the Eleven Point and two nests were found in the North Fork River. It is estimated that approximately 50 percent of the Ozark hellbender population was killed during the 2017 floods. The most severe individual and habitat losses occurred below the Mark Twain National Forest proclamation boundary. Missouri State University continues monitoring of large wood structures in the North Fork of the White River. The installation of the large wood structures in North Fork of the White River, while not an activity directed at recovery of hellbenders, provided habitat protection from sediment produced by recreation area improvements.

Prescribed burns and non-native invasive species treatments, including extensive hog trapping near fens, have contributed to maintaining habitat, including designated critical habitat, for Hine's emerald dragonfly. Cedar removal was mentioned to improve habitat for Casey Fen. Fortune Hollow and Bates

Hollow Fen have fencing to protect the fen. Bee Fork Fen has been fenced since 2017. See photos 11 through 13.



Photo 11. Bates Hollow Fen



Photo 12. Casey Fen



Photo 13. Fortune Hollow Fen

Prescribed fires, timber harvesting, and cedar removal in glades and open woodlands have contributed to improving habitat for Monarch butterfly and other pollinators. Butterfly surveys were conducted by Missouri University – St. Louis in 2018 and 2019 (Marquis 2019). The survey gave a baseline for presence of species, including monarch butterfly, and confirmed the hypotheses that active management increases butterfly populations and the number of butterfly species encountered.

In 2020, U.S. Fish and Wildlife Service surveyed Dry Creek, Big Spring, and Spring Creek for Arkansas mudalia, a regional forester sensitive species-listed aquatic snail. Two specimens were confirmed as Arkansas mudalia during this survey.

Recommendations

Additional old growth should be designated in management prescription 6.1 to meet the 2005 Forest Plan objective.

Specialized habitat field inspections should be continued and conducted consistently each year. Documentation of these visits should be filed where they are available to biologists or other specialists working on projects.

Ongoing research into a cure for white-nose syndrome and minimize impacts to bats from wind turbines is the critical need currently. Unless these issues can be addressed, forest management for bat habitat is unlikely to have any positive impacts on bat populations.

Continue implementing TES recovery actions, to aid in recovery of species. This includes improving and protecting essential habitat like caves, rivers, streams, and forested habitat.

Evaluation of Monitoring Question and Indicator(s)

These monitoring items appear to be effective in helping us understand how forest management activities are contributing to the conservation of threatened, endangered, and sensitive species and moving toward objectives for their habitat conditions.

References

Bat survey reports

Cave Research Foundation reports

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Mark Twain National Forest GIS layers

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5.5 - Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Monitoring questions 12-15 address required monitoring element 36 CFR 219.12(a)(5)(v) “The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.” (FSH 1909.12 32.13d)

5.51 – What is the status and trend of visitor use, visitor satisfaction, and progress toward meeting recreation objectives in the plan? (File Code 2300)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded more than 80 percent of visitors are very satisfied with their overall recreation experience. Satisfaction ratings for both safety and access items were over 90 percent for all types of sites.

Monitoring Indicator(s)

Annual visitation estimates by type of visit (day use, developed, general forest area); Description of visit (demographics, visit descriptions, activities); Economic information (spending, substitute behavior, etc.); Visitor Satisfaction

Monitoring Frequency

Through National Visitor Use Monitoring System (NVUM) on a periodic basis. Last completed in 2018 for the Mark Twain National Forest.

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2 Provide a Variety of Uses, Values, Products, and Services and to goal 2.8 Recreation Opportunities which states, “Provide a diversity of recreational opportunities and benefits through a variety of settings” and “Contribute to local, regional, and national economies by providing recreational opportunities in a socially and environmentally acceptable manner.” Standards and guidelines for recreation management are found on pages 2-21 through 2-24 of the 2005 Forest Plan.

The Mark Twain National Forest is the largest public forest acreage in the state and is disproportionately represented in those southern counties where natural resource related recreation is a larger part of the economy. The amount of recreation opportunities provided by the Mark Twain National Forest is an important factor in the sustainability of many local businesses. The indicators (visitation estimates and economic information) indicate how effective we are at contributing to the local economy.

Characteristics of the recreation visit, such as length of visit, types of sites visited, activity participation, and visitor satisfaction with facilities and services, help managers understand recreation use patterns and use of facilities. This allows them to plan workforce and facility management.

Basic demographic information helps managers identify the profile of the visitors they serve. Management concerns, such as providing recreation opportunities for under-served populations, may be monitored with this information.

Managers are usually very interested in the impact of National Forest recreation visits on the local economy. As commodity production of timber and other resources has declined, local communities look increasingly to tourism to support their communities. When considering recreation-related visitor spending, managers are often interested both in identifying the average spending of individual visitors (or types of visitors) and the total spending associated with all recreation use. Spending averages for visitors or visitor parties can be estimated using data collected from a statistically valid visitor sampling program such as National Visitor Use Monitoring System (NVUM). To estimate the total spending associated with recreation use, three pieces of information are needed: an overall visitation estimate; the proportion of visits in the visitor types; and the average spending profiles for each of the visitor types. Multiplying the three gives a total amount of spending by a particular type of visitor. Summing over all visitor types gives total spending.

Visitor satisfaction information helps managers decide where to invest in resources and to allocate resources more efficiently toward improving customer satisfaction.

Monitoring Indicator 1

Annual visitation estimates by type of visit (day use, developed, general forest area)

Results

Table 18. NVUM Annual Visitation Estimate (NVUM 2013)

Visit Type	Visits (1,000s)	90% Confidence Level (%)
Total Estimated Site Visits*	1,230	±39.2
Day Use Developed Site Visits	121	±23.1
Overnight Use Developed Site Visits	42	±24.5
General Forest Area Visits	1,038	±46.4
Designated Wilderness Visits†	29	±31.3
Total Estimated National Forest Visits§	801	±41.5
Special Events and Organized Camp Use‡	0	±0.0

* A site visit is the entry of one person onto a National Forest site or area to participate in recreation activities for an unspecified period.

† Designated Wilderness visits are included in the site visits estimate.

‡ Special events and organizational camp use are not included in the site visit estimate, only in the National Forest visits estimate. Forests reported the total number of participants and observers, so this number is not estimated; it is treated as 100 percent accurate.

§ A National Forest visit is defined as the entry of one person upon a national forest to participate in recreation activities for an unspecified period. A National Forest Visit can be composed of multiple Site Visits.

This value defines the upper and lower bounds of the visitation estimate at the 90% confidence level, for example if the visitation estimate is 100 +/-5%, one would say "at the 90% confidence level visitation is between 95 and 105 visits."

Table 19. NVUM Annual Visitation Estimate (NVUM 2018)

Visit Type	Visits (1,000s)	90% Confidence Level (%)
Total Estimated Site Visits*	687	±18.8
Day Use Developed Site Visits	109	±36.5
Overnight Use Developed Site Visits	50	±24.1
General Forest Area Visits	506	±24.0
Designated Wilderness Visits†	22	±45.8
Total Estimated National Forest Visits§	433	±20.5
Special Events and Organized Camp Use‡	0	±0.0

Discussion

The current data shows that about half as many visitors entered National Forest sites or areas. This can be due to many factors including the weather, the economy, or if the collection template was changed from the previous collection period. Mark Twain National Forest staff and visitors noticed there was an uptick in visitors in the 2020 recreation season likely due to the Covid-19 pandemic's social distancing and stay at home mandates.

Monitoring Indicator 2

Description of visit – demographics, visit descriptions, activities

Results

Demographics

In the Mark Twain National Forest, about 37 percent of visits are made by females. Hispanic/Latino visitors account for about 4 percent of visits. More than twenty percent of visit are children under the age of 16. Adults over age 60 make up only about 10 percent of visits. The Mark Twain National Forest serves a mostly local recreation customer base. More than 75 percent of visits are from people who traveled less than 50 miles to recreate (National Visitor Use Monitoring Data collected FY 2013). 2018 NVUM data

reveals 38 percent of the visits are made by females. Native Americans are 4.3 percent of the visits of the minority population. Additionally, 20 percent are children under 16, and 21 percent are people over the age of 60. Also contributing, 40 percent of the visits come from folks who visit up to 5 times a year and 16 percent of the visits are made by visitors who come more than 50 times per year.

Visit Descriptions

The average recreation visit to the Mark Twain National Forest lasts only about 7.5 hours. The median length is under 3 hours (NVUM 2013). The 2018 data reveals average length of stay is 10.7 hours, which is affected by the number of multi-night stays on National Forest System land.

Table 20. Visit Duration (NVUM 2013)

Visit Type	Average Duration (hours)‡	Median Duration (hours)‡
Site Visit	6.8	2.5
Day Use Developed	2.1	1.5
Overnight Use Developed	30.6	29.3
Undeveloped Areas	6.3	2.5
Designated Wilderness	9.7	6.3
National Forest Visit	7.4	2.5

Table 21. Visit Duration (NVUM 2018)

Visit Type	Average Duration (hours)‡	Median Duration (hours)‡
Site Visit	10.7	2.6
Day Use Developed	2.0	1.2
Overnight Use Developed	36.5	41.3
Undeveloped Areas	10.0	2.7
Designated Wilderness	6.4	2.2
National Forest Visit	13.6	3.2

* A Site Visit is the entry of one person onto a national forest site or area to participate in recreation activities for an unspecified period. Sites and areas were divided into four site types as listed here.

† A National Forest Visit is defined as the entry of one person upon a National Forest to participate in recreation activities for an unspecified period. A National Forest visit can be composed of multiple site visits.

‡ If this variable is blank not enough surveys were collected to make inferences.

Activities

Visitors were asked how many hours they spent participating in their main activity during their national forest visit. Because most national forest visitors participate in several recreation activities during each visit, it is more than likely that visitors also participated in other activities but did not identify it as their main activity.

Table 22. Activity Participation (NVUM 2013)

Activity	% Participation*	% Main Activity†	Avg Hours Doing Main Activity
Relaxing	49.0	13.9	3.3
Hiking / Walking	41.6	14.2	1.7
Viewing Natural Features	40.5	14.1	2.4
Fishing	26.2	19.3	3.4
Driving for Pleasure	23.4	2.9	1.2
Viewing Wildlife	23.2	2.7	1.9

Activity	% Participation*	% Main Activity‡	Avg Hours Doing Main Activity
Picnicking	14.1	5.1	3.4
Other Non-motorized	14.0	8.0	2.9
Non-motorized Water	8.0	6.8	10.3
Motorized Trail Activity	7.2	3.8	3.5
Nature Study	7.2	0.0	0.0
Some Other Activity	6.7	3.4	1.7
Hunting	6.6	4.2	3.2
Developed Camping	6.1	1.6	31.0
Motorized Water Activities	6.0	1.1	5.2
Visiting Historic Sites	4.2	0.0	0.0
Gathering Forest Products	3.7	0.1	1.1
OHV Use	3.4	2.1	15.2
Nature Center Activities	2.9	0.1	26.3
Bicycling	2.3	1.5	1.5
Primitive Camping	1.8	0.1	21.8
Horseback Riding	0.8	0.7	7.6
Resort Use	0.7	0.0	24.4
Other Motorized Activity	0.1	0.1	10.0
Backpacking	0.0	0.2	38.0

* Survey respondents could select multiple activities so this column may total more than 100%.

‡ Survey respondents were asked to select just one of their activities as their main reason for the forest visit. Some respondents selected more than one, so this column may total more than 100%.

Table 23. Activity Participation (NVUM 2018)

Activity	% Participation*	% Main Activity‡	Avg Hours Doing Main Activity
Viewing Natural Features	54.0	15.9	4.2
Relaxing	44.6	7.2	12.3
Hiking/Walking	37.5	14.7	3.0
Viewing Wildlife	31.4	1.5	5.7
Picnicking	21.8	4.1	1.4
Fishing	19.4	10.4	3.7
Other Non-motorized	14.1	5.1	3.4
Driving for Pleasure	16.2	3.7	2.2
Motorized Water Activities	13.8	5.5	5.2
Developed Camping	8.1	2.7	30.8
Some Other Activity	7.4	5.4	2.6
Bicycling	7.2	6.4	1.5
Visiting Historic Sites	5.5	0.4	1.0
Backpacking	5.1	0.8	35.2
Gathering Forest Products	3.5	1.0	2.1
Nature Center Activities	2.7	0.4	2.0
OHV USE	2.5	1.5	5.1
Motorized Trail Activity	2.4	1.7	14.5
Hunting	2.2	1.7	7.5
Primitive Camping	2.0	0.4	40.3
Horseback Riding	1.3	1.3	17.2
Resort Use	0.3	0.0	0.0
No Activity Reported	0.2	0.2	0.0
Other Motorized Activity	0.0	0.0	0.0
Snowmobiling	0.0	0.0	0.0
Downhill Skiing	0.0	0.0	0.0
Cross-country Skiing	0.0	0.0	0.0

Discussion

In the 2013 data, fishing (19 percent) is the most frequently listed primary activity for the Mark Twain National Forest. Next in popularity are hiking and walking (14 percent), viewing natural features and scenery (14 percent), and relaxing and hanging out (14 percent). Although not in the top group, non-motorized water activities (floating, canoeing) on the rivers in the Mark Twain National Forest are a large contributor to summer recreation in the Ozarks and southern Missouri. There are two National Scenic Rivers and several other world class rivers and streams which draw people to the Mark Twain National Forest each year.

In the 2018 data, viewing natural features (16 percent), is the most frequently listed primary activity for the Mark Twain National Forest. Hiking or walking (15 percent) is the next in popularity, fishing (10 percent), and relaxing (7 percent). Even though picnicking is not the primary activity for the users, 22 percent of the visitors picnic while visiting the Mark Twain National Forest. Non-motorized water activities, driving for pleasure, and motorized water activities round out the top activities for the Mark Twain National Forest in the Ozarks of Southern Missouri.

Monitoring Indicator 3

Economic information – spending, substitute behavior, etc.

Results and Discussion

Less than 20 percent of visits are made during overnight trips away from home. Income results show a wide range. More than 25 percent of visitors report incomes over \$100,000 per year; but 17 percent of visitors report incomes under \$25,000 per year.

Visitors were asked if for some reason they were unable to visit this national forest, what they would substitute for that activity. Most visitors indicate their substitute behavior choice is activity driven (going elsewhere for the same activity), and a smaller percentage indicate they would come back later to this national forest for the same activity.

Table 24. Trip Spending and Lodging Usage (NVUM 2013)

Trip Spending	Value
Average Total Trip Spending per Party	\$81
Median Total Trip Spending per Party	\$30
% NF Visits made on trip with overnight stay away from home	17.8%
% NF Visits with overnight stay within 50 miles of NF	16.1%
Mean nights/visit within 50 miles of NF	2.2
Area Lodging Use	% Visits with Nights Near Forest
NFS Campground on this NF	28.6%
Undeveloped Camping in this NF	13.2%
NFS Cabin	0.5%
Other Public Campground	1.1%
Private Campground	11.7%
Rented Private Home	11.7%
Home of Friends/Family	29.4%
Own Home	4.8%

Table 25. Trip Spending and Lodging Usage (NVUM 2018)

Trip Spending	Value
Average Total Trip Spending per Party	\$130

Median Total Trip Spending per Party	\$25
% NF Visits made on trip with overnight stay away from home	21.3%
% NF Visits with overnight stay within 50 miles of NF	22.5%
Mean nights/visit within 50 miles of NF	3.2
Area Lodging Use	% Visits with Nights Near Forest
NFS Campground on this NF	29.2%
Undeveloped Camping in this NF	26.5%
NFS Cabin	0.6%
Other Public Campground	3.8%
Private Campground	13.6%
Rented Private Home	12.9%
Home of Friends/Family	16.6%
Own Home	6.9%
Other Lodging	0.0%

Two-thirds of all visitors' trips to the Mark Twain National Forest is a day trip from home, rather than a trip requiring an overnight stay. For the 2018 visitor use monitoring data, the income concentration shows the lower middle range; over 40 percent of the visits come from households making below \$50,000 per year; thirty percent make between \$25,000 and \$50,000 per year. About 25 percent of the visitor's income range between \$75,000 and \$100,000 per year.

Monitoring Indicator 4

Visitor Satisfaction

Results and Discussion

In the 2013 survey, more than 80 percent of visitors are very satisfied with their overall recreation experience. Satisfaction ratings for both safety and access items were over 90 percent for all types of sites. In the 2018 survey, 84 percent of the visits received an overall satisfaction rating of very satisfied.

Table 26. Percent Satisfied Index[†] Scores for Aggregate Categories (NVUM 2013)

Satisfaction Element	Satisfied Survey Respondents (%): Developed Sites [‡]	Satisfied Survey Respondents (%): Undeveloped Areas (GFAs)	Satisfied Survey Respondents (%): Designated Wilderness
Developed Facilities	87.1	78.8	95.6
Access	94.8	94.8	98.0
Services	85.8	75.7	84.9
Feeling of Safety	95.5	100.0	100.0

[†] This is a composite rating. It is the proportion of satisfaction ratings scored by visitors as good (4) or very good (5). Computed as the percentage of all ratings for the elements within the sub-grouping that are at or above the target level and indicates the percent of all visitors that are reasonably well satisfied with agency performance.

[‡] This category includes both day-use and overnight-use in developed sites.

Table 27. Percent Satisfied Index[†] Scores for Aggregate Categories (NVUM 2018)

Satisfaction Element	Satisfied Survey Respondents (%): Developed Sites [‡]	Satisfied Survey Respondents (%): Undeveloped Areas (GFAs)	Satisfied Survey Respondents (%): Designated Wilderness
Developed Facilities	76.9	85.1	33.3
Access	83.5	89.2	70.0
Services	77.5	75.2	37.9

Feeling of Safety	95.0	94.9	47.2
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† This is a composite rating. It is the proportion of satisfaction ratings scored by visitors as good (4) or very good (5). Computed as the percentage of all ratings for the elements within the sub-grouping that are at or above the target level and indicates the percent of all visitors that are reasonably well satisfied with agency performance.

‡ This category includes both day-use and overnight-use in developed sites.

It appears from the 2013 survey we are doing well at providing the types of services and experiences that visitors are looking for. One NVUM survey question compares the importance of services (such as signage, parking, and such) to the visitor with how well we are providing that service. For items that are important to visitors and ones we are performing quite well, visitors scored:

- 14 of 14 in the day-use developed sites
- 12 of 14 in the overnight developed sites
- 11 of 14 in undeveloped areas (general forest areas).

These scores suggest we are doing well at providing those services that are important to people in their recreational experiences.

No items scored as important items to the public had ratings indicating that performance is not where it needs to be. Again, indicating we seem to be doing well with things that recreationists value.

For items that are not highly important to visitors, but our performance is quite good, visitors scored:

- 1 item in overnight developed sites
- 2 items in undeveloped areas (general forest areas)

This suggests that there may be a few items we could consider providing at a lower level of service and still satisfy visitor needs and desires.

One item was scored as performance is not very good, but neither is important to visitors in the overnight developed sites and undeveloped areas (general forest areas), however it was a different item for each of the areas.

Data on whether visitors felt crowded showed that only the overnight developed areas had responses that indicated some high degrees of “too many people”. Day-use developed areas had a few instances that indicated some overcrowding (NVUM 2013 p. 35 table 23).

The Mark Twain National Forest’s recreation customers seem to be primarily local people who travel less than 50 miles to participate in their chosen activities. The general forest area is the type of area chosen most often, and trips are generally of less than a day duration. Minority visitors are a very small proportion of those who were interviewed. Satisfaction with services and experiences provided seems to be relatively high.

We have implemented a recreation program that provides a variety of recreational settings, experiences, and opportunities; and it appears from NVUM 2013 data, that visitors are satisfied with that mix of experiences.

Recommendations

The information gained from the 2013 data seems to show that the Mark Twain National Forest recreation niche is primarily local, short duration visits to enjoy the mere presence of natural resources (relaxing, hiking, viewing, driving, wildlife watching, etc.).

Water-based recreation is a large part of the recreation opportunity base, which fell somewhere in the middle of experiences that visitors came for. There may be other information (such as outfitter and guide visitor numbers) that would give another view of the importance of water-based recreation to the visitors.

The backlog of deferred maintenance items is a good indication that the funding for the Mark Twain National Forest recreation program is not keeping pace with the priorities outlined in 2005 Forest Plan goals, objectives, and standards and guidelines. However, visitor satisfaction seems to indicate that visitors are fairly satisfied with the experiences and opportunities provided.

With the plan derived from the Recreation Site Analysis and the 5-year recreation strategy, we have priorities documented for the next five years. Implementing this process, with the assistance of funding for deferred maintenance from the Great American Outdoors Act, we plan to catch up on maintenance on some of the large projects in the next five years.

Evaluation of Monitoring Question and Indicator(s)

We will continue to follow National and Regional direction for monitoring recreation use through NVUM.

Other than NVUM, staffing levels and recreation budget are not conducive or sufficient to monitor in a meaningful way, particularly for effectiveness. We have not been particularly effective in documenting issues identified by monitoring or the resolution of those issues. Recreation (and engineering) staff are generally overwhelmed with the annual workload; and therefore, monitoring, inspections, and INFRA data entry tend to become low priority compared to doing work. While we understand that effective monitoring would help identify and track workload, it never seems to be the priority espoused by program managers or Forest leadership when choices must be made.

The Forest Recreation Staff is hopeful there will be time to update the NRM database to have a more complete data set for funding plans and special project requests.

References

U.S. Department of Agriculture, Forest Service. 2013. Mark Twain National Forest. National Visitor Use Monitoring Data collected FY2013.

U.S. Department of Agriculture, Forest Service. 2018. Mark Twain National Forest. National Visitor Use Monitoring Data collected FY2018.

5.52 – To what extent do Forest recreation facilities and opportunities meet accessibility, health, safety, and maintenance requirements and achieve resource and social objectives? (File Code 2300)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded bacterial results have been within acceptable levels in Council Bluff Lake.

Monitoring Indicator(s)

Water quality at swimming beaches; Facility inspections for compliance with critical and other standards from INFRA; Water quality of drinking water

Monitoring Frequency

Annual (pre-recreation season and during recreation season)

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2 Provide a Variety of Uses, Values, Products, and Services and goal 2.8 Recreation Opportunities which states, “Provide a diversity of recreational opportunities and benefits through a variety of settings” and “Contribute to local, regional, and national economies by providing recreational opportunities in a socially and environmentally acceptable manner.” Standards and guidelines for recreation management are found on pages 2-21 through 2-24 of the 2005 Forest Plan.

This question is also tied to 2005 Forest Plan goal 2.1 Public Values “Within the capability of sustainable ecosystems, offer multiple benefits that contribute to the social and economic well-being of local and regional communities by providing a variety of uses, values, products, and services in a cost-effective manner for present and future generations” and “Provide accessibility of the full range of uses, values, products, and services to members of under-served and low-income populations.”

When visitors come to the national forest, they should be able to do so with the expectation that facilities meet safety and health standards. Facility inspections are the way that we determine if our facilities are appropriate for use. Inspections are conducted according to state and national standards.

The only authorized swimming beach in the Mark Twain National Forest is the Chapel Hill Beach at Council Bluff Lake. The site is monitored for fecal coliform bacteria in compliance with state requirements. Water samples are taken monthly.

Drinking water is provided at many campgrounds and some day-use sites. Periodic sampling of water quality is conducted prior to and during the seasons of use. Water samples are submitted to Missouri Department of Natural Resources for testing.

Monitoring Indicator 1

Water quality at swimming beaches

Results and Discussion

Results of water testing at Chapel Hill Beach in Council Bluff Lake can be found on file at the Forest Supervisor’s Office in Rolla, MO. Bacterial results have been within acceptable levels.

Sampling protocols and results are consistent with state and federal laws, 2005 Forest Plan objectives, and public safety.

Monitoring Indicator 2

Facility inspections for compliance with critical and other standards from INFRA

Results and Discussion

Facility inspections are routinely completed by the Forest’s recreation staff. Items that are not in compliance with safety or other critical standards are remediated immediately and corrected as soon as possible. Facility needs are documented in INFRA.

Monitoring Indicator 3

Water quality of drinking water

Results and Discussion

Drinking water sites are managed in compliance with all Missouri Department of Natural Resource regulations. Water quality is tested monthly, and all samples are sent to Missouri Department of Natural Resources. Any issues identified are resolved immediately under the direction of Missouri Department of Natural Resources.

Recommendations

Continue to adhere to Missouri Department of Natural Resources standards and protocols for swimming beach water quality and drinking water supplies.

More emphasis could be placed on correcting non-critical facilities in a timely manner and documenting those actions in NRM or by some other method that is timely and accessible to recreation managers.

Evaluation of Monitoring Question and Indicator(s)

The recreation program, including facilities, is historically under-funded and under-staffed for work that is needed. Recreation program managers rely heavily on the Forest's Facility Engineer for planning and program management, leaving less time for technical engineering assistance, which is the primary responsibility of that position. Engineering and recreation programs need to clarify roles and responsibilities for monitoring, particularly where facilities are involved. Additional staff is needed to ensure that monitoring is given the attention it requires to be accurate, timely, and useful. The current Recreation Program Manager has requested that the Regional Program Manager investigate partnerships at the regional level which would allow funding for full time data stewards to assist in the input of data into the NRM Database. The Region is planning on funding based upon the database increasingly in the future. We should place a higher priority on updating INFRA and developing systems and procedures to track the resolution of issues identified through monitoring.

References

Missouri Department of Natural Resources (MoDNR) Public Drinking Water.

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Infrastructure application (INFRA).

5.53 – To what extent are management activities meeting Recreation Opportunity Spectrum objectives? (File Code 2300)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded 57 percent of projects reviewed specifically identified recreation opportunity spectrum (ROS) objectives and stated consistency of proposed activities with ROS objectives.

Monitoring Indicator(s)

Projects that are consistent with ROS objectives

Monitoring Frequency

Annual

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2 Provide a Variety of Uses, Values, Products, and Services and to goal 2.8 Recreation Opportunities which states "Provide a diversity of recreational opportunities and benefits through a variety of settings." Standards and guidelines for ROS class are found on page 2-22 of the 2005 Forest Plan.

People of all walks of life come from all over the country and world to visit the Ozarks and the Mark Twain National Forest. They are coming with expectations of participating in a wide variety of recreational experiences and settings. It is difficult to provide all the settings and experiences that everyone wants. We have carefully considered the physical, environmental, and social setting, and have determined which recreational experiences and opportunities we are able to provide. Sometimes this meets our visitor expectations, and sometimes it does not.

The recreation opportunity spectrum was developed as a planning tool to identify, evaluate, and define the supply of recreation settings on national forests. Each management prescription in the 2005 Forest Plan has a ROS class objective which describes the desired condition for lands allocated to that management prescription. These land allocations are designed to provide a range of recreation opportunities to satisfy diverse public interests.

A climbing management plan has been developed to formally and proactively manage climbing on National Forest System land. By building a cooperative relationship between climbers and resource managers, Devil's Elbow and Devil's Backbone are the first two areas to be included in this plan to manage this recreation use and conserve the resource base for the future generations of climbers. By partnering with Access Fund, Missouri S & T, and Mid-Missouri Climbers Alliance, we have opened the path to communicating how resource management activities will support long term use for climbing areas.

Monitoring Indicator 1

Projects that are consistent with ROS objectives

Results

Environmental analysis documentation (environmental assessments and decision notices) for vegetation management projects planned in 2015 and 2016 were reviewed to determine if ROS had been considered and evaluated for the projects. Four out of seven (57 percent) projects reviewed specifically identified ROS and stated consistency of proposed activities with ROS.

No projects to change ROS were proposed in 2015 or 2016.

Discussion

The NVUM results from 2013 indicated that the public feels that we are providing a variety of recreation experiences, and most people are relatively satisfied with the experiences and opportunities available. Some people are finding the kinds of experiences they seek, and others are not as satisfied with the opportunities available to them. Unfortunately, even the largest land area would not be able to satisfy every individual preference. Taken as a whole, public input indicates we are effectively meeting the objectives for recreational experiences as outlined in the 2005 Forest Plan.

Recommendations

ROS objectives should continue to be looked at as part of project-level environmental analysis.

Evaluation of Monitoring Question and Indicator(s)

ROS was developed primarily as a planning tool. Over the past decade, there have been very few instances where we identified a need to change ROS for a particular area (general forest area being designated State Natural Area as an example). Compliance with ROS objectives is addressed during project development and analysis.

While ensuring consistency with ROS is an important part of planning, "Projects that are consistent with ROS objectives" as an indicator of annual progress in complying with ROS is non-specific and difficult to assess. Other indicators (like visitor satisfaction) are probably better indicators of how well we are providing different types of recreational experiences.

References

U.S. Department of Agriculture, Forest Service. National Visitor Use Monitoring Program (NVUM).

5.54 – How are management activities affecting unauthorized OHV use? (File Codes 2300 and 5300)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded “vehicle off-road” is consistently in the top three or four violations each of the last four to five years. That includes other vehicles besides off-highway vehicles (OHVs), but that is an indicator that this is a recurring issue on the Mark Twain National Forest.

Off-highway vehicle damage, such as soil rutting and erosion, have been identified at both ATV trail areas (Sutton Bluff and Chadwick) and in the general forest.

Monitoring Indicator(s)

Comparison of citations issued; Documentation of resource damage; Public complaints to areas of management activities

Monitoring Frequency

Annual or as received

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2 Provide a Variety of Uses, Values, Products, and Services and to goal 2.8 Recreation Opportunities which states, “Provide a diversity of recreational opportunities and benefits through a variety of settings” and “Contribute to local, regional, and national economies by providing recreational opportunities in a socially and environmentally acceptable manner.” Standards and guidelines for recreation management are found on pages 2-21 through 2-24 of the 2005 Forest Plan.

This question is also tied to 2005 Forest Plan goal 2.1 Public Values “Within the capability of sustainable ecosystems, offer multiple benefits that contribute to the social and economic well-being of local and regional communities by providing a variety of uses, values, products, and services in a cost-effective manner for present and future generations” and “Provide accessibility of the full range of uses, values, products, and services to members of underserved and low-income populations.”

Off-highway vehicles and all-terrain vehicles are extremely popular recreational vehicles and use has increased dramatically over the past several decades. Conflicts with other users, national forest neighbors, and illegal uses are all part of the management of this kind of recreational experience. Monitoring the number of citations issued, public complaints, and resources damaged allows us to make more informed decisions on how best to balance providing this kind of recreational opportunity with the needs and desires of the off-highway vehicle users.

Monitoring Indicator 1

Comparison of citations issued

Results and Discussion

In 2015, there were 60 National Forest System roads and trails and 66 OHV incident reports and violation notices issued which totals 12 percent and 13 percent, respectively, of all incident reports and violation notices.

In 2016, there were 112 National Forest System roads and trails and 36 OHV incident reports and violation notices issued which totals 18 percent and 6 percent, respectively, of all incident reports and violation notices.

“Vehicle off-road” is consistently in the top three to four violations each of the last four to five years. That includes other vehicles besides OHVs but is an indicator that this is a recurring issue on the Mark Twain National Forest.

If there are OHVs, there will be people who ride them in unauthorized or illegal ways. This issue is not one that will ever be completely resolved. We need to continue efforts to educate users and cite unauthorized uses when they occur.

Monitoring Indicator 2

Documentation of resource damage

Results and Discussion

We received funding for a deferred maintenance project for the Ozark Trail in the Hazel Creek Watershed. The project includes reducing deferred maintenance caused by illegal OHV use. There are portions of the trail that are experiencing severe soil erosion and degradation. In late 2020, we noted the trail system needed an operating plan to control the illegal OHV use and correct the damaged trail tread. The area also includes a section of the Trail of Tears in the watershed. The signing has been vandalized and the trails are being used contrary to their management design. The project will include installing non-motorized trail signage, Carsonite posts with regulatory decals, reassurance markers, boulders, bollards and fencing to protect the non-motorized trail experience and to reduce further degradation to the natural and cultural resources in the area. This is a pilot project for the Mark Twain National Forest. We will be monitoring the success and trials of the project to implement on other problem sites.

There is no identified or consistent method to report and document resource damage from unauthorized use of OHVs. Anecdotal reports may or may not be documented and filed. Documentation that any actions were taken because of resource damage is also hard to find. Individual project environmental analyses and decisions may identify damage and propose projects to remediate such damage, but there is no consistent way to keep track of this information.

ATV damage to resources has been identified from:

- Soil rutting and erosion from ATVs off-trail or off-road
- ATVs operating on established firelines or hiking trails
- Soil rutting in wetlands

These issues occur at both ATV trail areas (Sutton Bluff and Chadwick) and in the general forest area. When identified, these issues are addressed by placing boulders or large tree boles in strategic locations to discourage use, mechanical replacement of soil where possible and ecologically sound, signing to educate users, construct gates and fences to discourage use, conduct law enforcement patrols, and trail reconstruction.

We have no illusions about illegal ATV or OHV use in the future. It is impossible to eliminate such use. We will continue to identify problem areas and work to restore the resources and prevent future occurrences.

Monitoring Indicator 3

Public complaints to areas of management activities

Results and Discussion

We receive complaints regarding ATV and OHV use in the Mark Twain National Forest. Complaints are basically of two types – too much ATV use or too little ATV use. Some complaints are there are not

enough places to ride or that ATVs should be allowed off-road. The other type of complaint is from adjacent landowners or non-ATV recreationists that ATVs are being operated where they should not be or that they are disturbing others.

Specific complaints may be investigated or not, depending on the circumstances involved.

Recommendations

Unauthorized OHV use will continue. Conflicts between ATV and OHV riders and other recreation users or neighbors will continue to occur in the future. We will continue to patrol and issue citations as appropriate. We will work to identify and repair any resource damage from ATV and OHV use just as we would for any other source of damage. We will continue to respond to complaints as needed.

Evaluation of Monitoring Question and Indicator(s)

The Forest Patrol Captain prepares an annual law enforcement report for the Mark Twain National Forest. This report details law enforcement activities for the year, including citations given. We do not need to duplicate that effort by repeating those statistics in the monitoring report.

It seems as if the monitoring indicators for this question do not really answer the intent of the question. If we want to identify whether management actions are affecting how or why people illegally use OHVs, then these three indicators are not really answering that question.

More specific and appropriate questions and indicators to consider for future monitoring might be:

- Where and when specifically does unauthorized use occur (hunting season, year-round, old woods roads, temporary roads, and so on)?
- Are we creating unauthorized “user-friendly” trails by our management actions (such as fireline construction, temporary road construction without adequate obliteration)?
- Do our management actions encourage OHV unauthorized use?
- What management actions have we taken to discourage OHV unauthorized use?

Whatever question or indicator is used, we need to ensure there is a system in place to capture that information effectively and store it in a way that it can be found and used to help influence future management decisions.

References

U.S. Department of Agriculture, Forest Service. Law Enforcement Officer reports 2015 and 2016.

5.6 – Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.

Monitoring question 16 addresses required monitoring element 36 CFR 219.12(a)(5)(vi) “Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area” (FSH 1909.12 32.13e).

5.61 - How is the occurrence of mortality across the plan area changing on an annual basis? (File Code 2400)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded mortality has increased roughly 30 percent in less than a decade. Annual mortality increase was precipitated by the 2012 drought; however, losses appear to be stabilizing due to less droughty years recently.

Monitoring Indicator(s)

Acres of mortality

Monitoring Frequency

Annual

Background & Driver(s)

This question is tied to the second part of 2005 Forest Plan goal 2.4 Timber Management, “Respond to disturbance events (storms, wildfires, disease, or insect attacks, etc.) in a timely manner. Salvage damaged forest resources when compatible with management prescriptions.”

The Mark Twain National Forest has always been subject to a wide variety of disturbances which can result in mortality of overstory trees – the very trees that also provide resources for people and the structure for healthy, sustainable forests. Tracking the areas where mortality is occurring helps us plan for effective and efficient response to natural or human-caused events which lead to substantial tree mortality.

Mortality has been identified in several different ways in the past. Before 2000, the primary method of identifying mortality was through field observations conducted on a sporadic schedule as field-going personnel noticed areas of dying trees. Since 2000, mortality has been identified through aerial mapping by Northern Research. Since 2013, they have conducted an annual flight in July or August.

Monitoring Indicator 1

Acres of mortality

Results

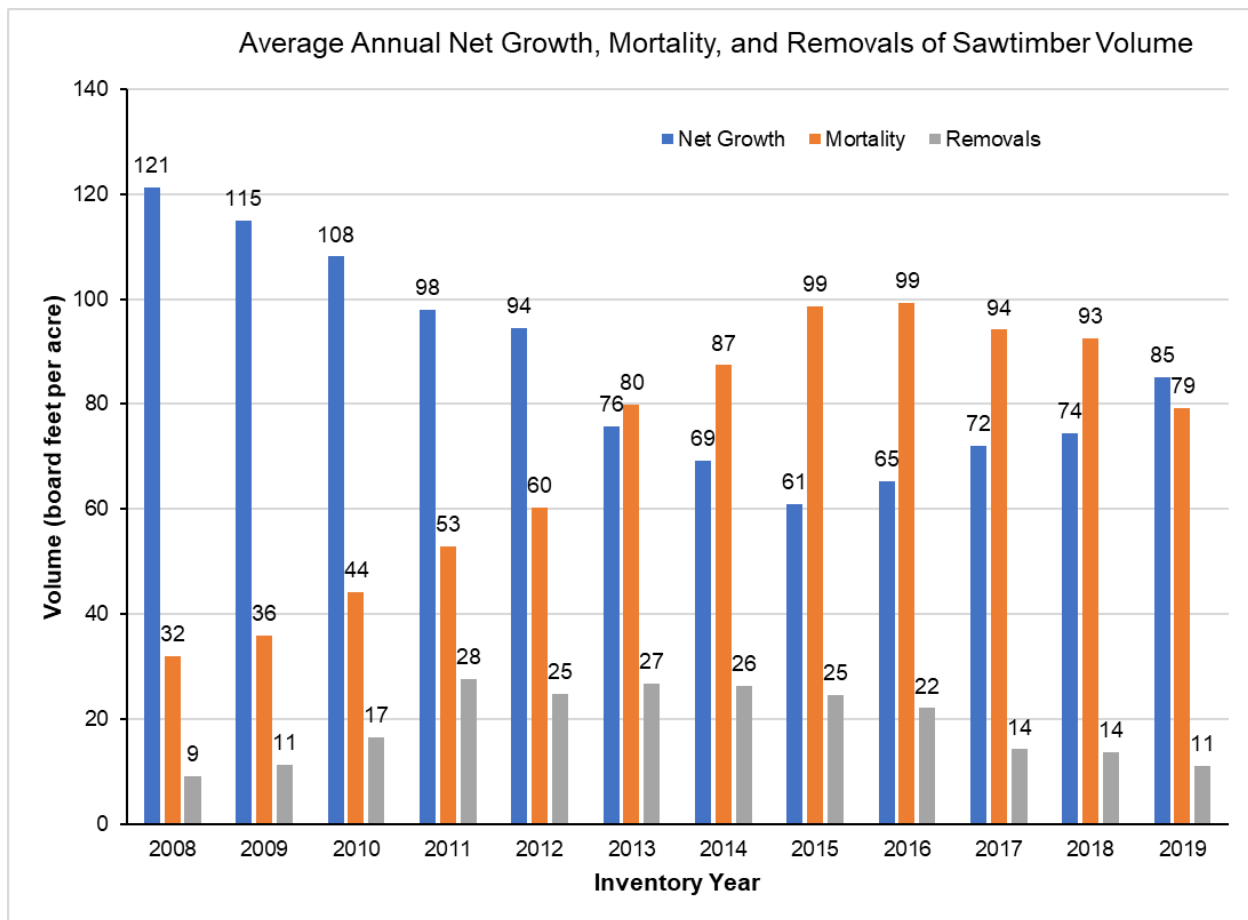


Figure 17. Average Annual Growth, Mortality, Removals in Board Feet Per Acre

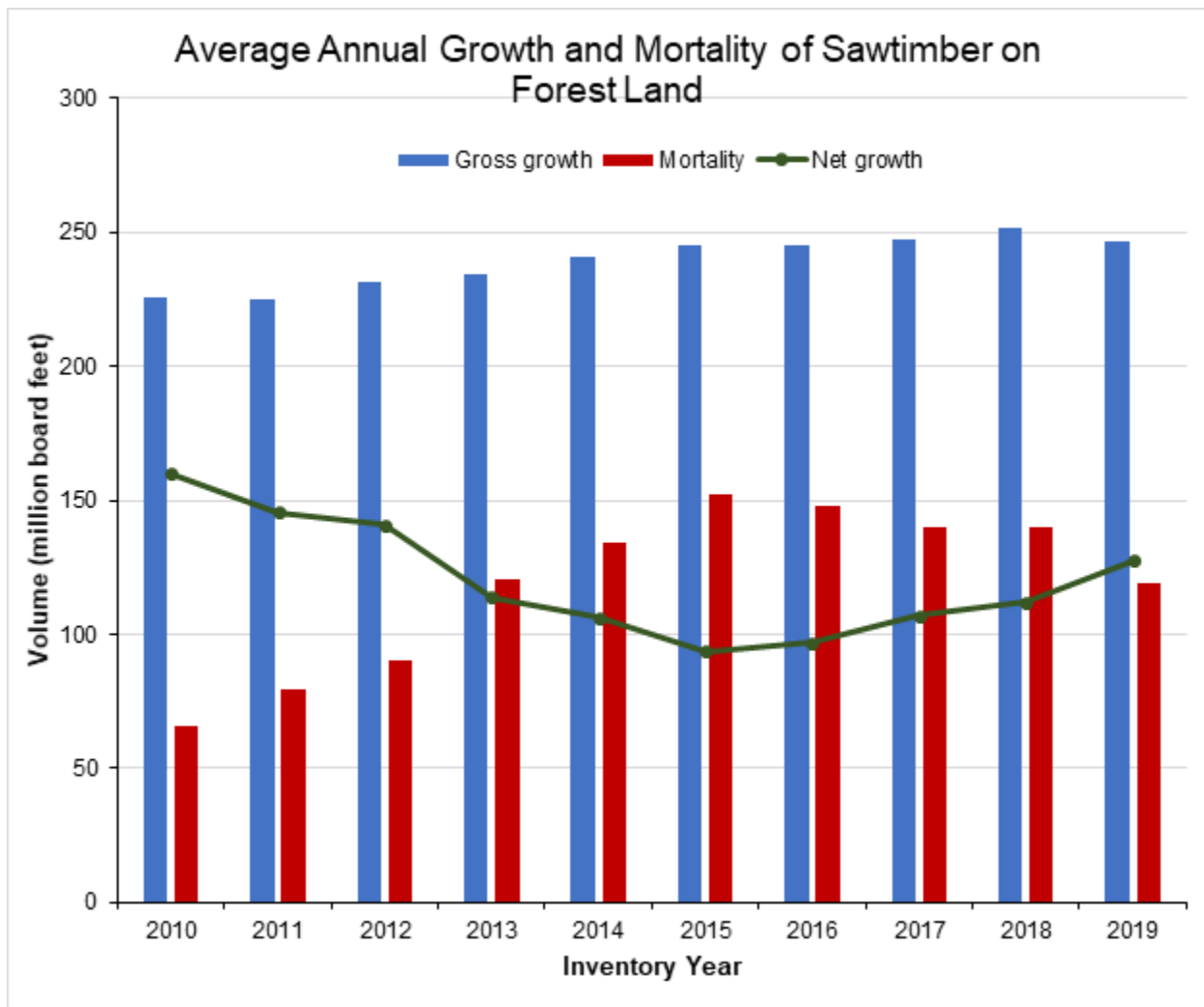


Figure 18. Average Annual Growth and Mortality of Sawtimber on Forestland

Table 28. Average Annual Growth and Mortality of Sawtimber on Forestland data displayed in figure 18

	Gross growth	Mortality	Net growth
2010	226,078,694	66,023,156	160,055,547
2011	224,689,654	79,167,714	145,521,952
2012	231,451,149	90,480,204	140,970,955
2013	234,111,966	120,359,681	113,752,296
2014	240,768,456	134,593,854	106,174,614
2015	245,557,006	151,985,221	93,571,798
2016	245,209,326	148,137,173	97,072,163
2017	247,413,494	140,347,167	107,066,332
2018	251,964,825	139,789,878	112,174,954
2019	246,707,729	119,079,722	127,628,016

Discussion

We have taken steps over the past five years to become more proactive and responsive to the occurrence of mortality. The forest timber output target has increased consistently since 2013 thus capturing more timber volume before mortality occurs.

As the previous graphs show, between 2013 and 2018 mortality outpaced net sawtimber growth. Timber outputs have continued to increase over the past decade to capture mortality and treat the landscape. Mortality has started to decline after a peak in 2015. A positive trend is forming with net growth outpacing mortality within the last data set available in 2019.

This is all translated into an annual average mortality acreage of roughly 5,000 acres a year, with the caveat being almost all mortality at the stand level is limited to 10 percent of the stand, with rare occurrences of the annual mortality occurring within the same stand in successive years.

2016 aerial reconnaissance showed minimal mortality as most of the losses are stabilizing due to less droughty years than in the past.

The Forest Health Initiative Environmental Assessment was completed in 2018 allowing for the treatment of approximately 46,000 acres of forest land with the primary objective of treating oak decline. This project was focused across the Mark Twain National Forest and allows for the removal of trees that have succumbed to mortality.

The Disturbance Recovery Project was completed in 2020. This project allows for the timely implementation of vegetation treatment to forest land that has been affected by a natural disturbance.

Recommendations

Mortality will continue to occur, and we will continue to identify areas affected, re-prioritize project area scheduling, evaluate appropriate resource management responses, and develop additional projects to meet 2005 Forest Plan objectives, including consideration of local needs.

Evaluation of Monitoring Question and Indicator(s)

We will continue to cooperate with Northern Research Station scientists and researchers to conduct field and aerial surveys to identify areas being affected by mortality.

The indicator for this question is acres of mortality occurring. It is also important to distinguish, if possible, what the causes of yearly mortality are, since that information might be critical in how we decide to respond. This is particularly true to ascertain if the mortality is related to climate change or other stressors. Acres of mortality by cause might be a better indicator for this question.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Inventory and Analysis (FIA).

5.7 – Progress toward meeting the desired conditions and objectives in the plan, including providing multiple use opportunities.

Monitoring questions 17 and 18 address required monitoring element 36 CFR 2129.12(a)(5)(vii) “Progress toward meeting the desired conditions and objectives in the plan, including providing multiple use opportunities” (FSH 1909.12 32.13f).

5.71 - How close are projected outputs and services to actual? (File Code 2400)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded we should maintain around a 44 million board foot program in sawtimber given current markets and funding. If markets develop for small round wood, then we could sustain a higher target. There is a decline in acres cut and sold starting in 2016 even though the volume is increasing. This is due to the amount of oak decline harvested stands with a higher volume per acre than in the previous years (FACTS data).

Monitoring Indicator(s)

Timber volume sold; acres harvested; product mix

Monitoring Frequency

Annual

Background & Driver(s)

This question is tied to 2005 Forest Plan goal 2 “Provide a Variety of Uses, Values, Products, and Services” and to the first part of goal 2.4 Timber Management; “Use timber management, where appropriate, to restore or enhance degraded natural communities, sustain healthy and productive forests, and reduce hazardous fuels to reach the desired condition on the forest.” It is also tied to the 2005 Forest Plan guideline which states, “Use silvicultural systems, harvest methods, and intermediate treatments to move the forest towards the desired condition.”

The Mark Twain National Forest is the largest public forest acreage in Missouri and is disproportionately represented in those southern counties where timber is a larger part of the economy. The amount of timber provided by the Mark Twain National Forest is an important factor in the sustainability of local businesses. The indicator volume sold indicates how effective we are at contributing to that local economy. Volume sold is determined by contract volume awarded to purchasers, not just advertised for sale. No Bid sales are not counted towards actual accomplishment.

The 2005 Forest Plan emphasizes restoration and maintenance of sustainable and healthy natural communities. Timber harvest is a vital method to affect structure and composition of natural communities and is like natural disturbances of wind, insect and disease, ice, fire, and so on that would have altered structure and composition in the past. The indicator - acres harvested, - therefore, is an indication of whether we are moving toward achievement of those desired conditions stated in the 2005 Forest Plan. Acres harvested are determined by reported sale closures and tracked within the corporate data warehouse (CDW).

Product mix is important both to the local economy and to the achievement of the 2005 Forest Plan desired conditions. While local markets have long favored sawtimber, removal of small roundwood is vital to meeting structural objectives and creating conditions favorable for increased diversity. The product mix is identified by species and product codes on completed sales recorded in CDW.

Monitoring Indicator 1

Timber volume sold (1,000 board feet (MBF)) (100 cubic feet (CCF))

Results

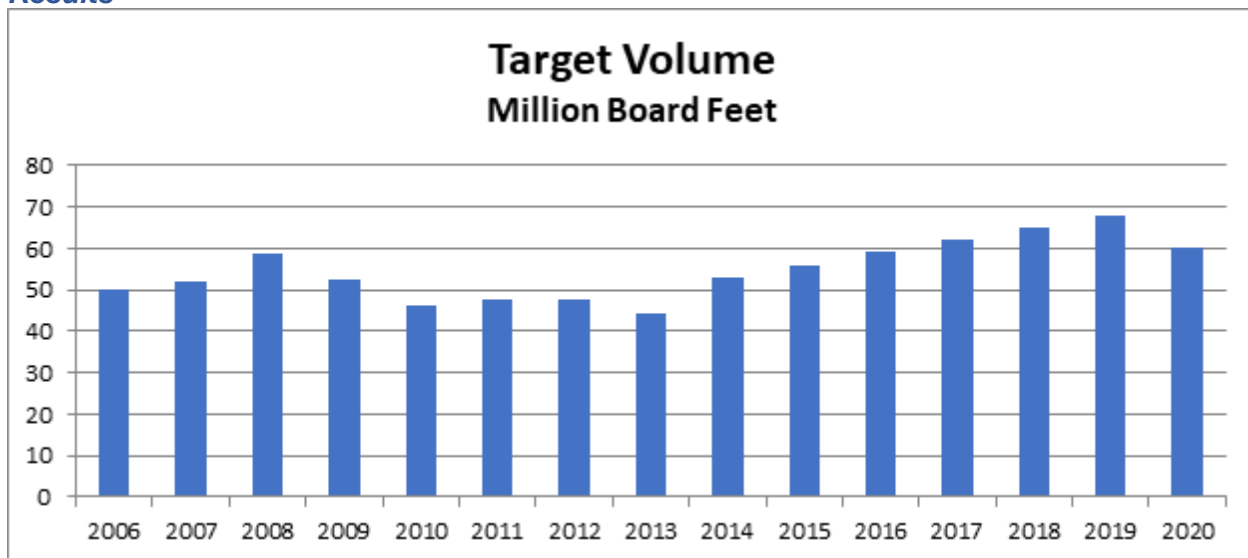


Figure 19. Target Volume in Million Board Feet (MMBF)

This is the target assigned by the Regional Office to the Mark Twain National Forest. The quantity of timber sold by product type is in the figures below.

Discussion

The volume sold target during this period has varied but has not been directly correlated with the funding. According to the 2005 Forest Plan, for the first decade (2006-2015) we should have maintained around a 44 million board foot program in sawtimber given markets and funding. Beginning in the second decade (2016), we can increase sawtimber to around a 49 million board foot program as market demand increases. If markets develop for small roundwood, then we could sustain a higher target.

Monitoring Indicator 2

Acres harvested

Results

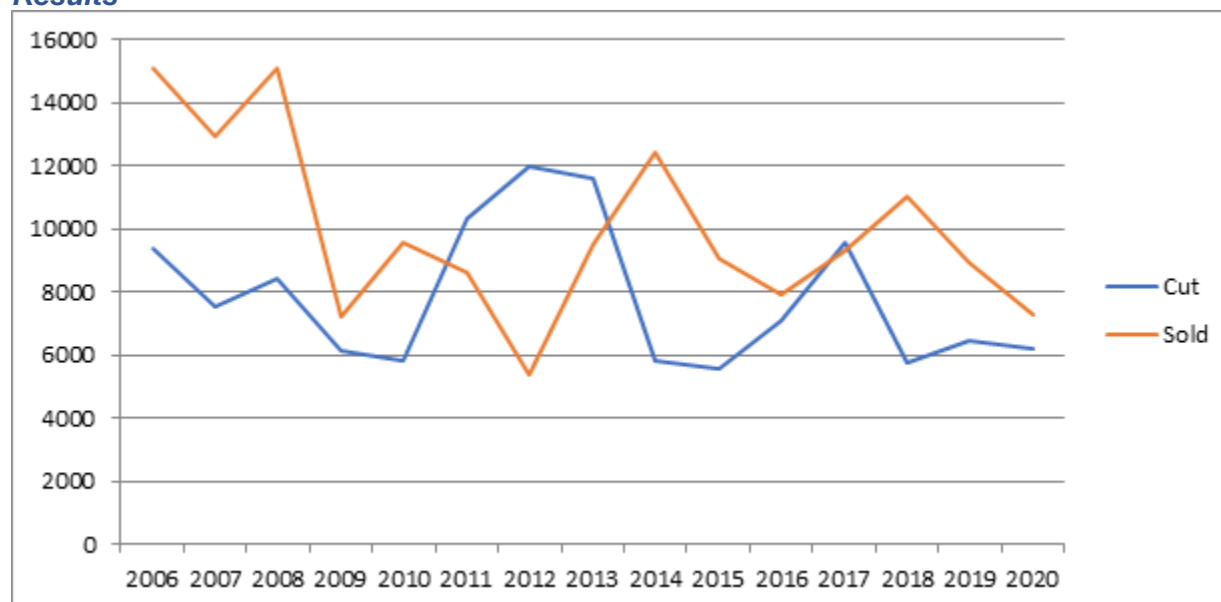


Figure 20. Acres Harvested

Discussion

Acres of timber harvest acres sold and cut each year tend to follow the same trend as volumes. There is some variation year to year due to types of harvest methods, weather impact on harvest operability, and market demand. There is an overall decline in acres cut and sold even though the volume is increasing. This is due to the amount of oak decline harvested stands with a higher volume per acre than in the previous years (FACTS data).

Monitoring Indicator 3

Product mix

Results

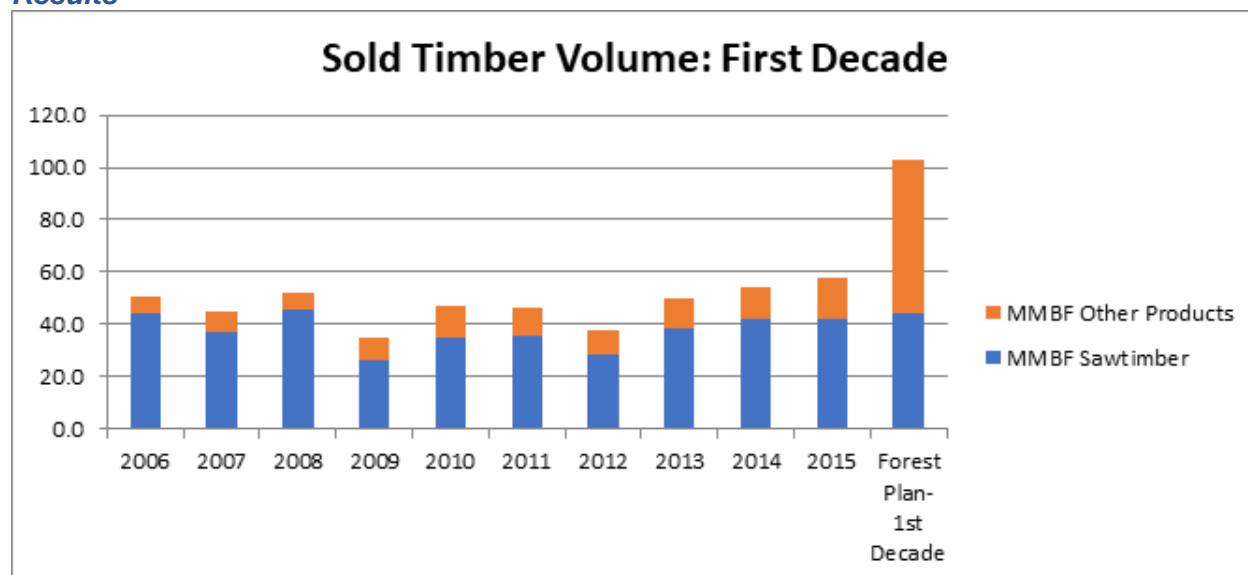


Figure 21. Timber Sold in First Decade of 2005 Forest Plan

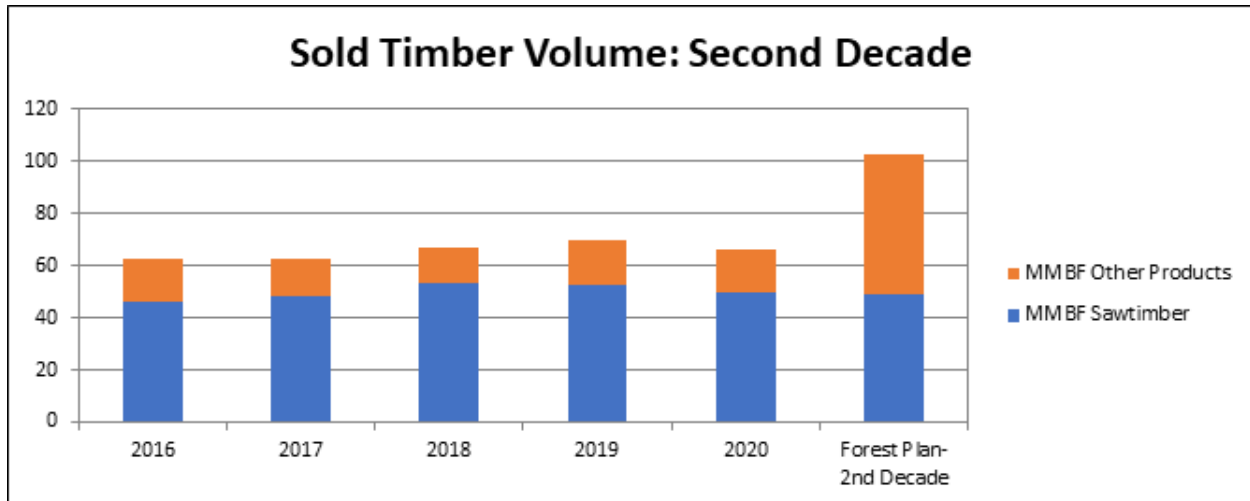


Figure 22. Timber Sold in Second Decade of 2005 Forest Plan

Discussion

We have not come close to selling the amount of small roundwood that was projected in the 2005 Forest Plan. Only a small percentage of the small diameter roundwood is being utilized by purchasers. This small material is considered merchantable but due to the lack of widespread markets, much of the material remains unused at this time. We continue to work with industry to try to develop markets.

The level of sawtimber has remained generally stable at the upper end of the allowable sale quantity in the second decade of the forest plan. If market demand continues to be high for sawtimber products a consistent level of volume will be offered for sale in the future.

Recommendations

Increasing roundwood production is not economically viable without a major change in market demand. Most current production is generally sold at minimum rates, so any price reduction will not affect demand.

We need to track and proceed with the allowable sale quantity (ASQ) for sawtimber without exceeding that limit by more than 10 percent in any given year. The argument that any previous year's volume when sawtimber ASQ was not attained would allow for exceeding ASQ in future years ignores the mortality issue described above. Total growing stock on suitable acres is not cumulative.

Acres harvested is largely driven by targets and funding, and as such is stable at around 10,000 acres per year.

Evaluation of Monitoring Question and Indicator(s)

This question includes only timber indicators, when the goal it is tied to asks more generally about providing multiple use opportunities. We need to consider including other outputs and services provided as indicators for this question.

References

U.S. Department of Agriculture, Forest Service. Timber Sale Accounting system reports.

5.72 - What progress has been made towards meeting objectives in the plan? (File Code 1900)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded a more robust geographic information system analysis, by community type, within each subsection, to track progress on number of treated acres is needed to evaluate restoration of terrestrial natural communities (goal 1.1).

For goal 1.2, we have surpassed the 10-year objective of treating 2,000-acres of non-native invasive species, however treatment does not necessarily equal control or eradication. We must remain aggressive in the identification and treatment of non-native invasive species.

For goal 1.3, we have only achieved about 4.5-miles of stream stabilization of the 10-mile objective. We need to survey streams to determine stream stabilization work needed. We have likely surpassed the 10-year objective of restoring 125-acres of bottomland hardwood forest, however the reporting metrics don't lend themselves to clear identification of bottomland hardwood forest restoration. We have only achieved 1-mile of the 3-mile objective for 100 to 300 pieces of large woody material per stream mile. We need to survey streams to determine large woody material work needed. We also need to determine if 100 to 300 pieces per stream mile is an appropriate measure. We have achieved approximately 688-acres of the 900-acre goal for wetland management.

For goal 1.4, we have achieved approximately 3,000-acres per year since 2005 of improvement of open woodland. This far exceeds the objective of 10,500-acres, however a single treatment may not meet the structural and composition characteristics needed for habitat of the species listed in the objective. We have reached approximately 90 percent of the Mark Twain National Forest in forest, closed woodland, or open woodland, which exceeds the 85 percent objective. Approximately 5,282-acres of glade habitat was treated, which exceeds the objective of 4,000-acres. We have designated approximately 8.7 percent old growth in management prescription 2.1, 11 percent in management prescription 6.1, and 10 percent in management prescription 6.2. We need to continue designating old growth in management prescription 6.1 to achieve the objective 15 percent.

For goal 2.2, we have not made any progress toward meeting the objective of growing season and fall prescribed burns. We need to decide whether to change this objective or plan to implement it. We also have not met the objective of prescribed burning 45,000-acres per year. This objective may need changed.

Monitoring Indicator(s)

Quantitative objectives from Chapter 1 of the 2005 Forest Plan

1. Objective 1.1a: Table 1-1 (Restoration objectives for Mgmt Prescription 1.1)
2. Objective 1.1b: Table 1-2 (Restoration objectives for Mgmt Prescription 1.2)
3. Objective 1.2a: Control a minimum of 2,000 acres of existing noxious or non-native invasive species over the plan period.
4. Objective 1.3a: Stabilize 10 miles or more of stream reaches.
5. Objective 1.3b: Restore or enhance 125 acres of bottomland hardwood forest.
6. Objective 1.3c: Increase loading in 3 miles or more in a stream or river to 100 to 300 pieces of large woody material (LWM) per stream mile.
7. Objective 1.3d: Protect and improve 900 acres of wetlands.
8. Objective 1.4a: Improve open woodland habitat conditions on at least 10,500 acres to provide habitat for summer tanager, northern bobwhite, Bachman's sparrow, and eastern red bat.
9. Objective 1.4b: Increase the proportion of managed native grasslands to that of exotic cool season grasses from the current 46% native grass (in 2005) to 55% native grass to provide habitat for northern bobwhite.

10. Objective 1.4c: Maintain forest, closed woodland or open woodland cover over 85% or greater of Mark Twain National Forest acres to provide habitat for worm-eating warbler.
11. Objective 1.4d: Treat at least 4,000 acres of glades to reduce woody vegetation to provide habitat for Bachman's sparrow.
12. Objective 1.4e: Designate permanent old growth on 8% to 12% of each 2.1 and 6.2 management area, and on 15%-20% of each 6.1 management area.
13. Objective 2.2a: Prescribe burning up to 20% of total projected burn acres from May through September and prescribe burning up to 40% of total projected burn acres from September through December.
14. Objective 2.2b: Use prescribed fire to reduce hazardous fuels and improve Fire Regime Condition Class on 45,000 acres or more per year.

Monitoring Frequency

These objectives were to be accomplished over the life of the 2005 Forest Plan and are used as indicators to see how we are progressing.

Background & Driver(s)

Several of these objectives overlap with other resource-specific questions (non-native invasive species, watershed, wildlife, fire management).

This question is tied to 2005 Forest Plan goal 1 "Promote Ecosystem Health and Sustainability" and goal 2 "Provide a Variety of Uses, Values, Products, and Services." It is also tied to the more specific goals for terrestrial natural communities, watershed, wildlife, and prescribed fire.

The rationale for the selection of these "Monitoring Indicators" is simply that these were objectives set forth in chapter 1 of the 2005 Forest Plan.

Monitoring Indicator 1

Objective 1.1a: Table 1-1 (Restoration objectives for Mgmt Prescription 1.1) (USDA Forest Service 2005, p. 1-2)

Table 29. Replica of Table 1-1 from 2005 Forest Plan of desired percentage of NFS lands treated to restore natural community types in Management Prescription 1.1 areas

Subsection	Savanna	Open woodland	Closed woodland	Upland Forest	Ozark Fen	Glade
Current River Hills	0-1%	6-7%	9-10%	0-4%	683 ac (9 areas)	13 ac
Meramec River Hills	0-1%	3-4%	5-6%	0-2%	0	5 ac
Black River Ozark Border	1-18%	13-26%	10-20%	0-3%	0	<1 ac
Central Plateau	1-8%	3-4%	14-19%	0-6%	0	7 ac
White River Hills	4%	15-17%	11-12%	0-6%	0	15-17%
St. Francis Knobs and Basins	0-2%	13-17%	15-20%	0-16%	0	140 ac
Gasconade River Hills	3-5%	9-17%	4-8%	0-1%	15 ac (1 area)	10 ac
Claypan Till Plains	0-1%	0-1%	7-25%	0-30%	0	<1 ac

Results and Discussion

47,626 acres of restoration activities were implemented in 2015 through 2016 in management area 1.1.

Table 30. NFS lands treated to restore natural community types in Management Prescription 1.1 areas

Subsection	Total Acres Treated in MP 1.1	Savanna	Open woodland	Closed woodland	Upland Forest	Ozark Fen	Glade
Current River Hills target acres	36,057-50,854	0-1%	6-7%	9-10%	0-4%	683 ac (9 areas)	13 ac
Treated Acres	26,281 (Riparian 418 ac)	418	20,399	4,350	108	0	5
Meramec River Hills Target Acres	1,487- 2,238	0-1%	3-4%	5-6%	0-2%	0	5 ac
Treated Acres	0						
Black River Ozark Border Target Acres	3,693-13,710	1-18%	13-26%	10-20%	0-3%	0	<1 ac

Subsection	Total Acres Treated in MP 1.1	Savanna	Open woodland	Closed woodland	Upland Forest	Ozark Fen	Glade
Treated Acres	3,395 (63 ac Riparian)	684	2,224	425	0	0	0
Central Plateau Target Acres	5,770-8,463	1-8%	3-4%	14-19%	0-6%	0	7 ac
Treated Acres	4,957	418	409	4,113	1	1	111
White River Hills Target Acres	20,454-31,893	4%	15-17%	11-12%	0-6%	0	15-17%
Treated Acres	9,860 (280 ac riparian)	0		8,061	7,622	0	1,958
St. Francis Knobs and Basins Target Acres	1,849- 3,270	0-2%	13-17%	15-20%	0-16%	0	140 ac
Treated Acres	0						
Gasconade River Hills Target Acres	3,152- 5,524	3-5%	9-17%	4-8%	0-1%	15 ac (1 area)	10 ac
Treated Acres	3,141	43	890	2,054	106		8
Claypan Till Plains Target Acres	50- 560	0-1%	0-1%	7-25%	0-30%	0	<1 ac
Treated Acres	0						

Recommendations

Completing this table by determining the treated acres for the life of the 2005 Forest Plan, if possible, is a project which should be undertaken sometime in the next year or two, certainly before work begins on the next Forest Plan revision. Perhaps a more robust geographic information system analysis. This is currently an unwieldy exercise to calculate.

Evaluation of Monitoring Question and Indicator(s)

This table is a foundation of the 2005 Forest Plan, but unless a better way is found to determine how well we are achieving it, we should evaluate whether there is a better method of monitoring our work in ecological subsections. Importantly, we can track what we've achieved much better than we can calculate what the original target acres were.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 2

Objective 1.1b: Table 1-2 (Restoration objectives for Mgmt Prescription 1.2) (USDA Forest Service 2005, p. 1-2)

Table 31. Replica of Table 1-1 from 2005 Forest Plan of desired percentage of NFS lands treated to restore natural community types in Management Prescription 1.2 areas

Subsection	Savanna	Open woodland	Closed woodland	Upland Forest	Ozark Fen	Glade
Meramec River Hills	0-4%	4-6%	3-5%	0-1%	0	5 ac
Central Plateau	0-1%	0-1%	3-7%	0-28%	0	5 ac
White River Hills	4-5%	19-21%	14-15%	6-7%	0	19-21%
St. Francis Knobs and Basins	0%	5-6%	9-11%	11-15%	0	100 ac
Gasconade River Hills	3-5%	4-8%	1-3%	0-1%	191 ac (1 area)	9 ac

Results and Discussion

Table 32. NFS lands treated to restore natural community types in Management Prescription 1.2 areas for 2015 through 2016

Subsection	Total Acres Treated on MTNF in MP 1.2	Savanna	Open woodland	Closed woodland	Upland Forest	Ozark Fen	Glade
Meramec River Hills		0-4%	4-6%	3-5%	0-1%	0	5 ac
Treated Acres							
Central Plateau		0-1%	0-1%	3-7%	0-28%	0	5 ac
Treated Acres	5		5				
White River Hills		4-5%	19-21%	14-15%	6-7%	0	19-21%
Treated Acres	1,095 12 ac Riparian			437			646
St. Francis Knobs and Basins		0%	5-6%	9-11%	11-15%	0	100 ac
Treated Acres							
Gasconade River Hills		3-5%	4-8%	1-3%	0-1%	191 ac (1 area)	9 ac
Treated Acres							

Recommendations

Completing this table by determining the achieved acres over the life of the 2005 Forest Plan is a project which should be undertaken sometime in the next year or two, certainly before work begins on the next Forest Plan revision. Perhaps a more robust geographic information system analysis, by community type within each subsection, would help track progress on these numbers. This is currently an unwieldy exercise to calculate currently.

Evaluation of Monitoring Question and Indicator(s)

This table is a foundation of the 2005 Forest Plan, but unless a better way is found to report how well we are achieving it, we should evaluate whether there is a better method of measuring our work towards natural community restoration. Importantly, we can track what we've achieved much better than we can calculate what the original target acres were.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

Monitoring Indicator 3

Objective 1.2a: Control a minimum of 2,000 acres of existing noxious or non-native invasive species over the plan period (USDA Forest Service 2005, p. 1-3)

Non-native invasive species (NNIS) include terrestrial and aquatic plants and animals. Infestations of NNIS increasingly threaten the integrity of the ecosystems and biodiversity in the Mark Twain National Forest. Of particular concern are those species successful at invading natural habitats.

There are 33 species of NNIS (32 plants and 1 animal) known to exist in the Mark Twain National Forest. There are 1,966 individual mapped and inventoried invasive plant infestations, totaling 32,438 acres. Throughout the Mark Twain National Forest, NNIS plants are most abundant in regularly disturbed areas such as roadsides, grazing allotments and old fields.

Since 2017, an additional 5,569 acres of infestations of invasive plants were inventoried and mapped. *Sericea lespedeza* (*Lespedeza cuneata*) continues to be the most prolific invasive plant in the Mark Twain National Forest. Nine new species infestations have been mapped since 2016. Most new infestations continue to be along roadsides or disturbed open lands. However, more infestations are being inventoried within interior portions of the Mark Twain National Forest, away from roads and disturbed area. Shade tolerant species such as privet, princess tree, bush honeysuckle, and autumn olive are being found in forest and woodland understories.

Results

Invasive plant treatments total 59,749 acres from 2017 to 2020. Most treatments are pesticide treatments, especially along roadsides and open fields. We take an integrated approach, utilizing a combination of mechanical and chemical treatments, to control invasive plant species. We are also beginning to utilize goats in our integrated approach in some areas. We have two administrative studies that look at using a combination of goats and prescribed fire to evaluate the effectiveness of this combination of treatments.

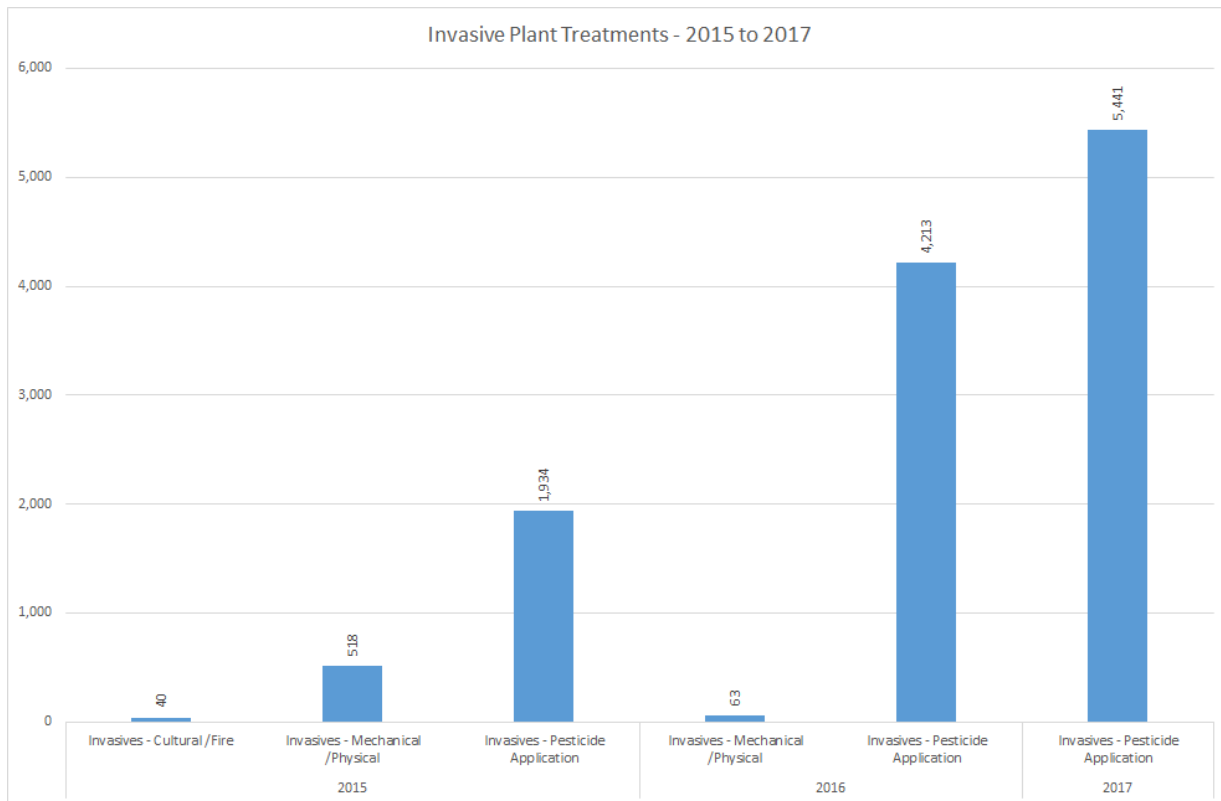


Figure 23. Non-Native Invasive Plant Treatments 2015 to 2017

Obviously, we have surpassed the 2005 Forest Plan 10-year objective of treating 2,000 acres of non-native invasive species. However, it is also clear that treatment does not necessarily equal control or eradication; so, we must remain aggressive in the identification and treatment of these species.

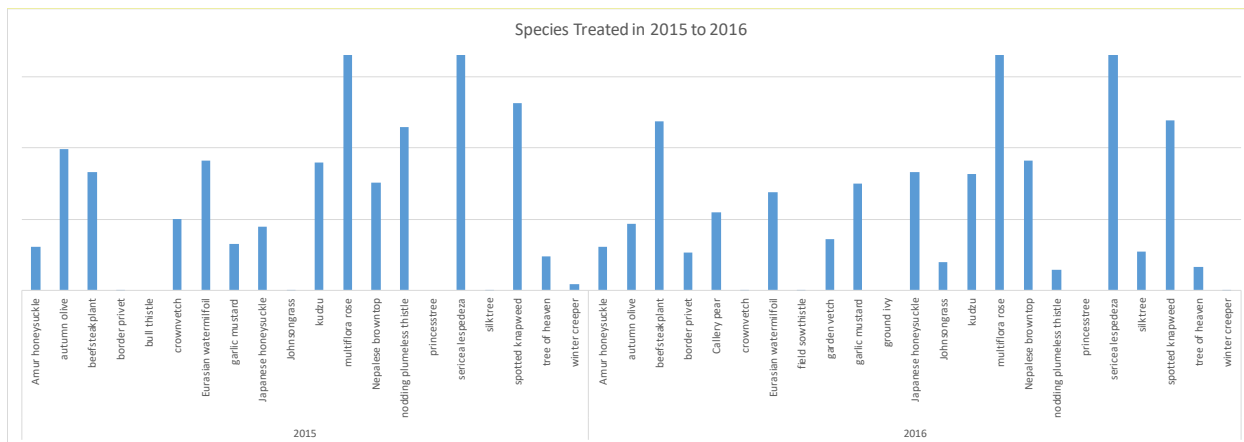


Figure 24. Species treated in FY 2015 & FY 2016

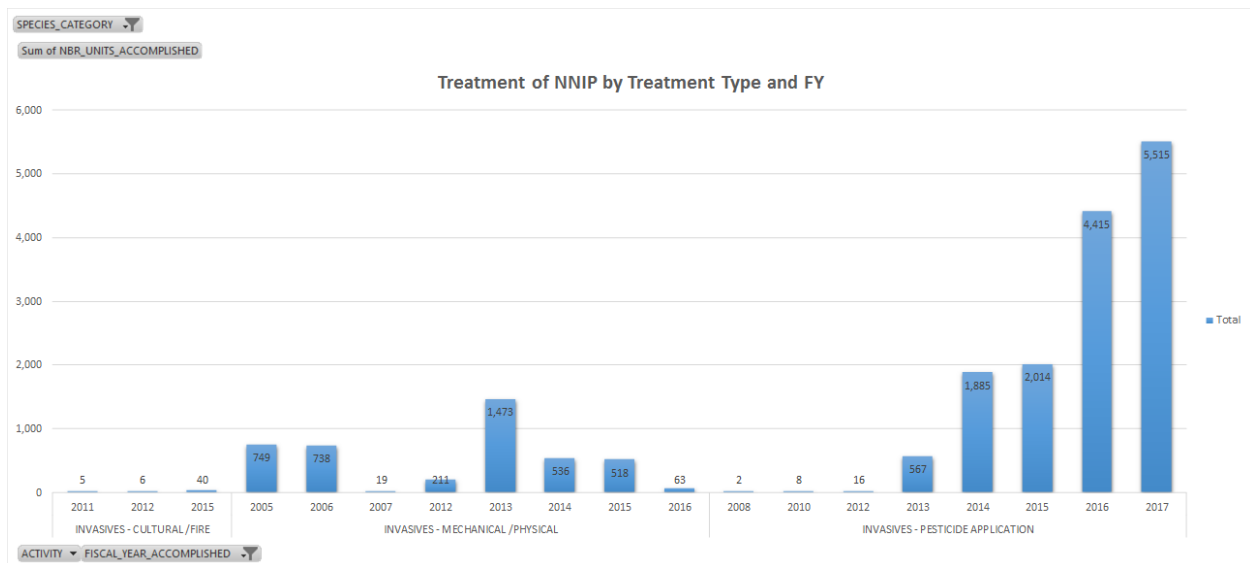


Figure 25. Treatment on Non-native Invasive Plants by type of treatment and Fiscal Year

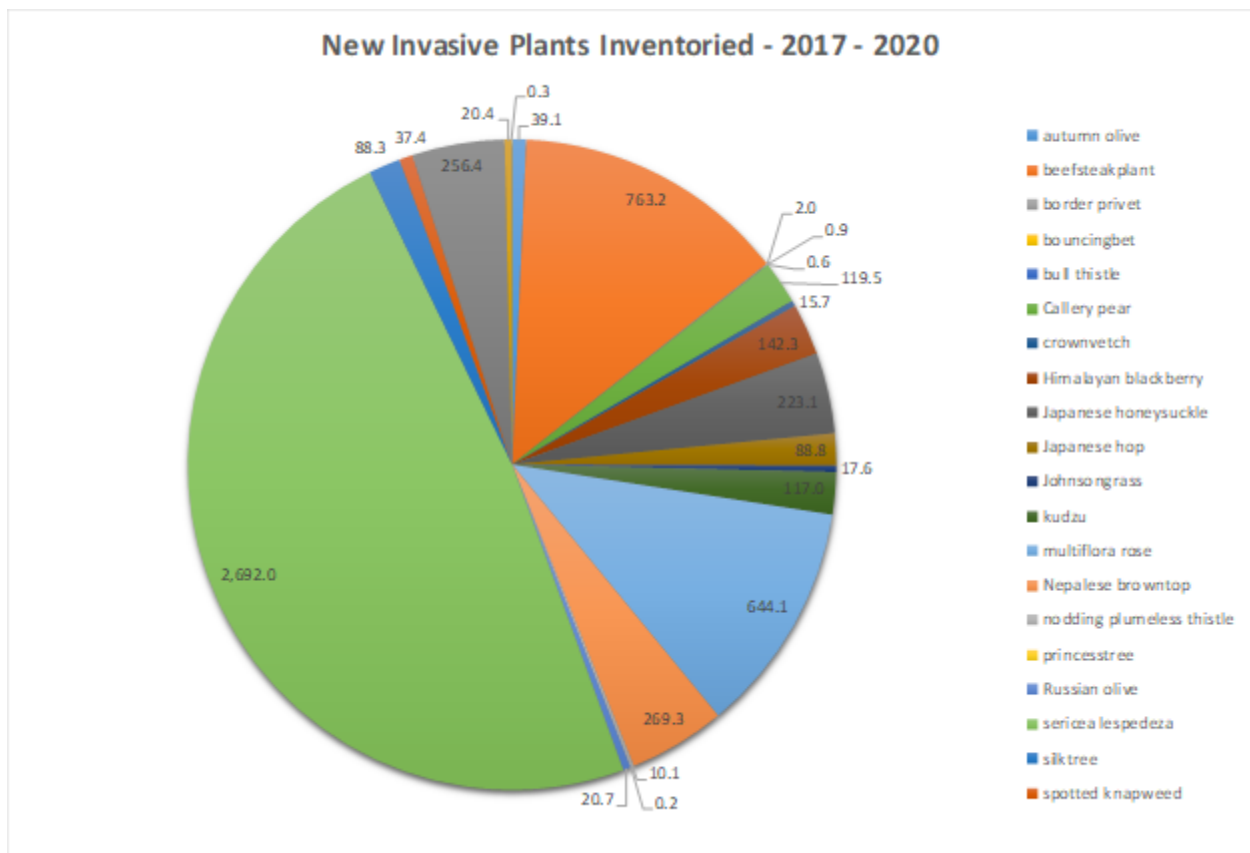


Figure 26. New Invasive Plants Inventoried 2017-2020

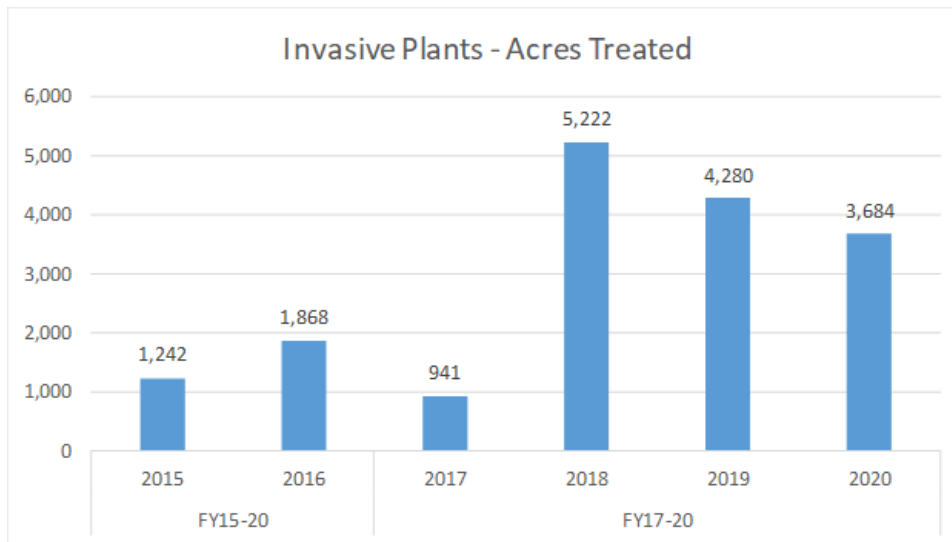


Figure 27. Invasive Plants Acres Treated

Discussion

As was indicated in the 2011-2012 Monitoring Report, we had treated over 2,000 acres by 2012, which exceeded the non-native invasive species control objective of the 2005 Forest Plan. Acres treated annually continues to increase. From 2006 through 2016, we have treated 23,787 acres of non-native invasive species sites. However, the report also clarified that “control” and “eradication” are two separate goals. While we have been relatively successful at “control”, we would prefer to accomplish a minimum of 2,000 acres of “eradication” or actual reduction of the number of acres of NNIS infestation. This has not yet been achieved in 2016.

The most-treated species is *Sericea lespedeza*, and that is likely to continue to be the case. However, three other species are considered the highest priority for treatment wherever they are discovered – Asian honeysuckle, (*Lonicera morrowii* and *L. maackii*), Japanese stiltgrass (*Microstegium vimineum*), and Spotted knapweed (*Centaurea stoebe micranthos*).

In February 2012, the Forest Supervisor signed a record of decision approving the use of certain chemical and biological non-native invasive species treatments in the Mark Twain National Forest. As the results section shows, these treatments have been applied on 74,145 acres from 2013 through 2020.

In addition, the 2012 record of decision included the decision to implement a method to evaluate and monitor the effectiveness of non-native invasive species treatments. Over the past five years, various control methods have been evaluated for efficacy. Each method has benefits and challenges, and the conclusion drawn so far is that varying treatments over a period of several years is more effective than using any treatment repeatedly.

Recommendations

We need to continue with aggressive identification and treatment of non-native invasive species infestations with the objective of reducing the number of areas and extent of those infestations. All treatment methods should be considered, and the most effective and appropriate method applied in each specific situation. We should also continue to search out new treatments and technologies to assist in the control of these species.

Evaluation of Monitoring Question and Indicator(s)

Monitoring and evaluation in accordance with the 2012 record of decision should be gathered and compiled into a single document that summarizes this effort. We should use this document to recommend any changes to the objective for non-native invasive species.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 4

Objective 1.3a: Stabilize 10 miles or more of stream reaches (USDA Forest Service 2005, p. 1-3)

Goal 1.3 includes several items regarding stream integrity, including “Maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the riparian corridor” and “Maintain streams in normal function within natural ranges of flow, sediment movement, temperature, and other variables.”

Stable stream reaches are an indicator of healthy functioning of the stream itself within the riparian corridor. This indicator helps us show progress toward normal stream functioning.

Results and Discussion

The Mark Twain National Forest System lands has very limited perennial streams, most of the bottomland areas are in private ownership. Currently there is no monitoring data collected in the Mark Twain National Forest to determine if stream reaches are stable. Very few projects are proposed, and currently proposed projects are a result of priority watershed work, stream crossing replacements due to safety concerns, or is located within the analysis area for larger landscape-scale projects. The only stream project for 2015 and 2016 was the North Fork Large Woody Material project. Funding for this project was allocated in 2016, but the project continued into 2017. This project affected one-mile of North Fork River (see section 5.09, Monitoring Indicator 1 for previously discussed details of this project).

Since 2006, there have been a few stream stabilization projects in the Mark Twain National Forest; aquatic organism passage crossings at Sutton Bluff and Swiney Creek, and two bridge replacements in Washington County. Total stream miles stabilized with these projects is only about 3.5 miles. We are not on target to meet this objective. These types of projects are very expensive for the relatively small accomplishment that can be claimed. It is difficult to argue successfully for funding when there are other projects that are deemed higher priority and staff is limited. Many times, these projects do not fall within a larger project area, so individual environmental analysis is required. This takes time, personnel, and funding to accomplish and often requires expertise that we must acquire from outside the Mark Twain National Forest, taking additional time and funds to complete. These projects take specialized experience in design that is not readily available within or to the Forest Service.

Recommendations

We need to survey stream reaches to determine if there are streams in need of stabilization work. Most often these sections of stream are outside of the larger landscape-scale project areas. Currently, stream stabilization projects are identified during the larger landscape-scale project area assessments, to minimize costs and time for analysis. However, most of this work is in uplands areas away from the major streams. We should continue to work with other agency and non-government organization hydrologists and biologists to identify and procure professional expertise and funding sources for these projects.

Evaluation of Monitoring Question and Indicator(s)

We need to address why we are not on target for this objective, whether we have a plan to meet this objective, and if it remains reasonable for the current 2005 Forest Plan or upon Forest Plan revision.

Monitoring Indicator 5

Objective 1.3b: Restore or enhance 125 acres of bottomland hardwood forest (USDA Forest Service 2005, p. 1-3)

Goal 1.3 includes several items regarding the health of terrestrial communities associated with the riparian corridor: “Maintain healthy, sustainable, and diverse natural communities”; and “Maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the riparian corridor.”

Bottomland hardwood forest is part of the riparian corridor and is one of the natural communities that has been reduced greatly as people settled the Ozarks and cleared the flat bottoms for agriculture and to supply wood products. Restoring bottomland hardwood forests to streamside and riparian corridors will help achieve the goals of protecting soil and water quality, the integrity of watersheds, and allowing the natural functions of the riparian corridor to occur.

Results and Discussion

This metric does not lend itself to specifically be identified either by cross referencing Forest Type (79 – Bottomland Hardwood) or Land Suitability Class (812 old growth or 600 wildlife) with activities reported. These stands are not identified as such across the landscape, except for old growth, which is not normally available for management.

In 2015 and 2016, 2,240 acres of riparian area were treated with prescribed fire, treated for invasive plants, and mechanical removal of biomass (chainsaw). This is considerably more than the 2005 Forest Plan objective of 125 acres, but it is likely that only a portion of the treated riparian acres are in bottomland hardwood forest types. However, it is obvious that we have moved substantially toward meeting this 2005 Forest Plan objective.

Recommendations

This objective should be reviewed to determine if it can be refined during Forest Plan revision.

Evaluation of Monitoring Question and Indicator(s)

If this is a monitoring indicator that we want to use in the future, there needs to be a more specific effort to track treatments in these areas. Either with the data that is currently available, or with a new dataset specifically set up to monitor this indicator.

References

U.S. Department of Agriculture, Forest Service. Mark Twain National Forest Geographic Information System (GIS) layers.

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 6

Objective 1.3c: Increase loading in 3 miles or more in a stream or river to 100 to 300 pieces of large woody material (LWM) per stream mile (USDA Forest Service 2005, p. 1-3)

Goal 1.3 includes several items regarding stream integrity, including “Maintain, restore, and enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the riparian corridor” and “Maintain streams in normal function within natural ranges of flow, sediment movement, temperature, and other variables.”

Large woody material in a stream is an indication that natural processes are occurring in the terrestrial portion of the riparian corridor (trees dying and falling into the stream) and those processes are being integrated with the aquatic portion of the riparian corridor. Large woody material provides important habitat for aquatic species. In addition, it becomes a structural component of the stream bank and stream bed which contributes to stream morphology, and can both protect against scouring and cause scouring - processes that occur as part of a healthy, functioning stream system.

Results and Discussion

The only stream project for 2015 and 2016 was the North Fork large woody material project. Funding for this project was allocated in 2016, but the project continued into 2017. This project affected one-mile of North Fork River (see section 5.27 Monitoring Indicator 1 for previously discussed details of this project).

Preliminary results from Missouri State University indicate the large wood within the channel increased. 101 large wood debris pieces with 4 to 25 pieces per 100-meters was inventoried pre-flood. Post-flood April 2017, 210 large wood debris pieces with 4 to 55 pieces per 100-meters was recorded.

We are not on target to meet this objective. There are two more projects planned to add large wood into the channel. The Barney Creek project is planned for December 2018 and the Mill Creek Large Wood project has completed NEPA in September 2018 with no planned construction schedule yet.

Recommendations

In 10-years, we have only accomplished one project (for 1/3 of the objective) for this indicator. Surveys are needed to determine if there are more streams in need of large woody debris structures. This objective has the same issues as implementing stream stabilization projects (see section 5.72, Monitoring Indicator 4). After surveys and analysis completed, we need to determine if 100 to 300 pieces per stream mile is an appropriate measure.

Evaluation of Monitoring Question and Indicator(s)

We should continue to collect and analyze data and use the best available scientific information to consider determining if this 2005 Forest Plan objective it is still useful for moving towards desired future conditions.

References

Missouri State University Inventory.

Monitoring Indicator 7

Objective 1.3d: Protect and improve 900 acres of wetlands (USDA Forest Service 2005, p. 1-3)

Goal 1.3 states “Prevent wetland degradation and loss and restore and enhance wetlands when possible.”

There are several different kinds of wetlands in the Mark Twain National Forest, but most are small and scattered across the landscape, providing a niche for unique species. This objective was included to show that we are working to maintain wetlands as part of the entire ecological system in a cohesive, functioning whole.

Results and Discussion

No new acres of wetland have been identified and mapped in the Mark Twain National Forest. Several large wetlands, such as Grasshopper Hollow Fen, Barton Fen, and Kaintuck Fen have been included in prescribed fires to maintain herbaceous species and control invading woody species. Several sinkhole ponds are designated state natural areas (such as Cupola Pond, Tupelo Gum Pond, Marg Pond, and Brushy Pond).

In 2015, 688 acres of wetlands were treated, including Barton Fen which was included in a prescribed fire. No acres of wetland were treated in 2016.

We have moved substantially toward meeting this 2005 Forest Plan objective by treating the large wetland complexes of Grasshopper Hollow, Kaintuck Fen, Barton Fen, and by protecting sinkhole ponds with state natural area status.

Recommendations

Wetland management and protection needs should continue to be reviewed and determined during project-level environmental analyses.

Evaluation of Monitoring Question and Indicator(s)

There are no recommendations for change for this objective.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 8

Objective 1.4a: Improve open woodland habitat conditions on at least 10,500 acres to provide habitat for summer tanager, northern bobwhite, Bachman's sparrow, and eastern red bat (USDA Forest Service 2005, p. 1-4)

Open woodland is a natural community that was common pre-European settlement but decreased as a component of the Ozarks landscape over the past 50 to 75 years. Restoring and maintaining a healthy component of this natural community is an important objective in the 2005 Forest Plan. The species selected as monitoring indicators all have one or more life history requirements that are met within open woodland natural communities.

For all Land Suitability Classes (LSC), approximately 500 stands for 541,000 acres are identified as open woodland. This is about 36 percent of the total acres in the Mark Twain National Forest.

Results and Discussion

Since 2005, a concerted effort has been made to restore and enhance open woodland conditions on several ecological types. Approximately 3,000 acres per year are harvested with the intent of reducing basal area and improving structural characteristics of these woodland communities. Each year, we accomplish prescribed fire on thousands of acres of open woodland communities.

The information shown above illustrates that we have reached this target in the first decade of Forest Plan implementation. We treated 23,922 acres of open woodland in 2015 and 2016 alone.

Number of acres treated annually does not, however, tell the whole story. Several treatments of different kinds are necessary to develop the structure and species composition that characterize healthy open

woodland communities. Therefore, while the cumulative acres treated is generally more than the total acres that are intended to meet the open woodland objective.

Other ways to measure the success of open woodland community health can be found in Monitoring Questions 3 and 4 (see sections 5.21 and 5.22) showing vegetative responses to forest management of open woodland communities, and Question 10 (see section 5.31) regarding pine and oak-pine woodland communities.

Recommendations

Areas need to be treated multiple times to effectively restore characteristic structure and composition. Future analysis should include determining the acreage that has been treated enough times with the proper treatments to determine if we are continuing to meet this objective over time.

Evaluation of Monitoring Question and Indicator(s)

We may want to review this objective upon Forest Plan revision since we are far exceeding the objective in each year, much less in the lifespan of the Forest Plan.

References

Bat Conservation International.

U.S. Department of Agriculture, Fish and Wildlife Service. North American Breeding Bird Survey.

Monitoring Indicator 9

Objective 1.4b: Increase the proportion of managed native grasslands to that of exotic cool season grasses from the current 46% native grass (in 2005) to 55% native grass to provide habitat for northern bobwhite (USDA Forest Service 2005, p. 1-4)

Much of the open-land habitat is a remnant of the time when it was private pastureland before being acquired by Forest Service. Acquired lands invariably had non-native cool season grasses, such as fescue, planted to provide forage for cattle. We have been moving towards converting non-native open lands to native grass and forb mixes that more closely resemble the prairie remnant and savanna patches which preceded European settlement. While recognizing it is not practical or financially feasible to convert all those areas, we have selected this indicator to show progress toward providing more native grass open-land habitat.

Results and Discussion

As of 2016, we have 55,747 acres of open land. Of this, 44,658 acres or 80 percent is primarily native grass and forb.

We are on target to meet this objective in the first decade of Forest Plan implementation. Implementation monitoring shows we are consistent with the objective of providing a higher proportion of native grasses. However, this has not yet translated to better news for northern bobwhite populations. Therefore, effectiveness monitoring has not yet shown positive results.

According to the USFWS Breeding Bird Survey, Northern bobwhite numbers have steadily declined in Missouri, the Central Hardwoods, and the U.S. since 1966. The rate of decline is slightly less in the Central Hardwoods and U.S. in the last decade 2005-2015 as opposed to the period from 1966-2015, but not by much. In Missouri, the rate of decline was slightly more in the last decade than over the longer period.

Recommendations

Priority should be placed on maintaining and improving the native grass areas that currently exist. Conversion of non-native to native grassland should be done where the chance for success is high and as time and funding allow.

Evaluation of Monitoring Question and Indicator(s)

From the available population monitoring data for northern bobwhite, it is doubtful that any action on the part of the Mark Twain National Forest will reverse the downward trend for this species. National Forest System lands is only 3.3 percent of the state of Missouri and only has about 20,000 acres of open grassland to work with. While it is important that we continue to emphasize native species in all its natural ecosystems, it may be that we need to select a different measure of success than northern bobwhite population numbers and trends.

References

U.S. Department of Agriculture, Forest Service. Mark Twain National Forest Geographic Information System layers.

Monitoring Indicator 10

Objective 1.4c: Maintain forest, closed woodland, or open woodland cover over 85% or greater of Mark Twain National Forest acres to provide habitat for worm-eating warbler (USDA Forest Service 2005, p. 1-4)

This indicator was selected when Management Indicator Species (MIS) were being used as surrogates for a suite of species which require similar habitat components and types. The worm-eating warbler was the management indicator species for continuous canopy cover in a variety of forest and woodland community types. In 2012, the new Planning Rule mandated the use of focal species, so this indicator needs to be updated to be consistent with the new requirements.

Results and Discussion

For all Land Suitability Classes (LSC), approximately 5,000 stands for 812,000 acres are forest, and 541,000 acres are open woodland. This totals about 1,353,000 acres.

As of 2016, approximately 90 percent of the Mark Twain National Forest is in forest, closed woodland, or open woodland. We have exceeded this target in the first decade of Forest Plan implementation.

Worm-eating warbler populations have shown a slight increase in the Central Hardwoods and U.S. from 1966 to 2015; with a slightly higher rate of increase for 2005 to 2015. For Missouri, worm-eating warbler populations increased overall from 1966 to 2015 but have shown a slight decrease over the period 2005 to 2015. Since the percentage of the Mark Twain National Forest in forest, closed woodland, or open woodland has not changed substantially from 2005 to 2015, it is difficult to correlate the Missouri difference to any changes in landscape composition in the Mark Twain National Forest.

Recommendations

Upon Forest Plan Revision under the 2012 Planning Rule, chapter 1 Objectives should not mention management indicator species.

Evaluation of Monitoring Question and Indicator(s)

The 2012 Planning Rule made the change from Management Indicator Species to Focal Species. Worm-eating warbler was identified as a management indicator species for the 2005 Forest Plan. This indicator needs to be reviewed and changed to more appropriately reflect the focal species chosen to represent forest, closed or open woodland cover.

References

U.S. Department of Agriculture, Fish and Wildlife Service. North American Breeding Bird Survey.

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

Monitoring Indicator 11

Objective 1.4d: Treat at least 4,000 acres of glades to reduce woody vegetation to provide habitat for Bachman's sparrow (USDA Forest Service 2005, p. 1-4)

Glades are one of the Ozarks' most unique natural communities. They provide habitat for a variety of plants and animals more commonly associated with western prairies. We are committed to maintaining these unique ecological systems. This indicator shows what progress we are making to ensure that glades survive on the Ozarks' landscape.

Results and Discussion

A FACTS activity query was performed for glade restoration. This layer is embedded with statewide natural community types, so cross-referencing is somewhat tedious. There are six different glade types in the Mark Twain National Forest.

In 2015 and 2016, 5,282 acres of glade habitat were treated by prescribed fire, mechanical treatment, and non-native invasive plant control. Some of the glade communities have been treated to maintain their open character and unique species composition since the 1960s. We have exceeded this target in the first decade of Forest Plan implementation.

Recommendations

Continue to treat glade communities with periodic prescribed fire, removal of invading red cedar and other woody species, and reduce or control infestations of non-native invasive plants.

Evaluation of Monitoring Question and Indicator(s)

We continue to surpass this objective, exceeding the minimum for the life of the 2005 Forest Plan in 2015 and 2016 alone.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 12

Objective 1.4e: Designate permanent old growth on 8 percent to 12 percent of each 2.1 and 6.2 management area, and on 15 percent to 20 percent of 6.1 management area (USDA Forest Service 2005, p. 1-4)

This indicator was selected because a variety of common and listed or candidate species use one or more habitat components found in old growth natural communities.

Results and Discussion

Old growth is normally designated during environmental analysis of project areas. While efforts are made to carry-over previous old growth designations from earlier project decisions, it is common for old growth designations to change with new information and different priorities. Therefore, some designated old growth areas never actually achieve the structural, age, and composition objectives that are desired.

To monitor old growth, it makes more sense to show the total acres of old growth designated in the Mark Twain National Forest than just those acres designated during specific years.

Table 33. Designated Old Growth Acres by Management Area for 2020

Management Prescription	2.1	6.1	6.2
Objective Acres	53,592 to 100,485 acres	11,040 to 14,720 acres	15,712 to 23,568 acres
Total 2020	56,064 acres	7819 acres	20,486 acres
70-99 yrs	20,722 acres	3,545 acres	9,554 acres
>100 yrs	33,116 acres	4158 acres	10,276 acres

In addition to acres designated, it is useful to look at the age-class distribution of those designated acres to determine if we are progressing toward having actual old growth conditions on the ground. In all three management areas, well over 90 percent of the designated acres are greater than 70-years old. Designated stands greater than 100-years old comprise 41 percent to 51 percent of the management areas. These are the areas where old growth characteristics are more likely present.

The table shown above illustrates we have met this objective in the first decade of Forest Plan implementation for management prescriptions 2.1 and 6.2; but is about 3,000 acres short of meeting the minimum for management prescription 6.1.

Whether this is an actual lack of designation, or a lapse in record keeping is something we should investigate. To track management decisions made during environmental analysis, including designation of old growth areas, those decisions are entered into the FACTS database. However, it is possible that old growth designations are not being entered with as much consistency as vegetation manipulation activities.

Recommendations

Continue to insist that old growth designation be included in all vegetation management projects in the future (particularly those in management prescription 6.1); and that most designated stands are of an age to truly provide old growth conditions.

Evaluation of Monitoring Question and Indicator(s)

Old growth is an important habitat component that is easy to overlook in an agency that is activity-oriented, but it is vital to the continued health and maintenance of Ozark ecosystems. This objective should continue to be an objective.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Field Sampled Vegetation (FS Veg).

U.S. Department of Agriculture, Forest Service. Mark Twain National Forest Geographic Information System layers.

Monitoring Indicator 13

Objective 2.2a: Prescribe burning up to 20 percent of total projected burn acres from May through September; and prescribe burning up to 40 percent of total projected burn acres from September through December (USDA Forest Service 2005, p. 1-5)

Prescribed fire can achieve a variety of results depending upon the conditions under which an area is burned. To achieve the effects that are shown as desired conditions for the various natural communities,

prescribed fire should be done in a variety of seasons, including fall and during the growing season. Traditionally, prescribed fire has been accomplished during the late winter or spring. This objective will help us see whether we are making progress toward diversifying our prescribed burning timing and results.

Results and Discussion

The 2011-2012 Monitoring Report showed that we were not even close to meeting this objective. The recommendation was to identify and address barriers to achieving this timing. As the 2015 and 2016 results show, we have not made any headway toward meeting this objective. No prescribed burns were conducted from May through September in either 2015 or 2016.

Why is this objective not being achieved?

Logistical barriers to meeting this primarily relate to the availability of personnel during the May through September period. In the Mark Twain National Forest, spring fire season runs essentially from January through April or early May. Once fire season concludes here, fire personnel take some time to reconnect with family and other responsibilities, then make themselves available for fire assignments in other parts of the country. Many of the fire leaders, and key fire positions for prescribed burning, leave Missouri during much of the summer. This makes it very difficult to plan and implement prescribed fires during this time.

Socially speaking, it is difficult to defend starting fires in Missouri when the public is seeing national news coverage of homes burning and people being displaced due to wildfires in other states.

Practically speaking, our fire managers are technically excellent at prescribed fire during the dormant season. They are comfortable with the risks, and with the techniques and practices that effectively and safely achieve the objectives or respond to unplanned circumstances. They are not as familiar or comfortable with growing season issues, problems, and risks. The public is not used to seeing wildland fire smoke in the summer months, and visitors are not expecting to encounter wildland fire in Missouri in the summer.

So, if we are not meeting this objective, does it matter? The original intention of this requirement was to vary the vegetative response by varying the seasonality of treatment (and presumably the intensity of the burn) and its effect on vegetation that may not be affected by dormant season fires. Do we know enough about how different plants respond to seasonal timing of prescribed burns to answer this question?

Recommendations

Based on a consideration of future conditions and achievable and valuable objectives, we need to decide whether to remove this objective from the Forest Plan, amend it to make it a guideline, or a plan to implement it in future years.

This objective has not been a priority to implement in the first decade of the 2005 Forest Plan and does not appear to be something that will receive priority in the few years remaining before the Forest Plan is updated. If we still feel it is important to seasonally vary our prescribed fires, then change this to a guideline and revisit its necessity during the next Forest Plan revision.

Evaluation of Monitoring Question and Indicator(s)

This objective should be dropped; and the issue of seasonal prescribed burning addressed during the next Forest Plan revision, and future conditions are assessed as both achievable and valuable.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

Monitoring Indicator 14

Objective 2.2b: Use prescribed fire to reduce hazardous fuels and improve Fire Regime Condition Class on 45,000 acres or more per year (USDA Forest Service 2005, p. 1-5)

To continue a schedule of prescribed fire which would significantly impact about 250,000 acres, we need to accomplish between 45,000 acres per year and 60,000 acres per year. If fewer acres are accomplished, the frequency of prescribed fire on some parts would decrease, and the effects we are trying to achieve would be delayed.

Results and Discussion

We did not achieve prescribed burning of 45,000 acres in either 2015 or 2016. Totals were 27,009 acres in 2015 and 30,837 acres in 2016. Throughout the first decade of 2005 Forest Plan implementation, the closest we came to achieving this goal was 45,896 acres in 2012.

The reasons for not achieving this objective vary from year to year but include:

- Weather conditions must be right to achieve burn plan objectives and there are a limited number of days that meet those conditions
- Availability of staff and equipment due to conflicting priorities, leave, and training needs
- Conflicts with wildland fire suppression availability needs
- Inability to have units prepared due to staffing or weather issues over the fall and winter

We have identified ecological units and landscapes which are priority for continued prescribed fire for ecological health and hazardous fuel management. The following map shows the areas that have been treated over the past 10-years for a total of 331,961 acres and which are planned for continuing treatment on a fire interval consistent with the ecological history of each area.

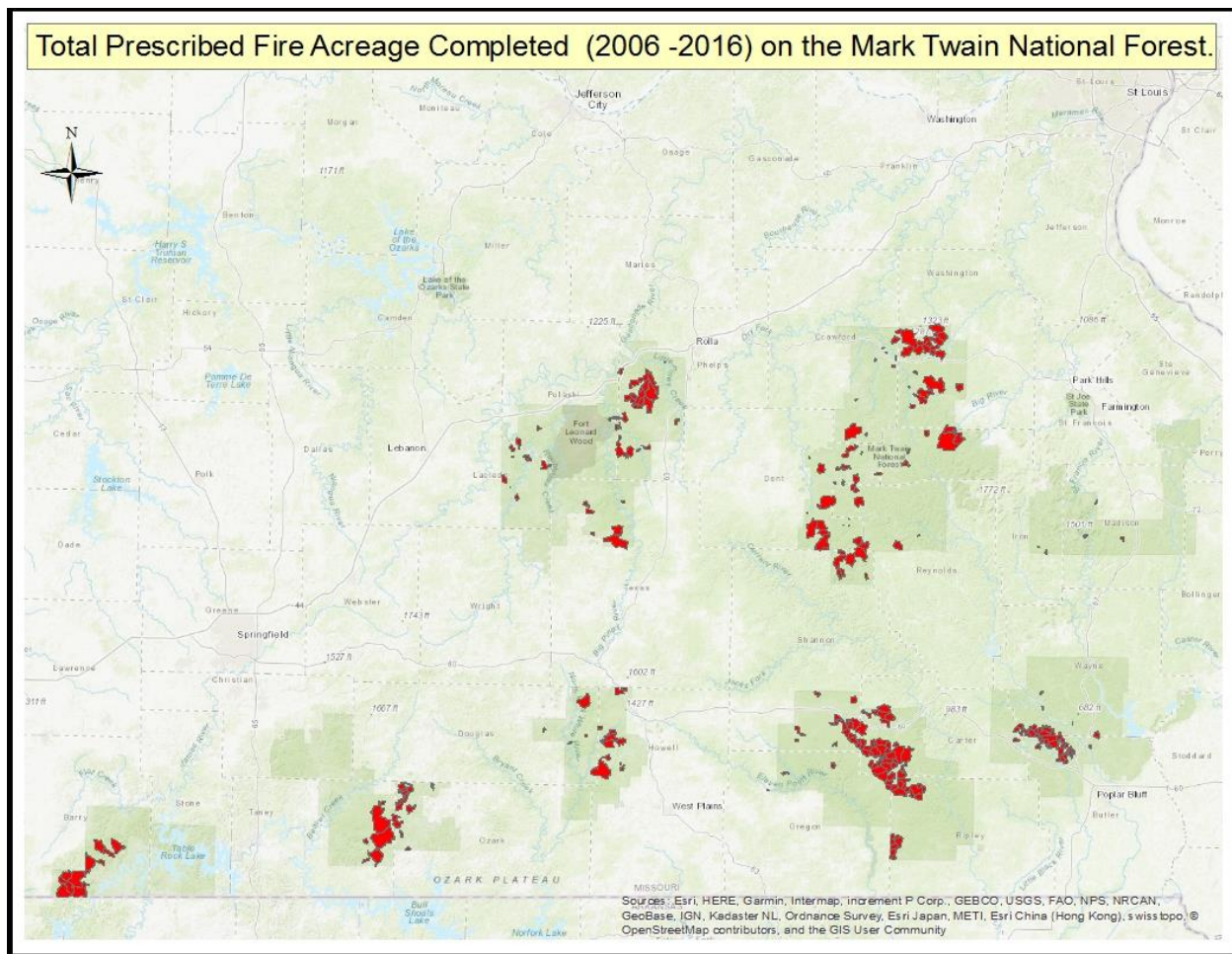


Figure 28. Total Prescribed Fire Acreage Completed 2006 through 2016

Recommendations

While we continue to plan for the minimum of 45,000 acres of prescribed burning each year, it is clear from the first decade of the 2005 Forest Plan that it is unlikely to be achieved on a regular basis.

During the next Forest Plan revision, this objective may need to be reviewed and revised.

Evaluation of Monitoring Question and Indicator(s)

As noted above, this objective may need to be reviewed and revised during the next Forest Plan revision.

References

U.S. Department of Agriculture, Forest Service. Natural Resource Manager (NRM) Forest Service Activity Tracking System (FACTS).

5.8 - The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land

Monitoring question 19 addresses required monitoring element 36 CFR 219.12(a)(5)(viii) “The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (NFMA – 16 U.S.C. 1604 (g) (3) (C)) (FSH 1909.12 32.13g).

5.81 - Are the effects of forest management, including prescriptions, resulting in significant impairment to productivity of the land? (File designation 2550)

Last Updated

The 2015-2016 Mark Twain National Forest monitoring evaluation report concluded meaningful results will be available after the first data collection scheduled for 2018.

Monitoring Indicator(s)

Summary of results of monitoring using the National Soils Protocol

As of 2017, we had no data on soil disturbance monitoring utilizing the Forest Soil Disturbance Monitoring Protocol (Page-Dumroese et al. 2009). Prior to 2017, former Forest Soil Scientist Wallace Dillon and Resource Ecologist Brian Davidson began planning for implementation of soil disturbance monitoring, but no sites were formally set up. In 2018, an agreement new Forest Soil Scientist Kyle Steele began working with Missouri State University - Ozarks Environmental and Water Resources Institute under an agreement to establish this monitoring. Six pre-treatment sites were selected in 2017 and data collection was completed in 2018. The team coordinated with Regional Soil Scientist Greg Nowacki and Northern Research Station Research Forester John Kabrick to help with site selection and data collection to ensure a strong experimental design, strengthening the ability to make conclusions on this topic.

Monitoring Frequency

Frequency of data collection is variable and based on available funds and trained personnel. The current plan is to collect pre- or post-treatment data collection on up to six sites per year, depending on funding.

Background & Driver(s)

Under goal 1.3 Soils, Watersheds, and Water Quality, the 2005 Forest Plan states, “Minimize erosion and compaction” and “Restore and maintain soil productivity and nutrient retention capacity.”

Standards and guidelines for soil productivity are found on page 2-5 of the 2005 Forest Plan.

The National Soils Protocol was developed to determine if significant soil disturbance is occurring. It uses primarily visual cues located at random locations to determine levels of disturbance. Disturbance using the Protocol primarily deals with timber and silvicultural activities but also includes prescribed fire. Wildfire is not considered. The following is a list of disturbance types documented: evidence of past operation and disturbance; rutting and wheel tracks; level of soil exposure; soil physical condition (like structure); level of penetration resistance; evidence of erosion; and evidence of deposition. Effective identification and documentation of these factors, following the Protocol, are indicators related to understanding if the “productivity of the land” has been altered.

Site selection should be random, if possible, but not required. Sites should also be selected based on ecological condition score factors, considering the most common landscapes and site types that tend to be the most heavily managed. Sites can also be selected based on their potential for disturbance. For example, it is reasonable to purposely select sites we know have a higher potential for compaction.

Monitoring Indicator 1

National Soils Protocol monitoring results

Results and Discussion

Two sampling periods have been conducted on six sites and data were summarized by Missouri State University in March of 2020 (Owen et al. 2020). Pre-treatment data was collected in 2018. Post-treatment data at those same sites was re-collected in 2020. Pre-treatment data at all six sites classified as a “0”

category in the Forest Soil Disturbance Monitoring Protocol. As per the protocol, there was: 1) no evidence of compaction from past equipment operation; 2) no evidence of depressions or wheel tracks; 3) forest floor layers were present and intact; 4) no soil displacement was identified; and 5) no management-generated soil erosion was documented. Five of the six post-treatment assessments occurred 3 to 12 months after harvest was completed. Most post-treatment data points continued in the “0” category, but approximately 18 percent moved into another category of degradation. Most of these were in the “1” category, which documents: 1) faint wheel tracks or slight depressions; 2) forest floor layers present and intact; 3) surface soil has not been displaced and shows minimal mixing; 4) compaction in the surface soil is slightly elevated; 5) transition to massive or platy structure present but not continuous within 10-centimeters of soil surface; and 6) erosion if present is slight. An extremely small proportion of sites included categories “2” and “3”, which include a variety of more extreme examples of soil disturbance, including deep rutting, severe compaction, significant erosion, and so on.

Overall, the Missouri State University team found that the severity of the disturbance appears to be due to several factors including the size of the harvest unit, the presence of a main haul road within the harvest unit, and the amount of rock content within the soil profile. A preliminary model was developed to better understand the three specific disturbance indicators identified at these six sites and how these indicators were used to assign disturbance class values. These disturbance indicators are: 1) the presence of rutting at the surface; 2) the presence of the “O” horizon at the surface; and 3) the depth of compaction in the soil profile. These indicators were identified as the most important for these six sites, however, these can be revised as needed.

Recommendations

Continue adding sites to obtain National Soils Monitoring Protocol data and follow up on post-treatment sites at five-year intervals.

Evaluation of Monitoring Question and Indicator(s)

Continued funding over three years has been provided to begin implementing the National Soils Monitoring protocol. We need to continue the progress with our partner Missouri State University. Missouri State University has developed a localized, effective, and valuable protocol to conduct this work, complete with photo documentation, geodatabase standardization, and analysis metrics. We need to continue providing funding for this effort due to extremely limited staffing potential in this resource area. The Forest Soil Scientist has only 50 percent of his time allocated to soil science duties and is aggressively pursuing numerous other areas of his program that, like soil monitoring, have essentially no history in the Mark Twain National Forest. Having a partner who is able and willing to do this work is vital to an effective soil monitoring program.

References

- Owen, Marc R., Coonen, Kayla A., Pavlowsky, Robert T. 2020. Post-Harvest Activity Assessment using the U.S. Forest Service’s Forest Soil Disturbance Monitoring Protocol (FSDMP), Mark Twain National Forest, Missouri. Ozarks Environmental and Water Resources Institute, Missouri State University, Springfield, Missouri. 52 p.
- Page-Dumroese, Deborah S.; Abbott, Ann M.; Rice, Thomas M. 2009. Forest Soil Disturbance Monitoring Protocol: Volume I: Rapid assessment. Gen. Tech. Rep. WO-GTR-82a. Washington, DC: U.S. Department of Agriculture, Forest Service. 31 p.

6.0 RECOMMENDATIONS OVERVIEW AND SUMMARY

This evaluation finds no need to change the 2005 Mark Twain National Forest Land and Resource Management Plan. It does, however, identify areas in which additional or different indicators, or increased

implementation, documentation and designation should be considered to improve the pace of our restoration work and evaluating conditions on the ground. Further, it also indicates that some of the objectives outlined in chapter 1 should perhaps be reconsidered upon a pragmatic assessment of available resources during Forest Plan Assessment or Revision. In general, progress is being made to implement 2005 Forest Plan objectives and move landscapes to desired natural community types. Most issues identified in this evaluation and report have been identified previously but are summarized again below.

General Recommendation for Future Monitoring & Evaluation Report

Increase prioritization and emphasis on the monitoring evaluation report forest-wide. Incomplete data and missed deadlines due to a lack of prioritization and required specialist time and evaluation plagued the timely production of this report.

MANAGEMENT ISSUES IDENTIFIED

The following were identified as items which are not being *fully* implemented as intended:

- Small roundwood removal
- Old growth designation in MP 6.1
- Growing season and fall season prescribed fire
- 45,000 acres prescribed fire per year
- Deferred maintenance backlog

These issues are difficult to resolve as they have been identified in the last two monitoring reports and not much has changed. We should examine these few issues to determine the barriers to achieving some Forest Plan objectives and implementation goals, and then decide whether changes to the 2005 Forest Plan or Monitoring Program are needed upon Forest Plan revision that can address these issues.

BROADER CONSIDERATIONS FOR THE MONITORING PROGRAM MOVING FORWARD

Some indicators could be adjusted to better answer the question being asked.

Several of the monitoring questions have indicators which are intended as surrogates for the answer we are trying to find or show that we have completed some action that we think will meet an objective, but we do not have any measure for accomplishment of the actual objective. Those indicators may tell us that we are doing what we said we would do in terms of management activity, but do not really answer the resource question being asked. We might want to consider either changing the question or developing new indicators that answer the question better.

An example of this is question 15 (sec 5.54): *How are management activities affecting unauthorized OHV use?* The indicators used give us information about ATV and OHV use, but it is not connected to management activities. We should review current indicators and develop indicators that answer the question asked within the current capacity.

- Provide more clarity or balance between implementation monitoring and effectiveness monitoring

RECOMMENDATIONS FOR FUTURE MONITORING & EVALUATION

- Monitoring should help managers make better current and future management decisions. Monitoring should be an integral part of each project; and should be supported by all resource personnel. Because of the complexity of the information needed, and the breadth of resources involved, we should consider adding a position of Monitoring Coordinator, whose sole duty is to guide the monitoring program and ensure consistency and attention to monitoring needs. Current

staff have difficulty prioritizing monitoring due to the myriad other duties that take precedence in daily management.

- Data in support of long-term effects analysis (FIA, FQI plots, species trends, etc.) should continue to be collected to develop a continuous database that supports statistically accurate analysis. However, if we keep collecting data, but don't use it to inform decisions in current and future project analyses, then we have wasted time and money.
- Therefore, we should prioritize the evaluation of current datasets to determine what has been learned to date, and what information is needed to improve gaps in our knowledge. This is a vital part of monitoring where we have not yet made much progress. Having this kind of evaluated data and conclusions will also make the next round of Forest Plan revision much easier.
- It may be useful to have a meeting with Northern Research Station leadership and staff to develop a plan for the next 10 to 20 years of ecological research that will take existing data (water, soil, wildlife, vegetation, air, etc.) and evaluate what it means in the context of forest management activities and effects on targeted resources. There are other universities, non-profits, and biological contractors who may also be able to take various datasets and start analyzing the data we have for trends or to determine if the changes we thought would happen are happening.

Summary of additional resource-related observations during evaluation:

2200 – Vegetation/Ecological/Range

- Analysis of data gathered has been limited to scattered, informal efforts by individuals interested in a specific issue or topic. We have a large amount of data that needs to be evaluated prior to starting Forest Plan revision. The sooner the data is analyzed, the better information we have about how well our current management is achieving objectives; or if we need to adjust in how or when we conduct management activities.
- We should contract to assess data, evaluate results, and provide us a final report. An important component of this assessment should look at the cause-effect relationship between changes in plant diversity and coverage to changes in wildlife species, soil productivity, water quality and quantity.
- Annual changes in species richness and cover are not very meaningful on a biological time scale. Trends in species richness and ground cover would be more accurate in helping us understand if our management was achieving the objectives set in the 2005 Forest Plan. Data should continue to be collected annually as funds permit; and should be evaluated and analyzed on a 5-to-10-year cycle.
- We need to continue with aggressive identification and treatment of non-native invasive species infestations with the objective of reducing the number of areas and extent of those infestations. All treatment methods should be considered, and the most effective and appropriate applied in each specific situation. We should continue to search out new treatments and technologies to assist in the control of these species. We should use this mapping to recommend any changes to monitoring of non-native invasive species.
- Priority should be placed on maintaining and improving the native grass areas that currently exist. Conversion of non-native to native grassland should be done where the chance for success is high and as time and funding allow.

2300 – Recreation

- The next round of NVUM data in 2023 to 2024 needs to be compared to the data which was obtained in 2018. The information gained from the 2018 NVUM data seems to show that the Mark Twain National Forest recreation niche is primarily local, short duration visits to enjoy the mere presence of natural resources (relaxing, hiking, viewing, driving, wildlife watching, etc.).
- Water-based recreation is a large part of the recreation opportunity base, which fell somewhere in the middle of experiences that visitors came for. There may be other information (like outfitter and guide visitor numbers) that would give another view of the importance of water-based recreation. Offer outfitters incentives to assist with river management through communication and relationships.
- The backlog of deferred maintenance items is a good indication that the funding for the Mark Twain National Forest recreation program is not keeping pace with the priorities outlined in 2005 Forest Plan goals, objectives, and standards and guidelines. Visitor satisfaction seems to indicate that visitors are fairly satisfied with the experiences and opportunities provided. The 2021 to 2025 GAOA projects need to be proposed based upon the recreation priorities and deferred maintenance, as well as be consistent with the RSA/RFS to lead to sustainability of the program.
- The recreation program, including facilities, is historically underfunded and understaffed for work that is needed. Recreation program managers rely heavily on the Forest's Facility Engineer for planning and program management, leaving less time for technical engineering assistance which is the primary responsibility of that position. Engineering and recreation programs need to clarify roles and responsibilities for monitoring, particularly where facilities are involved. Additional staff is needed to ensure that monitoring is given the attention it requires to be accurate, timely, and useful. We should place a higher priority on updating the INFRA database, and on developing systems and procedures to track the resolution of issues identified through monitoring. Request Regional funding for forests that do not have NRM Data Stewards. This could be regional partnership funding for the data steward positions. This could be from large outfitters or sporting goods stores. Otherwise, we will be behind the curve for the foreseeable future regarding sustainability.
- ROS was developed primarily as a planning tool. Over the past decade, there have been very few instances where we identified a need to change ROS for a particular area (general forest area being designated State Natural Area as an example). Compliance with ROS objectives is addressed during project evaluation.
- While ensuring consistency with ROS is an important part of planning, "Projects that are consistent with ROS objectives" as an indicator of annual progress in complying with ROS is non-specific and difficult to assess. Other indicators (like miles of road per square mile, and visitor satisfaction) might be better indicators of how well we are providing different types of recreational experiences than number of projects consistent with ROS objectives.
- It seems as if the monitoring indicators for monitoring question 15 do not really answer the intent of the OHV management question. If we want to identify whether management actions are affecting how or why people illegally use OHVs, then these three indicators are not really answering that question. Work on an adaptive management plan to assist in mitigating and enforcing trail regulations with appropriate signage and message.

More specific and appropriate questions and indicators to consider for future monitoring might be:

- Where and when specifically does unauthorized use occur (hunting season, year-round, old woods roads, temporary roads, etc.)?
- Are we creating unauthorized “user-friendly” trails by our management actions (like fireline construction, temporary road construction without adequate obliteration)?
- Do our management actions encourage unauthorized use?
- What management actions have we taken to discourage unauthorized use?

Whatever question or indicator is used, we should consider ensuring there is a system in place to capture that information effectively and store it in such a way that it can be found and used to help influence future management decisions.

2400 – Timber

- The indicator for question 16 is acres of mortality occurring. It is also important to distinguish, if possible, what the causes of yearly mortality are, since that information might be critical in how we decide to respond. This is particularly true to ascertain what stressors the mortality is attributable to. One possible suggestion is that we add acres of mortality by cause as an indicator for this question.
- We need to track and proceed with the ASQ for sawtimber without exceeding that limit by more than 10 percent in any given year. The argument that any previous year’s volume when sawtimber ASQ was not attained would allow for exceeding ASQ in future years ignores the mortality issue described above. Total growing stock on suitable acres is not cumulative.
- Question 17 includes only timber indicators, when the goal it is tied to asks more generally about providing multiple use opportunities. We may want to consider including other outputs and services provided as indicators for this question, or whether those are already covered in other monitoring questions (question #18 in particular).

2500 – Water

- Watershed projects should continue to be implemented as part of integrated resource projects.
- Priority watershed condition needs to be scored at intervals to assess progress toward meeting 2005 Forest Plan goals and objectives. We should continue to follow national and regional direction for determining watershed health.
- Additional information is needed on stream conditions and amount of large wood in the stream channels.
- In 10 years, we have only accomplished one project (for one-third of the objective) for the indicator large woody material on 3 miles of streams. Additional information is needed on amount of large wood in the stream channels. We should review if this indicator is the correct measure for amount of large wood in streams. We might consider reviewing this indicator to determine if it remains appropriate.
- While it is important to monitor accomplishment of stabilizing 10 miles of stream reach, additional information is needed on stream condition to determine project needs. Wetland

management and protection needs should continue to be reviewed and determined during project-level environmental analyses.

2550 – Soil

- Continued funding has been provided to continue implementing the National Soils Monitoring protocol. We need to continue the progress with our partner MSU. We need to continue providing funding for this effort due to extremely limited staffing potential in this resource area. The Forest Soil Scientist has only 50 percent of his time allocated to soil science duties and is aggressively pursuing numerous other areas of his program that, like soil monitoring, have essentially no history in the Mark Twain National Forest. Having a partner who is able and willing to do this work is vital to an effective soil monitoring program.

2600 – Wildlife

- It would be useful to have specific research on the impacts of fish stocking in lakes related to public use and satisfaction, and on the impact of additional vernal pools on increases in frog or salamander populations in the vicinity of constructed pools. The study done by Missouri Western State University should be continued or expanded to the Turnbough area to look at additional factors in amphibian use of the vernal pools. This could be accomplished by partnering with the recreation program in the future.
- Number of lakes stocked, and number of vernal pools constructed is an annual target in an accomplishment report that does not necessarily need to be repeated in the annual monitoring evaluation report. A better indicator for question 8 or rewording could perhaps provide information on selected fish and aquatic species population trends in lakes and changes to amphibian populations in areas where the pools are created. We will continue to monitor populations and habitat in coordination with MDC or other partners, as further monitoring on vernal pools is desired.
- We should consider whether question 8 is telling us anything that would help make better management decisions. Fish stocking is a political and public use issue in addition to a wildlife and fisheries issue. Vernal pools are an issue perhaps better evaluated in a research project focused specifically on that.
- Mark Twain National Forest and Northern Research Station are confident that Eastern wood peewee and pine warbler are good indicators for the health and sustainability of pine woodland communities. Continued data collection will help establish statistically meaningful long-term trends. The Cane Ridge East and West projects are nearly complete and has created some excellent habitat. Prescribed fire will continue in the area. Currently an extension proposal for funding to continue that work is nearly complete. Monitoring may continue but extent will be dependent on funding and personnel availability.
- Once enough data for Eastern wood-pewee and pine warbler has been collected to provide meaningful results, we will reevaluate question 10 and the monitoring indicators to determine if changes are needed.
- Additional focal species may be needed when Forest Plan revision is undertaken to represent other natural communities on the Forest.

- Ongoing research into a cure for white-nosed syndrome is the critical need currently. Unless WNS can be addressed, forest management for bat habitat is unlikely to have any positive impacts on bat populations.
- From the available population monitoring data for northern bobwhite, it is doubtful that any action on the part of the Mark Twain National Forest will reverse the downward trend for this species. The Mark Twain National Forest is only 3.3 percent of the state of Missouri and only has about 20,000 acres of open grassland to work with.
- Continue to treat glade communities with periodic prescribed fire, removal of invading red cedar and other woody species, and reduce or control infestations of non-native invasive plants.
- The 2012 Planning Rule made the change from management indicator species (MIS) to focal species. Worm-eating warbler was identified as an MIS species for the 2005 Forest Plan. This indicator needs to be reviewed and changed to more appropriately reflect the focal species chosen to represent forest, closed or open woodland cover upon Forest Plan revision.
- Additional old growth should be designated in management prescription 6.1 to meet the 2005 Forest Plan objective. We should continue to emphasize that old growth designation be included in all vegetation management projects in the future (particularly those in MP 6.1); and that most designated stands are of an age to truly provide old growth conditions.
- Specialized habitat field inspections should be continued and conducted consistently each year. Documentation of these visits should be filed where they are available to biologists and other specialists working on projects.
- The objective for restoration and maintenance of bottomland hardwood forest should be reviewed to determine if it can or should be refined for the future under Forest Plan revision. If this is an objective that the Forest wants to reach in the future, there may need to be a more specific effort to track treatments in these areas.

5100 – Fire

- We should continue to evaluate fire effects on prescribed burn areas; and make changes to fire intensity, season, or interval as needed to continue movement toward 2005 Forest Plan objectives.
- We should consider updating the risk assessment completed for the 2005 Forest Plan and make sure that all units are using the most up-to-date wildland-urban interface layer when planning projects.
- We need to decide whether to delete the growing season burn objectives from the 2005 Forest Plan, amend it to make it a guideline, or plan to implement it in future years. Growing season prescribed fire has not been a priority to implement in the first decade of the 2005 Forest Plan, and it does not appear to be something that will receive priority in the few years remaining before the Forest Plan is updated. Monitoring for objective 2.2a should be discontinued; change this from an objective to a guideline; and the issue of seasonal prescribed fire addressed during the next Forest Plan revision.
- While we continue to plan for the minimum of 45,000 acres of prescribed burning each year, it is clear from the first decade that it is unlikely to be achieved on a regular basis. During the next Forest Plan revision, this objective may need to be reviewed and revised.

5300 – Law enforcement

- It seems as if the monitoring indicators for question 15 do not really answer the intent of the question. If we want to identify whether management actions are affecting how or why people illegally use OHVs, then these three indicators are not really answering that question.

More specific and appropriate questions and indicators to consider for future monitoring might be:

- Where and when specifically does unauthorized use occur (hunting season, year-round, old woods roads, temporary roads, etc.)?
- Are we creating unauthorized “user-friendly” trails by our management actions (like fireline construction, temporary road construction without adequate obliteration)?
- Do our management actions encourage unauthorized use?
- What management actions have we taken to discourage unauthorized use?

Whatever question or indicator is used, we need to ensure there is a system in place to capture that information effectively and store it in such a way that it can be found and used to help influence future management decisions.

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