USDA United States Department of Agriculture

2023 - 2024 Monitoring Evaluation Report

for the Mark Twain National Forest

Forest Service **Mark Twain National Forest** **April 2025**

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1. Summary of Findings and Recommendations

In general, required monitoring is being accomplished on the Mark Twain National Forest (MTNF). The MTNF is on target to meet or exceed most of the goals and objectives outlined in the 2005 Forest Plan, 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 indicators have been identified in previous monitoring evaluations and should be further examined for change. Updating indicators could provide better metrics to accurately capture work being done across the MTNF.

After two decades of implementing the MTNF 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 that warrant review from 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

Monitoring Item	Reason for Review	Based on the evaluation of monitoring results, what changes may be warranted?[1]
Question 3	We now have enough data to determine if changes to Plan components are needed	A re-evaluation of the 2005 Forest Plan's Table A-1 may need to take place
Question 4	Monitoring methods need updated to incorporate other metrics	We need to continue integrating Community Health Index (CHI) to provide additional landscape context for adaptive management
Question 6	Appendix G of the Forest Plan is twenty years old	Updated risk assessment needed to better analyze effects
Question 8	Specific monitoring indicators may be useful	It is recommended that specific monitoring indicators may be needed to address vernal pool species
Question 11	Reporting needed on the amount of designated OG in 6.1	Standardize the way OG data is collected and reported so it can be shared across resource areas
Question 12	Site visits increased in Mark Twain Wilderness areas, but declined in other areas	The amount of data collected during the reporting year, when averaged, could account for the increase.
Question 15	Indicator doesn't seem to be accurately capturing how or why people illegally use OHVs	More specific indicators may be needed to accurately capture the data needed, or this indicator may need removed
Question 16	Indicator may not capture the type of data we need	It may be beneficial to distinguish the causes of mortality on forest as this determines how a response is conducted
Question 17	Indicator may not capture the type of data we need	Only timber is used as an indicator when the goal asks about multiple use opportunities. Different inputs may be needed.
Question 18	18.1 and 18.2: Indicator doesn't capture needs	18.1 and 18.2: A better method of data collection is needed to monitor work in subsections designated in the Plan

Monitoring Item	Reason for Review	Based on the evaluation of monitoring results, what changes may be warranted?[1]
	18.4: This indicator is not being met	18.4: We need to work toward meeting this objective, remove the indicator from our monitoring, or change this component of the Plan during the next revision
	18.5: This indicator is difficult to assess	18.5: Better mapping is needed along with better data collection to more accurately assess whether this objective is being met.
	18.8: We continue to exceed this objective each reporting year	18.8: During Plan revision this objective may need changed as we far exceed the amount outlined in our Plan each year
	18.9: We're not meeting this objective	
	18.10: This indicator still mentions "management indicator species"	18.9: Priority should be given on maintaining and improving the native grass areas that currently exist across the forest to help species such as bobwhite quail
	18.11: We continue to surpass this objective	18.10: Management Indicator Species is no longer something we monitor. Instead, we now look at focal species. This component needs updated during Plan revision.
	18.13: We're not meeting this objective	
	18.14: We're not meeting this objective	18.11: This objective may need to be revised when the Plan is updated
		18.13: This objective may need to be revised when the Plan is updated
		18.14: This objective may need to be revised when the Plan is updated.

[1] See body of the report for more details regarding any specific recommendations/opportunities for change.

2. 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 the 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.

3. 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 to 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 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.

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.
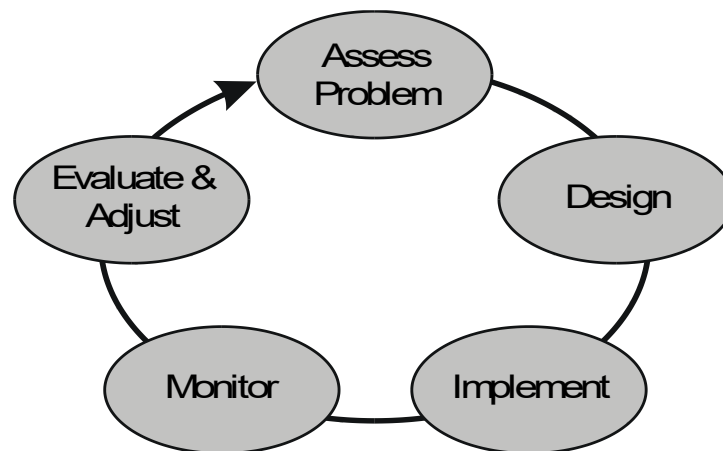
Figure 1: Evaluation and monitoring; feedback mechanism for adaptive forest management

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.

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 a value-added information 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.

4. 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 was 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 required under the current monitoring program are guided by the 2012 Planning Rule.

The Forest Plan for the Mark Twain National Forest was signed in 2005. Annual monitoring reports are available for the years 2006 to 2020. The most recent monitoring evaluation report was completed for fiscal years 2015 through 2020.

In 2014, final requirements for monitoring were changed under the 2012 Planning Rule, and this report is the third to be completed under the new 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 5.

In the 2015-2020 Monitoring Evaluation Report, major conclusions were:

- Monitoring is an integral part of each project and should be supported by all resource personnel. Due to the complexity of the information needed, and the breadth of resources involved, a position of Monitoring Coordinator should be added to the forest.
- Current staff have difficulty prioritizing monitoring due to the myriads of 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.
- We have a large amount of data that needs to be evaluated prior to starting Forest Plan revision.
- We should contract to assess data, evaluate results, and provide us with 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.
- 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
- 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.
- 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.
- 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.
- 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.

- 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.
- Question 17 includes only timber indicators, when the goal 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).
- Additional information is needed on stream conditions and the amount of large wood in the stream channels.
- 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.
- A better indicator for question 8 could perhaps be information on selected fish and aquatic species population trends in lakes and changes to amphibian populations in areas where the pools are created.
- 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
- 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.
- Additional old growth should be designated in management prescription 6.1 to meet the 2005 Forest Plan objective.
- 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.
- 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.
- 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.

5. Monitoring Activities During Fiscal Years 2020 – 2022

This section presents the specific monitoring questions that were addressed within this report. Section 6 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 2021 through fiscal year 2022 (October 1, 2020, through September 30, 2022) monitoring period, and their associated sections have been updated in Section 6.

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

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

Monitoring Question 3: Are vegetation management practices moving conditions towards desired natural community type

structural characteristics? (File Code 2200)

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

Monitoring Question 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? (File Code 5100)

Monitoring Question 6: 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: To what extent are fuel treatments affecting the successful suppression of wildfires? (File Code 5100)

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

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

Monitoring Question 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? (File Codes 2200 and 2600)

Monitoring Question 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? (File Code 2600)

Monitoring Question 12: 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: 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: To what extent are management activities meeting Recreation Opportunity Spectrum objectives? (File Code 2300)

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

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

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

Monitoring Question 18: 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: Are the effects of forest management, including prescriptions, resulting in significant changes to productivity of the land? (File Code 2500)

6. Monitoring Results

The last published monitoring evaluation report for the Mark Twain NF was for Fiscal Years 2015 through 2020. This current report builds upon the data and evaluations from that report along with the 2021 – 2022 report by analyzing trends across the years. This creates 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.

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)".

Question 1: To what extent is Forest management affecting water quality? (File Code 2500)

Last Updated

The 2020-2022 Mark Twain National Forest (MTNF) monitoring evaluation report concluded that, in general, best management practices are being implemented as required. Eighty-two percent of the best management practices that were inspected were either fully or mostly implemented. 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 are the resource areas with most of these issues.

Monitoring Indicator(s)

Best Management Practice (BMP) Implementation and Effectiveness Monitoring

Monitoring Frequency

BMP monitoring was first implemented on the MTNF in 2013. BMP monitoring and reporting is required on a biannual basis with different resource areas being monitored for compliance.

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 - 2.5 of the 2005 Forest Plan (FP). There are also standards and guidelines applicable to specific resource actions throughout the 2005 FP.

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, and 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 likely nonpoint source pollutant that would occur because of management activities on National Forest System land. The Clean Water Act Section 404 allows exemptions for discharge permits with the application of BMPs 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 by the implementation of BMPs. BMPs are established as standards in the 2005 Forest Plan.

In 2012, the National Best Management Practice Program was rolled out through a letter from the Deputy Chief and this was followed by the distribution of the National Core Best Management Practice Technical Guide. BMP monitoring began nationwide in 2013. 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 BMPs.

BMP monitoring is an interdisciplinary process that includes assessing the effectiveness of the best management practice applied to prevent a nonpoint source pollution, such as sediment, from entering a stream or waterbody. For example, waterbars are constructed on a skid trail when the timber harvesting of a unit is completed. Nationally, data from the evaluation forms are entered into a database and reports may be generated that compile all information. The data forms and pictures that were taken can be accessed through the Forest Service Dashboard Apps and locally can be found in the box folder R09MT 2500WatershedAirMgmt\BMP_Evaluations by FY.

Water quality data has not been 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 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 (https://waterdata.usgs.gov/mo/nwis/rt).

Other water quality data is collected 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 MTNF System lands is problematic since there are no watersheds where the MTNF manages 100 percent of the land. MTNF 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 seven watersheds have more than 40 percent National Forest ownership. Thirty-two of the 65 watersheds have 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 BMP effectiveness monitoring is used to answer this monitoring question.

The Forest collects 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- 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 monitoring data is entered into a database through the FS Apps application (https://fsapps.fs.usda.gov/). Data and reports can be retrieved from that database. National monitoring data is shared with the Environmental Protection Agency (EPA).

Field evaluations are used to determine whether appropriate site-specific BMP prescriptions were planned and implemented as intended. This includes reviewing the primary planning document to determine if provisions to protect water, aquatic, and riparian resources were included and if they were included, if they were fully successful. Between 2013 and 2024 there have been a total of 80 field evaluations and the tables below show overall scoring and summary by monitoring period.

Table 2: Implementation monitoring of field evaluations between 2013 and 2024

Implementation Rating	Number of Surveys per Implementation Rating	Percent of Surveys per Implementation Rating
Fully	43	54%
Mostly	20	25%
Marginally	9	11%
Not Implemented	5	6%
No BMPs	1	1%
Incomplete Data	2	3%

Table 3: Implementation monitoring field evaluations summary by monitoring period

Monitoring Period	Fully Implemented	Mostly Implemented	Marginally Implemented	Not Implemented	No BMPs	Incomplete Data
FY13-FY14	1	2	0	0	0	0
FY15-FY16	9	7	2	1	1	0
FY17-FY18	12	1	0	1	0	0
FY19-FY20	11	2	1	0	0	0
FY21-FY22	6	3	3	2	0	1
FY23-FY24	4	5	3	1	0	1
Monitoring Period	**% Fully Implemented**	**% Mostly Implemented**	**% Marginally Implemented**	**% Not Implemented**	**% No BMPs**	**% Incomplete Data**
FY13-FY14	33%	67%	0%	0%	0%	0%
FY15-FY16	45%	35%	10%	5%	5%	0%
FY17-FY18	86%	7%	0%	7%	0%	0%
FY19-FY20	79%	14%	7%	0%	0%	0%
FY21-FY22	40%	20%	20%	13%	0%	7%
FY23-FY24	31%	38%	23%	7%	0%	7%

In general, BMP implementation has successfully occurred, with 54 percent of the actions rated as fully implemented and 25 percent as mostly implemented. This is higher than the national averages of 39 percent and 22 percent, respectively. Sites rated as marginally or not implemented had no common or recurring issue. Each location had site specific issues that were different. The table below shows ratings for various resource areas monitored. Overall, the planning documents and on project activities include the implementation of BMPs and the Mark Twain Forest Plan and standards and guidelines.

Table 4: Watershed best management practice implementation monitoring by resource.

Resource Monitored	Total Sites Monitored	FY13-FY14	FY15-FY16	FY17-FY18	FY19-FY20	FY21-FY22	FY23-FY24
Aquatic Ecosystem	2				Fully-1		Marginally-1
Chemical	2						Mostly-2
Fire	20	Fully-1 Mostly-1	Fully-5	Fully-4	Fully-3	Fully-1 Mostly-2 Marginally-1	Mostly-2
Mineral	3					Not Impl-1	Fully-1 Marginally-1
Range	2	Mostly-1					Mostly-1

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Recreation	16		Fully-2 Mostly-3 Marginally-1 No BMPs-1	Fully-1 Mostly-1	Fully-2 Mostly-1	Fully-2 Marginally-1 Incomplete-1	
Road	15		Fully-1 Marginally-1 Not Impl-1	Fully-3 Not Impl-1	Fully-3	Fully-1 Marginally-1 Not Impl-1	Marginally-1 Not Impl-1
Vegetation	19		Fully-1 Mostly-4	Fully-4	Fully-2 Mostly-1 Marginally-1	Fully-2 Mostly-1	Fully-1 Mostly-2

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 2022 there have been a total of 80 field evaluations. The tables below show overall scoring for effectiveness and a summary by monitoring period and resource areas.

Table 5: Effectiveness monitoring of field evaluations between 2013 and 2024

Effectiveness Rating	Number of Surveys per Effectiveness Rating	Percent of Surveys per Effectiveness Rating
Effective	52	65%
Mostly	2	3%
Marginally	5	6%
Not	19	24%
Incomplete Data	2	3%

Table 6: Effectiveness monitoring of field evaluations summary by monitoring period

Monitoring Period	Effective	Mostly Effective	Marginally Effective	Not Effective	Incomplete Data
FY13-FY14	1	0	1	0	1
FY15-FY16	10	1	0	9	0
FY17-FY18	10	0	1	3	0
FY19-FY20	10	0	2	2	0
FY21-FY22	8	1	1	4	1
FY23-FY24	13	0	0	1	
Monitoring Period	**% Effective**	**% Mostly Effective**	**% Marginally Effective**	**% Not Effective**	**% Incomplete Effective**
FY13-FY14	33%	0%	33%	0%	33%
FY15-FY16	50%	5%	0%	45%	0%
FY17-FY18	71%	0%	7%	21%	0%
FY19-FY20	71%	0%	14%	14%	0%
FY21-FY22	53%	7%	7%	27%	7%
FY23-FY24	93%	0%	0%	0%	7%

In general, 68 percent of the sites evaluated for BMP effectiveness were considered effective or mostly effective (65% Effective, 3% Mostly Effective) at preventing pollutants from entering the stream. This is above the national average of 67 percent (58 percent effective and 9 percent mostly). Common issues include a lack of cross drains or incorrect cross drain spacing on fire lines, roads, and trails. The table below includes more detailed information about various resource areas.

Table 7: Watershed best management practice effectiveness monitoring by resource.

Resource Monitored	Total Sites Monitored	FY13-FY14	FY15-FY16	FY17-FY18	FY19-FY20	FY21-FY22	FY23-FY24
Aquatic Ecosystem	2				Effective-1		Effective-1
Chemical	2						Effective-2
Fire	20	Effective-1 Marginally-1	Effective-3 Not-2	Effective-3 Not-1	Effective-3	Effective-3 Marginally-1	Effective-2
Mineral	1					Not-1	Effective-2
Range	1	Inc. Data-1					Effective-1
Recreation	16		Effective-1 Mostly-1 Not-5	Marginally-1 Not-1	Effective-1 Marginally-1 Not-1	Effective-1 Mostly-1 Not-2	
Road	13		Effective-1 Not-2	Effective-3 Not-1	Effective-2 Not-1	Effective-2 Not-1	Effective-1 Not-1
Vegetation	16		Effective-5	Effective-4	Effective-3 Marginally-1	Effective-2 Inc. Data-1	Effective-3

In terms of protecting the integrity of the watersheds, our 12 years of effectiveness monitoring has shown that 2005 Forest Plan standards and guidelines regarding soil and water BMPs are effectively working (preventing sediment from reaching the stream). About 65 percent of the areas inspected showed that implementation of BMPs was fully effective at eliminating or reducing soil movement off-site. There are cases where BMPs have not been completely successful. Many 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 are the resource areas identified as most often having issues.

Overall, the MTNF has done well with BMP implementation and effectiveness in the twelve years of monitoring. While there are only five instances of BMPs not being implemented in 12 years, one of those occurred in the most recent monitoring period. Also, there was one not effective rating for BMPs in the most recent rating period.

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 MTNF, 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 on the MTNF.

Recommendations
Site-specific issues discovered during field monitoring trips should be dealt with on a case-by-case basis. Increase training opportunities especially for newer employees and fill the Forest Hydrologist position.

Evaluation of Monitoring Question and Indicator(s)
Best management practice monitoring is a national requirement. The Forest will continue to monitor water quality according to national and regional direction.

References
National BMPs website https://www.fs.usda.gov/naturalresources/watershed/bmp.shtml

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 https://waterdata.usgs.gov/mo/nwis/rt

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

Question 2: To what extent is Forest management affecting priority watershed condition? (File Code 2500)

Last Updated
The Mark Twain National Forest's three priority watersheds were initially scored in 2011 or 2012, reviewed in 2016 and in 2021. Watershed Restoration Action Plans (WRAP) were also reviewed and updated in 2021. Maps identifying the watershed conditions and the WRAPs are found on the Watershed Condition Framework website https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=f4332e5b80c44874952b57e1db0b4407.

Monitoring Indicator(s)
Watershed Condition Class scores are calculated using a 12-indicator model that includes 25 attributes (Figure 1). The indicators are grouped according to four major process categories: (1) aquatic physical, (2) aquatic biological, (3) terrestrial physical, and (4) terrestrial biological. Each attribute is rated and used to develop a watershed condition score. Using this score watersheds are rated as either 1) Functioning Properly, 2) Functioning at Risk or 3) Functionally Impaired.
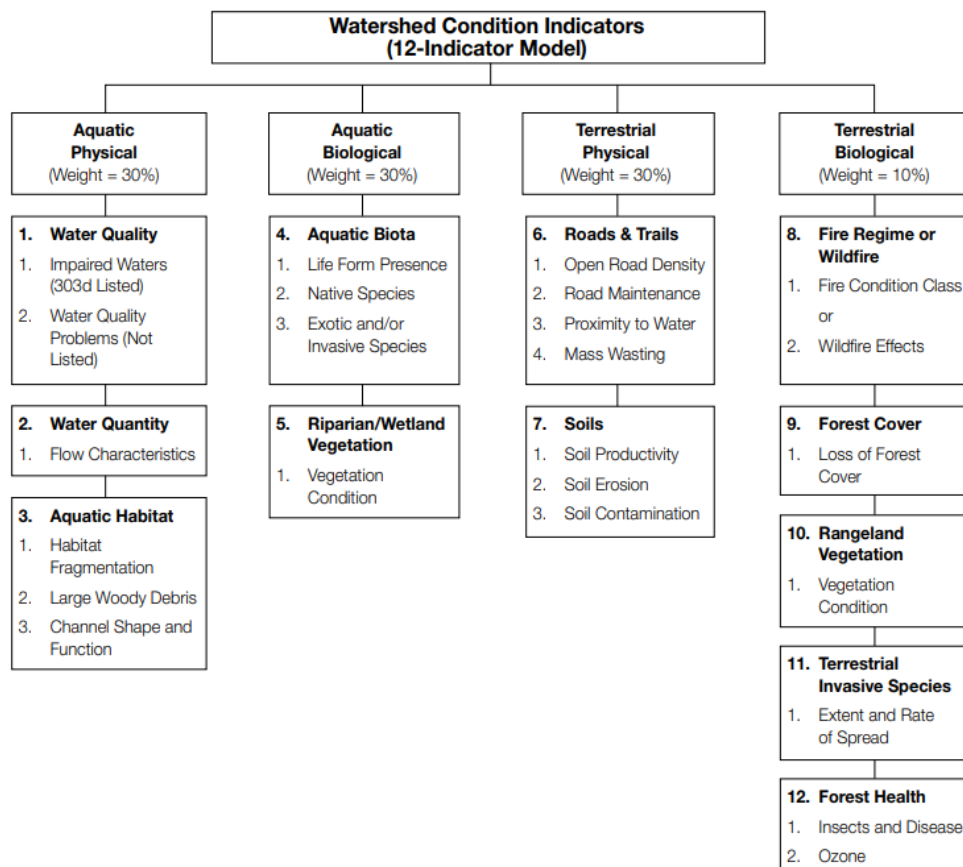
Figure 2: Watershed Condition Indicators Model

Monitoring Frequency
Each priority watershed is evaluated on an as needed basis once treatments identified in the WRAPs have been completed. The Forest plans to reevaluate the priority watersheds in 2025 once a new Forest Hydrologist is hired.

Background & Driver(s)
In 2011, the Forest Service directed Forests to 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. The priority watersheds are the Mill Creek Watershed on the Houston-Rolla-Cedar Creek Ranger District and the Headwaters Big Barren Creek and Big Barren Creek Watersheds both located on the Eleven Point Ranger District. Watershed plans and progress are documented in the 2021 Transition Watershed Restoration Action Plans. Physical location tracking of on-the-ground work is reported in Watershed Improvement Tracker (WIT) database.

Monitoring Indicator 1
See description above under Monitoring Indicator(s) heading.

Results and Discussion
The Mark Twain National Forest's priority watersheds were initially scored in 2011 or 2012, reviewed in 2016 and reevaluated in 2021. The table below shows the ratings for each indicator and the priority watershed's current overall ratings. The indicator ratings for all three watersheds have remained stable. The overall ratings have not changed and with a lower percentage of the Big Barren and Mill Creek watersheds under MTNF management it is more difficult for the Forest Service to manage the watersheds in a manner that produce substantial increase in the function of these watersheds. Overall, these watersheds remain fairly stable and all watersheds, not only priority watersheds, will get a full reevaluation in 2025.

Table 8: Priority Watershed Ratings

Watershed Name	Headwaters Big Barren Creek	Big Barren Creek	Mill Creek
Watershed Code	110100080605	110100080606	102902030107
Watershed Condition FS Area	Functioning Properly	Functioning at Risk	Functioning at Risk
Total Watershed Area Acres	20,778	26,326	29,801
FS Ownership Percent	89	70	60
Non-FS Area Percent	11	30	40
Aquatic Biota Condition	Good	Good	Fair
Riparian/Wetland Vegetation Condition	Fair	Fair	Poor
Water Quality Condition	Good	Good	Good
Water Quantity Condition	Fair	Poor	Fair
Aquatic Habitat Condition	Good	Poor	Fair
Road and Trail Condition	Fair	Fair	Fair
Soil Condition	Good	Good	Good
Fire Effects/Fire Regime Condition	Fair	Poor	Poor
Forest Cover Condition	Good	Good	Good
Forest Health Condition	Good	Good	Good
Terrestrial Invasive Species Condition	Fair	Fair	Fair
Rangeland Vegetation Condition	Fair	Fair	Fair

Watershed Restoration Action Plan	The Current River Watershed Restoration Plan	The Current River Watershed Restoration Plan	Mill Creek

Recommendations

Projects identified in WRAPs should continue to be implemented as part of integrated resource projects. Reevaluate all watersheds in 2025.

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. The Forest should continue to follow national and regional directions for determining watershed health.

References

U.S. Department of Agriculture, Forest Service. 2011. Watershed Condition Framework.
https://www.fs.usda.gov/naturalresources/watershed/condition_framework.shtml

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

Status of Select Ecological Conditions Including Key Characteristics of the Terrestrial and Aquatic Ecosystems

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

Last updated

The 2021-2022 monitoring evaluation report summarized Floristic Quality Assessment (FQA) data from the Pineknot and Cane Ridge areas, discussed the implementation of the Community Health Index (CHI) monitoring protocol, and noted the availability of Forest Inventory and Analysis (FIA) data as sources of information to evaluate the results of vegetation management practices. Overall, CHI is now considered the primary method for assessing changes in structural characteristics of areas managed for natural community restoration to determine if desired conditions are being achieved.

While development and implementation of CHI is still ongoing, available data indicate that management practices are improving the structures of natural communities. 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, understory thinning, and prescribed fire. Additional monitoring is needed as CHI protocols are developed for additional natural community types. Pre-treatment and periodic post-treatment monitoring will help monitor changes and support adaptive management.

The previous monitoring report noted that additional data collection and analysis of existing data is needed before assessing if this monitoring question and indicator need to be changed or adjusted.

Monitoring Indicators

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

Table 9: Selected structural parameters for respective natural community types in management prescriptions 1.1 and 1.2.

Natural Community Types	% Canopy	Basal area	Understory	Shrub layer	% Ground cover
Prairie	<10	NA	NA	Sparse	90-100
Savanna	10-30	<30	Scattered oaks and shrubs	Dense; mostly scattered oaks and other shrubs	90-100 grasses dominant
Open Woodland	30-50	30-50	Mixed shrubs, early-mid seral	Dense; mostly scattered oaks and various shrubs	60-80 grasses dominant
Closed Woodland	50-80	50-90	Early-mid seral trees	Sparse; mostly scattered oak and various shrubs	80-100
Upland Forest	80-100	80-100	Shade tolerant shrubs and small trees	Sparse; scattered; vines present	50-70
Bottomland Forest	80-100	80-100	Shade tolerant shrubs and small trees	Sparse; vines present	50-70
All glade types	<10	NA	Small shrubs and trees restricted to rock outcrops and borders	Variable	30-90 grasses dominant
Fen	<10	NA	NA	Dense to sparse or none; variable	90-100

Monitoring Frequency

Annual, with site revisits at three-year increments or before and/or after additional treatments occur.

Background & Driver(s)

The 2005 Forest Plan emphasizes restoration and maintenance of sustainable and healthy natural communities. This question is related 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." Management prescriptions 1.1 and 1.2 target natural community restoration in roaded and semi-primitive motorized areas, respectively. Tables 1-1 and 1-2 of the 2005 Forest Plan include the desired percentage of community types by ecological subsection in management prescription areas 1.1 and 1.2 respectively (USDA Forest Service 2005, p. 1-2). The percentage 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.

Various parameters for categorizing and evaluating natural communities are included in table A-1 of the 2005 Forest Plan. Many of these parameters are included in various data collection efforts, including forest inventory and analysis (FIA), FQA, and CHI monitoring. Selected parameters (displayed in table 1) are used as the indicator for this question.

Monitoring Indicator 1

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

Results and Discussion

The ability to effectively monitor at the landscape-scale has long been noted as a short-coming in previous monitoring reports. In recent years, the development and increasing implementation of CHI has begun to fill that gap and provide valuable information for more holistically evaluating the results of restoration activities. The CHI monitoring protocol is a semi-rapid assessment tool that assesses a range of parameters, including landscape context, overstory structure, and vegetation. Each protocol is designed specifically to evaluate a given group of like ecological sites as defined by Terrestrial Ecological Unit Inventory (TEUI) and data that has been collected over the last 5 years. Some data are preliminary, as they were gathered during protocol development, but they are still useful in detecting changes in the parameters specified in Table A-1 for this indicator.

Much of the CHI development work was initially focused on the pine-oak community type in the Collaborative Forest Landscape Restoration Project (CFLRP) area on the forest. A report (Leahy et al., 2024), discussed below, demonstrates the utility of the CHI protocol for detecting changes in the vegetation structure.

Available monitoring information is summarized by the ecological site group below. Landscape-scale woodland management contains a range of woodland characters defined by structural conditions, from open to closed woodlands and even savanna. CHI monitoring in woodlands is conducted across a range of conditions but divided by ecological site group. Therefore, the results are summarized by community type, but the sites could fall across the range of open to closed woodlands. It is important to note that due to the recency of the CHI tool, data are limited or lacking for some natural community types and completely lacking in many locations of the Forest. As additional protocols are finalized and monitoring activities implemented, more data will be available to determine the impact of vegetation management activities on natural community structure.

Note: percent ground cover is discussed in greater detail in Question 4 and was not discussed in this section.

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).

Open and Closed Woodlands: Pine-Oak Woodlands

In 2024, we published a report entitled: Monitoring the Ecological Response to Restoration Treatments in the Missouri Pine-Oak Woodland Restoration Project of the Mark Twain National Forest (Leahy et al., 2024). The report provides initial results from implementation of CHI and discusses how it compares to other monitoring. Forty of the 59 units discussed in the report were part of management units in the Missouri Pine-Oak Woodland Restoration Project. Many of these results were also discussed in the 2021-2022 monitoring report and also in Question 4 of this report. A few key findings are summarized here. In general, areas that have been under management the longest had higher scores, with reduced stocking and a more developed ground cover.

- Percent Cover – Average canopy cover for the highest scoring sites was 65% whereas the lowest scoring sites was 81%. There is a weak negative correlation between canopy closure and the CHI score.
- Stocking – Average stocking for the highest scoring sites was 60% compared to 81% for the lower scoring sites. There is a weak negative correlation between canopy closure and the CHI score.
- Understory & Shrub Layer – The CHI showed a negative correlation between the midstory cover and the herbaceous ground cover score. Denser midstories had a negative impact on the herbaceous layer. Areas with a high percentage cover of Rubus and Rhus species showed a moderate negative correlation with stocking, indicating that canopy openness could contribute to increased growth of Rubus and Rhus species.
- Percent Ground Cover – Grass, sedge, and forb cover was significantly higher in the highest scoring areas, indicating longer-term management positively impacts this metric. This is covered in more detail in Question 4.

These results help provide insight as to what management activities might be needed to achieve higher scores in certain areas. For example, areas with higher stocking may need additional thinning or midstory removal to improve the herbaceous component of a site. Conversely, areas that are very open may cause excessive shrubbery and Rhus/Rubus cover. The report also discusses the importance of prescribed fire on overall community health. Those with the longest

history of prescribed fire generally had the highest scores. 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.

Glades

Dolomite glades in the Ava/Cassville/Willow Springs district were monitored in 2020 – 2021 and these data are discussed under Question 4 of the 2021-2022 monitoring report. No additional CHI data has been collected in this area. Much of this data is considered the baseline, which will be useful in the future for this monitoring indicator as additional post-management data is collected.

A summary table of information from the Arcadia South proposed project area is provided below. The scores ranged from -4 to 44. Negative points are possible if the area is impacted by certain factors, for example extensive hardwood cover, cedar cover, non-native invasive plants, or feral hog activity. This pre-management data captures the eastern red cedar canopy, other tree canopy, midstory, understory, warm season grasses, and native forb cover. The table is sorted by score, from lowest to highest. While there are numerous parameters that contribute to the final CHI score and the dataset is too small to show strong trends, there are a few notable observations. In general, there is a relatively high percentage of cedar cover across these unmanaged glades. The lowest scoring sites have a higher midstory cover. In contrast, the highest scoring units have lower tree canopy, lower midstory, and lower understory cover (outlined in bold in table below). The highest scoring unit had the highest percentage cover of native forb cover. If approved, the project is anticipated to have positive impacts on these indicators and the quality of those igneous glade natural communities. Additional data about the herbaceous species are discussed under Question 4.

Table 10: Summary of igneous glade CHI results from the Arcadia South project area. Percent cover data is collected as a range across each unit. The table is arranged by scores from lowest to highest.

| Unit ID | Acreage of Unit | Percent (%) Cover Range | | | | | | CHI Score |
		Eastern Red Cedar	Other Trees	Midstory	Understory	Warm Season Grasses	Native Forbs	
F1	9.3	26-50	6-25	51-75	26-50	6-25	6-25	-4.0
F3	26.6	51-75	26-50	51-75	6-25	6-25	6-25	2
G1	31.3	26-50	6-25	26-50	6-25	6-25	26-50	3.0
H1	18.8	26-50	6-25	26-50	1-5	6-25	6-25	11.0
C1	5.5	26-50	6-25	26-50	6-25	6-25	26-50	12.0
H2	22.7	26-50	1-5	6-25	6-25	6-25	26-50	14.0
A1	5.2	6-25	6-25	6-25	6-25	6-25	6-25	19.0
H4	15.8	51-75	26-50	6-25	6-25	1-5	1-5	19.0
D1	5.6	51-75	6-25	6-25	1-5	1-5	1-5	22.0
D2	13.2	26-50	6-25	6-25	1-5	6-25	6-25	24.0
H3	10.7	26-50	6-25	26-50	6-25	1-5	6-25	28.0
G3	8.2	26-50	6-25	26-50	1-5	6-25	6-25	32.0
F4	4.5	26-50	1-5	26-50	6-25	6-25	26-50	41.0
E1	38.0	26-50	1-5	6-25	1-5	6-25	26-50	43.0
G2	32.4	26-50	1-5	1-5	1-5	6-25	51-75	44.0

Bottomland Hardwood Forest

There are several bottomland hardwood forest types on the Mark Twain. Management of these areas are discussed in detail under Question 18.5. There are currently no specific monitoring data to assess these parameters for bottomland hardwood forests.

Recommendations

The CHI data indicates that management activities are supporting the restoration of natural communities, as measured by the parameters in Table A. Additional periodic monitoring should be conducted to detect changes and facilitate adaptive management.

Some natural communities are not routinely monitored, in part because the management activities are less frequent. A plan should be developed to periodically assess these smaller or less intensively managed components of the forest.

Evaluation of Monitoring Question and Indicator(s)

Initial implementation of CHI has provided useful results and resulted in the increased adoption and implementation of this monitoring tool across project areas. Continued work to develop protocols, conduct periodic monitoring following management, and evaluation of the data should support adaptive management of natural communities on the forest. These will also inform any changes needed to the parameters listed in this indicator for future monitoring reports.

The natural community types and ecological parameters listed in table A-1 were created at the infancy of the practice of natural community management. Years of data collection may support a change in the characterization and ranges of parameters for some community types. For example, 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.

As explained in previous monitoring reports, FQA and FIA data are available and potential sources of information to track trends in the parameters for this monitoring indicator. They have been evaluated at various times to meet project needs, but it is recommended that these data be evaluated more holistically and prior to the next Forest Plan revision to ensure these indicators are appropriately capturing the changes in desired conditions and that management activities are achieving objectives.

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).

U.S. Department of Agriculture, Forest Service. 2024 Monitoring the Ecological Response to Restoration Treatments in the Missouri Pine-Oak Woodlands Restoration Project of the Mark Twain National Forest. Leahy et al. 2024_MOPWR_Monitoring_Report (usda.gov)

Question 4: Are restoration activities increasing plant species richness and native plant cover on woodlands, glades, and forests? (File Code 2200)

Last Updated

The 2021-2022 monitoring evaluation report for the Mark Twain National Forest concluded that available data indicates plant species richness and native plant cover are increasing on woodlands, glades, and forests managed with thinning and prescribed fire. In some cases, pre-management baseline data was collected in project areas, which can help set realistic restoration objectives. Continued management and periodic monitoring of representative sites will enable future detection of changes and support adaptive management.

The report also included three recommendations for the monitoring indicator and frequency:
(1) Annual monitoring frequency for species richness and cover may not be meaningful on a biological time scale. Evaluating trends in these indicators may be more useful in understanding if our management is achieving the objectives set forth in the 2005 Forest Plan.
(2) Floristic Quality Assessment (FQA) fixed plot data should continue to be collected as funds permit and as needed as management activities are completed.
(3) Community Health Index (CHI) assessments should be completed within project areas that emphasize natural

community restoration (primarily management prescriptions 1.1 and 1.2), both during the planning phase and after completion of vegetation treatments.

Monitoring Indicators
Change in native species richness and cover

Monitoring Frequency
Periodically

Monitoring Indicator 1
Change in native species richness and cover

Results & Discussion
Monitoring the woodland restoration projects in Management Areas 1.1 and 1.2 show response in ground flora production and species diversity. The Community Health Index (CHI) monitoring protocol was implemented on several project areas over the last 5 years and results are showing it is a useful tool for characterizing changes in community conditions because of management. Much of the CHI development work was initially focused on the pine-oak community type in the Collaborative Forest Landscape Restoration Project (CFLRP) area on the forest. A report (Leahy et al., 2024), discussed below, demonstrates the utility of the CHI protocol for detecting changes in the herbaceous community. The tool has now been deployed in additional natural communities and project areas, including glades in the Ava/Cassville/Willow Springs and Potosi/Fredericktown Districts. The Salem District has also used the pine-oak woodland protocol to establish pre-management baseline condition information. Monitoring information is summarized by the project area below.

Missouri Pine-Oak Woodland Restoration Project

The Missouri Pine-Oak Woodland Restoration Project was funded through the CFLR program and covers parts of the Eleven Point and Poplar Bluff Districts. As stated in previous monitoring reports, a summary analysis of the FQA vegetation monitoring plots of data collected from 2000 to 2017 was completed for the Pineknot and Cane Ridge sites. All treatment plots showed an increase in native cover and plant species richness with restoration activities (thinning and prescribed fire). Evaluation of this monitoring effort identified the limitations of those monitoring data at the landscape level and resulted in the development of the Community Health Index (CHI), as described in previous monitoring reports.

In 2024, the *Monitoring the Ecological Response to Restoration Treatments in the Missouri Pine-Oak Woodland Restoration Project of the Mark Twain National Forest* (Leahy et al., 2024) was finalized. The report provides initial results from implementation of CHI and discusses how it compares to other monitoring. Forty of the 59 units discussed in the report were part of the management units in the Missouri Pine-Oak Woodland Restoration Project. The results are discussed in the FY2021-22 monitoring report. A few key findings are summarized below as it relates to restoration of pine-oak woodlands.

Overall, the results found positive correlations between the number of prescribed fires in the last 20 years and the overall CHI score and the herbaceous layer component of the CHI score (Figure 1). This indicates that areas with a longer history of fire management have higher CHI scores, and that fire is particularly important for the herbaceous community.
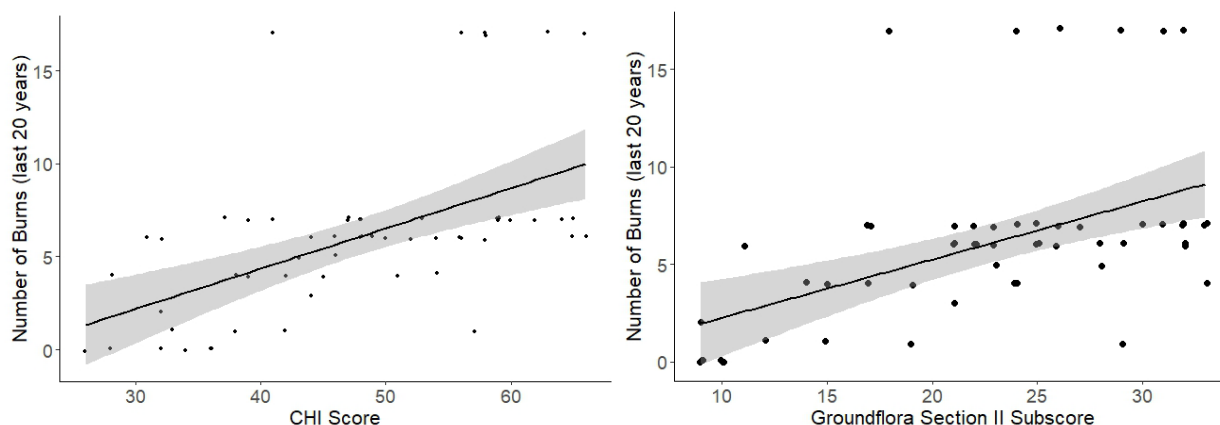
Figure 3: The graph on the left shows the moderate positive correlation (r=0.5) of the total CHI score to the number of burns in the last 20 years. The graph on the right shows the ground flora (matrix and conservative species) score versus number of burns in the last 20 years. The ground flora score has a moderate positive correlation (r=0.51) with prescribed fire activities. Grey area indicates confidence interval.

The CHI scores were placed into 5 equal groups based on the range of scores and the results show that the highest scoring units (top 20% of scores) had a very different profile than the lowest scoring areas (bottom 20%), as summarized in Table 1. On average, the highest scoring units had 9 times more native grass and sedge cover, and 7 times more flowering plant cover. The protocol also looks at native plant species based on their coefficient of conservatism, or C-value. C-values range from 1 to 10 and are assigned based on how sensitive a species is to changes in habitat. Species with low C-values can more easily colonize disturbed areas (e.g., roadsides, yards, or other places that have been disturbed). Matrix plant species have mid-range C-values (4 to 6). High C-value plants (7 to 10), known as conservative species, are sensitive to changes in the habitat and so are only expected in places that have retained their integrity. The highest scoring CHI units had 1.7 times more matrix plant species and 2.5 times more conservative species than the lowest scoring units. This indicates the CHI protocol is effectively tracking key parameters related to natural community structure and composition, and it could be an effective long-term monitoring tool to measure results of management.

Table 11: Summary of select CHI results categorized by quintile (0-20, 20-40, 40-60, 60-80, 80-100). The larger the quintile the higher the CHI score.

Quintile	Average graminoid cover (%)	Average forb cover (%)	Average # matrix species (C-value 4-6)	Average # conservative species (C-value 7 -10)
80-100	15.9 ± 7.3	43.8 ± 10.8	64.0	19.0
60-80	11.9 ± 9.6	34.2 ± 16.2	53.1	14.5
40-60	6.8 ± 5.8	32.3 ± 17.0	54.1	14.0
20-40	8.2 ± 6.2	17.8 ± 10.2	36.5	9.9
0-20	1.8 ± 1.3	5.8 ± 5.4	36.3	6.0

It is important to note that the restoration potential of sites will vary depending on several factors, including site quality and land use history. During the restoration process, the data indicates prescribed fire has a beneficial effect on the ground flora with the increasing number of burns. After a site reaches its maximum restoration potential, prescribed fire activity should continue to be important for maintaining the herbaceous community, but additional significant increases in species richness would not be expected. Continued monitoring of species richness will also be important to identify any negative impacts of repeated prescribed fire on the herbaceous plant community.

The FY2021-22 monitoring report includes a summary table of the data collected on Pine-Oak Woodland and Ozark Acidic Oak Woodland sites. Those data were collected using provisional protocols. The pine-oak woodland protocol was finalized and 8 of these same units were sampled during the 2024 growing season to establish baseline data under the finalized protocol. Additional sampling is anticipated to reestablish the baseline for the remainder of the units and the complete results should be available for the next monitoring report.

Ava Glades
In 2021, 16 Bald Knob Dolomite Glade units were sampled using CHI. The results are summarized in the FY2021-22 monitoring report. No additional sampling has occurred on these units.

Arcadia South Project Area
Arcadia South is a proposed project on the Fredericktown unit of the Potosi/Fredericktown District. As part of the planning effort, staff collected CHI data on 15 igneous glade units covering approximately 250 acres. The protocol includes a species list with 33 matrix plant species and 32 conservative plant species . The scores ranged from –4 to 44. Negative points are possible if the area is impacted by certain factors, for example extensive hardwood cover, cedar cover, non-native invasive plants, or feral hog activity. Table 2 summarizes some of the score information. There is a range of conditions, but overall, these igneous glades would not be considered high quality representations of this natural community in the region. They are not currently managed, and the herbaceous plant species diversity and abundance is low. Management is proposed and, if approved, this data will serve as a good baseline for determining the impacts of future activities.

In addition, botanical experts conducted a survey in 2023 of the project area, with emphasis on the igneous glades. They did not find any species of conservation concern on the glades, but did identify 235 native species present and 6 invasive species. The mean C-value of the native plants was 4.5, which indicates an herbaceous community of moderate quality with potential for restoration and recovery.

Table 12: Summary of igneous glade CHI results from the Arcadia South project area. Frequency ratings are: Not Present, Sparse (seen in <33% of the area), Frequent (seen in 33-66 % of the area), and Very Frequent (seen in >66% of the area).

Unit ID	Unit Acres	# Matrix Species	Frequency Matrix Spp.	# Conservative Spp.	Frequency Cons. Spp.	% Cover Red cedar	% Cover Other Trees	**CHI Score**
A1	5.2	10	Frequent	6	Sparse	6-25	6-25	**19**
C1	5.5	10	Frequent	3	Sparse	26-50	6-25	**12**
D1	5.6	10	Frequent	2	Not present	51-75	6-25	**22**
D2	13.2	14	Frequent	5	Not present	26-50	6-25	**24**
E1	38	15	Frequent	3	Not present	26-50	1-5	**43**
F1	9.3	14	Sparse	4	Sparse	26-50	6-25	**-4**
F3	26.6	11	Frequent	4	Sparse	51-75	26-50	**2**
F4	4.5	13	Frequent	4	Sparse	26-50	1-5	**41**
G1	31.3	8	Frequent	3	Not present	26-50	6-25	**3**
G2	32.4	12	Frequent	4	Not present	26-50	1-5	**44**
G3	8.2	11	Frequent	5	Not present	26-50	6-25	**32**
H1	18.8	11	Sparse	2	Sparse	26-50	6-25	**11**
H2	22.7	7	Sparse	2	Sparse	26-50	1-5	**14**
H3	10.7	12	Sparse	2	Sparse	26-50	6-25	**28**
H4	15.8	9	Sparse	x	Sparse	51-75	26-50	**19**

Bee Fork Project Area
In 2024, the Salem District assessed 26 pine-oak woodland units using CHI. Most of the units have not been actively managed in recent years and the district is proposing thinning and/or burning activities in the project area. The sampling will serve as baseline data to measure the impacts of future management on the restoration work. Table 3 includes a

25

summary of some of the metrics collected. This protocol includes a plant list with 71 species, with 46 matrix species and 25 conservative species. Overall, there were a fair number of matrix species present frequently across most units. Conservative species were observed less often and characterized as sparse in the project area. The expectation is that management should increase both the frequency of the herbaceous species and if the seed bank is still intact then the number of species should also increase.

Table 13: Summary of pine-oak woodland CHI results from the proposed Bee Fork project area. Frequency ratings are: Not Present, Sparse (seen in <33% of the area), Frequent (seen in 33-66 % of the area), and Very Frequent (seen in >66% of the area).

Unit ID	Unit Acres	# Matrix Species	Frequency Matrix Spp.	# Conservative Spp.	Frequency Cons. Spp.	CHI Score
U	28	28	Frequent	5	Sparse	33
O	50	26	Frequent	5	Sparse	38
N	24	21	Frequent	4	Sparse	36
S	34	24	Frequent	7	Sparse	48
D	22	26	Frequent	10	Sparse	44
W	27	24	Frequent	5	Sparse	37
M	37	29	Very Frequent	12	Sparse	62
Z	19	24	Frequent	7	Sparse	41
Q	21	22	Frequent	4	Sparse	34
F	28	26	Frequent	7	Sparse	35
AB	20	23	Frequent	4	Sparse	33
T	47	27	Frequent	7	Sparse	41
I	26	23	Frequent	7	Sparse	41
AA	51	22	Frequent	8	Sparse	38
AC	28	23	Frequent	7	Sparse	41
R	26	30	Frequent	11	Sparse	49
J	24	24	Frequent	9	Sparse	43
P	30	24	Frequent	5	Sparse	41
C	25	30	Frequent	7	Sparse	43
Y	21	27	Frequent	8	Sparse	40
V	31	28	Frequent	9	Sparse	41
E	25	28	Frequent	11	Sparse	38
H	22	26	Frequent	10	Sparse	39
B	31	23	Frequent	5	Sparse	35
A	28	28	Frequent	6	Sparse	37
K	26	18	Sparse	5	Sparse	26

Recommendations

In the Missouri Pine-Oak Woodland Restoration Project area, the available monitoring data indicates the restoration efforts are positively impacting the herbaceous community, increasing both richness and abundance. The CHI data demonstrates that the thinning and burning activities have positively impacted the overall woodland structure, including the quality of the ground flora. Some data have indicated areas that could lead to potential problems, for example an overly abundant midstory layer may interfere with quality of the herbaceous community. Continued periodic monitoring of CHI units and selected FQA plots should help detect those changes.

The Ava Glades CHI monitoring, as discussed in the previous report, ranked 10 areas as functioning and 6 were considered departed. In some cases, a high percentage of eastern red cedar cover resulted in lower scores. The mean C-value of the herbaceous ground flora was also a factor and those areas with higher herbaceous community scores had higher overall CHI scores. Continued monitoring of these areas following management activities (where applicable) should help identify changes and inform future management. For example, those units with a high percentage of eastern red cedar cover could likely be improved by reducing the cover of this species. It's important to note that the land use history in this area may be a limiting factor for some sites to achieve higher scores. Grazing or other land uses may have diminished the herbaceous plant community and seeding would be needed to increase the species richness and cover.

The monitoring data discussed for the Bee Fork and Arcadia South proposed project areas are considered baseline and will provide a good foundation for detecting natural community responses to management. Continued periodic monitoring following vegetation treatments is recommended.

Evaluation of Monitoring Question and Indicator(s)

The monitoring question is aimed at identifying if management activities are positively impacting the herbaceous community. Measuring species richness and cover is the selected method for assessing that impact, but as noted in previous reports, this has been done on a more periodic basis rather than annually. Species richness and cover are good indicators of the quality of an herbaceous community. However, the methodology for obtaining this information and the frequency for gathering this information should consider the rate of measurable change as management activities are implemented.

Early monitoring reports relied on FQA plot data to answer this question, and more recent reports have included CHI data. The FQA fixed plots are an intensive sampling method that provides high-quality botanical information with a complete inventory of the species encountered on each plot. Species richness and cover can be calculated from FQA plots, but the extent of these plots is limited and annual remeasures are impractical at scale due to the costly nature of the data collection. CHI is a more rapid assessment that provides additional information about the natural community and across a larger number of acres. Together, the measurement of FQA plots with CHI assessments provides monitoring that is more meaningful at the landscape scale while retaining a component of high-quality botanical information that is important for detecting and monitoring species of conservation concern.

The following recommendations are provided to improve future monitoring efforts:

- CHI monitoring should be used to supplement FQA data, providing additional landscape context and structural characteristics that can better inform adaptive management.
- FQA fixed plot data should continue to be collected as funds permit, to support project development and monitor changes. The following changes should be considered for the sample design and implementation of FQA monitoring:
    - Reduce the size of the plots to ensure they do not extend across multiple natural community types and discontinue sampling the overstory.
    - Evaluate each plot and discontinue sampling or abbreviate plots that are negatively influenced by roads, trails, utility rights-of-way and other human disturbances.
    - Discontinue sampling or abbreviate 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.
    - Pair the FQA plots with a CHI assessment for the natural community.
    - Document each ecological site description for each FQA plot.
- Change the monitoring frequency to timeframes that are more relevant for the project areas. Management is discontinuous and having periodic remeasurement of the CHI plots and selected FQA plots to reassess changes in the herbaceous community following management activities (or lack thereof) would be more efficient and provide relevant information to support decision-making.

The recommendations above allow us to better address the Forest Plan monitoring questions 5.21 and 5.22. It should improve monitoring efficiency and reduce costs, while providing an approach that is more flexible, holistic and meaningful to land managers.

References

Ava Ranger District Floristic Quality Assessment Report, Jacob Hadle and Justin Thomas, NatureCite 2020.

Cane Ridge Floristic Quality Assessment Report. Jacob Hadle and Justin Thomas, NatureCite 2019.

Ladd, D., and J. R. Thomas. 2015. Ecological Checklist of the Missouri Flora for Floristic Quality Assessment. Phytoneuron 2015-12: 1-274.

Miller, J. E. D. and E. Damschen. 2017. Holding the line: Three decades of prescribed fires halt but do not reverse woody encroachment in naturally fragmented grasslands. Landscape Ecology 32(12): 2297-2310.

Pineknot Floristic Quality Assessment Report, Jacob Hadle and Justin Thomas, NatureCite 2019.

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

U.S. Department of Agriculture, Forest Service. 2024 Monitoring the Ecological Response to Restoration Treatments in the Missouri Pine-Oak Woodlands Restoration Project of the Mark Twain National Forest. Leahy et al. 2024_MOPWR_Monitoring_Report (usda.gov)

Question 5: 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 2021-2022 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 2022 and 2024, over 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 2022, 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).

Management Area 1.1/1.2 Prescribed Fire by Fiscal Year

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Series1	23,586	26,379	31,352	28,124	42,158	26,407	56,627	46,910	51,280	53,187
Series2	24,197	29,339	32,994	33,262	55,709	26,407	57,466	46,910	63,376	53,187

Series1 Fiscal Year Series2
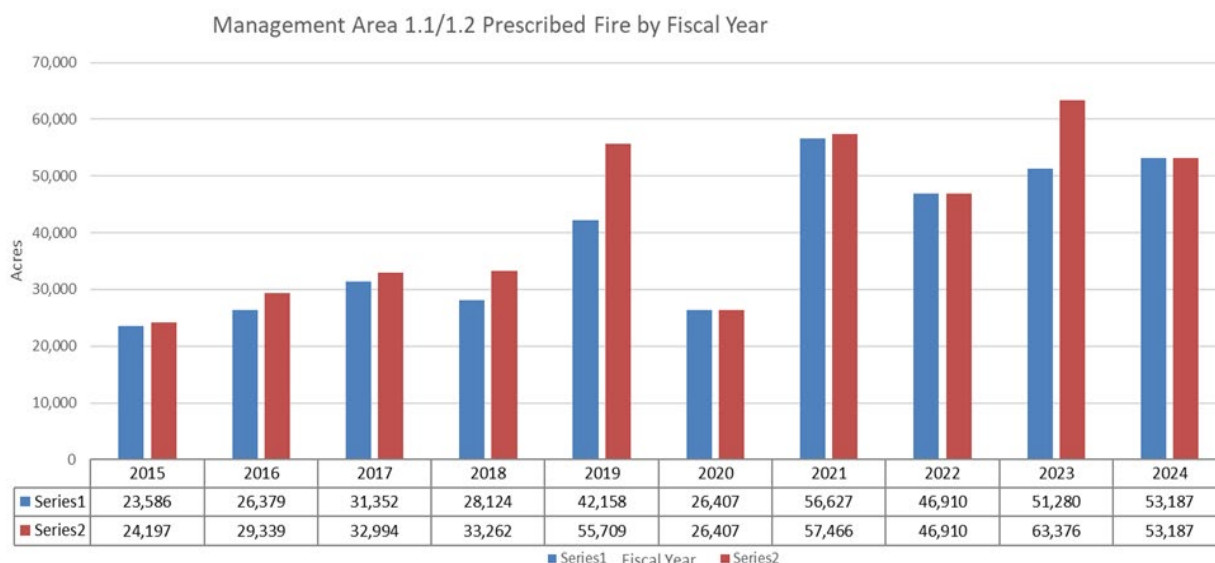
Figure 4: Prescribed Fire by Fiscal Year

We have increased the proportion of prescribed fire acres in these management prescriptions over the past ten 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).

Question 6: 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 2020-2022 Mark Twain National Forest monitoring evaluation report concluded that the 10-year average for

hazardous fuel treatments within wildland-urban interface or high-risk areas was 26,571 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.
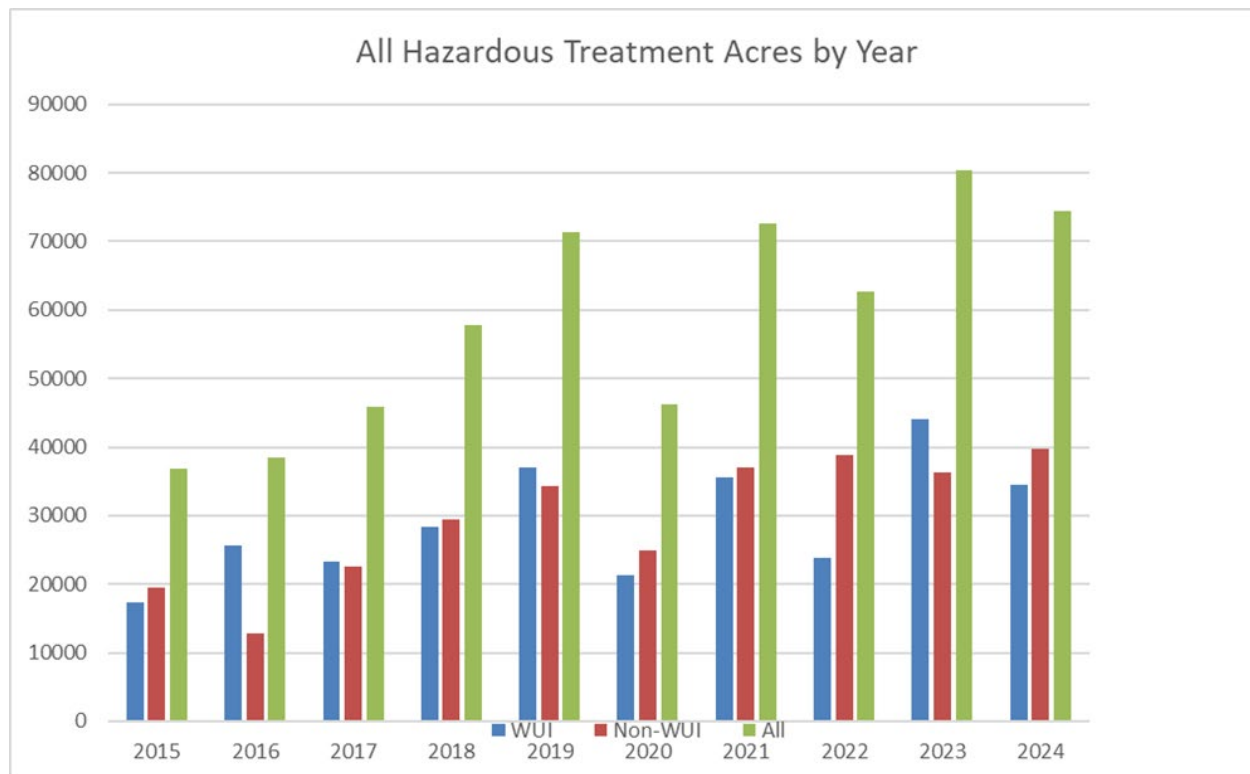
Results & Discussion

Figure 5: **Hazardous Fuels Treatment Acres by Fiscal Year**

In 2021, 35,623 acres within wildland-urban interface areas and high-risk areas were treated for hazardous fuels. In 2024, 34,561 acres were treated. Figure 5 displays acres treated by year in wildland-urban interface areas compared to non-

wildland-urban interface areas (FACTS Fuels-All Summary Report l). The category of "all" represents the sum of treatments across both types of areas for a given year. Over the past ten years, we have been trending upward in acres treated in wildland-urban interface areas. This upward trend could be attributed to the growth of urban-rural 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).

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

Last Updated
From 2021 through 2024, the database of record shows that 94 wildfires either started in or burned into a fuel reduction unit that been subject to prescribed fire or mechanical treatments (333). Overall, 85 percent of the treatment units exhibited a reduction or change in fire behavior, and 53 percent of the treatment units helped with control of the wildfires (see figures 12 through 19).

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 of 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

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

Results and Discussion

From 2021 through 2024, the database of record shows that 94 wildfires either started in or burned into a fuel reduction unit that been subject to prescribed fire or mechanical treatments (333). Overall, 85 percent of the treatment units exhibited a reduction or change in fire behavior, and 53 percent of the treatment units helped with control of the wildfires (see figures 6 – 9)

FTEM Missouri State Summary

Summary Created: 12/13/2023, 1:21:00 PM

User Name: Bennie Terrell

Total Records: 27

Summary of 2021 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	Pin Oak	0	0	1	100	0	0	1	100	1	100	1	
USFS	Booth	0	0	1	100	0	0	1	100	1	100	1	
USFS	412	1	100	0	0	0	0	1	100	1	100	1	
USFS	Mopping	0	0	1	100	0	0	1	100	1	100	1	
USFS	West Glade	0	0	6	100	0	0	6	100	6	100	6	
USFS	Turkey Spring	0	0	2	100	0	0	2	100	2	100	2	
USFS	West Glade 2	2	100	0	0	0	0	2	100	2	100	2	
USFS	3 Sisters	0	0	1	100	0	0	1	100	1	100	1	
USFS	412A	0	0	7	100	0	0	7	100	7	100	7	
USFS	Tram	1	100	0	0	0	0	1	100	1	100	1	
USFS	Glade Top Campfire	0	0	1	100	1	100	0	0	1	100	1	
USFS	Oder	0	0	1	100	0	0	1	100	1	100	1	
USFS	Buffalo Creek	0	0	2	100	0	0	2	100	2	100	2	
USFS	Flagmire	0	0	13	100	0	0	13	100	13	100	13	
USFS	Brush	0	0	3	100	0	0	3	100	3	100	3	
USFS	Tidwell	0	0	1	100	0	0	1	100	1	100	1	
USFS	White Oak	0	0	1	100	0	0	1	100	1	100	1	
USFS	Victory Hollow	0	0	4	100	0	0	4	100	4	100	4	
USFS	Young Hollow	0	0	2	100	0	0	2	100	2	100	2	
USFS	Roby	0	0	6	100	0	0	6	100	6	100	6	
USFS	Goetz	0	0	13	100	0	0	13	100	13	100	13	
USFS	Pine Flat	0	0	1	100	0	0	1	100	1	100	1	
USFS	Cedar	0	0	2	100	2	100	0	0	2	100	2	
USFS	AC	0	0	1	100	0	0	1	100	1	100	1	
USFS	Southern Crook	0	0	5	100	0	0	5	100	5	100	5	
USFS	Tabor	1	100	0	0	0	0	1	100	1	100	1	
USFS	Clark	0	0	41	100	0	0	41	100	41	100	41	
	Total	5	4	116	96	3	2	118	98	121	100	121	27

*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 6: Summary of 2021 Missouri Fuel Treatment Effectiveness on Wildfires

Total Records: 32

		Summary of 2022 Missouri Fuel Treatment Effectiveness on Wildfires											
		Number and Percentage of Treatments Tested By Wildfire											
		*Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire			
		No		Yes		No		Yes					
Agency	Fire	#	%	#	%	#	%	#	%	#	%	Total Records	Total Number of Fires
USFS	Sugar	0	0	3	100	0	0	3	100	3	100	3	
USFS	3723	0	0	7	100	0	0	7	100	7	100	7	
USFS	Davis Hollow	0	0	4	100	0	0	4	100	4	100	4	
USFS	Spice	0	0	1	100	0	0	1	100	1	100	1	
USFS	Cap	3	100	0	0	3	100	0	0	0	0	3	
USFS	Truck	0	0	2	100	0	0	2	100	2	100	2	
USFS	Slash	0	0	13	100	11	84	2	16	13	100	13	
USFS	Barn Log	0	0	1	100	0	0	1	100	1	100	1	
USFS	Irish	0	0	8	100	0	0	8	100	8	100	8	
USFS	Shammrock	0	0	1	100	0	0	1	100	1	100	1	
USFS	King Sink	0	0	3	100	0	0	3	100	3	100	3	
USFS	Bascomb	0	0	2	100	0	0	2	100	2	100	2	
USFS	King Sink 2	0	0	19	100	0	0	19	100	19	100	19	
USFS	443	4	100	0	0	4	100	0	0	0	0	4	
USFS	Yancy	0	0	2	100	1	50	1	50	2	100	2	
USFS	Harvester	1	33	2	67	2	66	1	34	3	100	3	
USFS	Horton	0	0	1	100	0	0	1	100	1	100	1	
USFS	Cavaness	1	100	0	0	1	100	0	0	0	0	1	
USFS	Hercules 2	0	0	1	100	0	0	1	100	1	100	1	
USFS	Grassy Pond	0	0	1	100	0	0	1	100	1	100	1	
USFS	Birch	0	0	3	100	0	0	3	100	3	100	3	
USFS	Devils Backbone 3	0	0	1	100	0	0	1	100	1	100	1	
USFS	Devils Backbone	0	0	1	100	0	0	1	100	1	100	1	
USFS	Devils Backbone 2	0	0	1	100	0	0	1	100	1	100	1	
USFS	Fisher Pond	1	100	0	0	1	100	0	0	0	0	1	
USFS	Duke	0	0	20	100	19	95	1	5	20	100	20	
USFS	Post Oak	0	0	2	100	2	100	0	0	2	100	2	
USFS	7989	2	100	0	0	2	100	0	0	0	0	2	
USFS	Grimmet	0	0	1	100	0	0	1	100	1	100	1	
USFS	Iron Side Ridge	0	0	1	100	0	0	1	100	1	100	1	
USFS	Tennyson	0	0	2	100	0	0	2	100	2	100	2	
USFS	Cave	0	0	1	100	0	0	1	100	1	100	1	
	Total	12	10	104	90	46	40	70	60	105	91	116	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 7: Summary of 2022 Missouri Fuel Treatment Effectiveness on Wildfires

Total Records: 10

| | | *Did Treatment Change Fire Behavior? | | | | Did Treatment Help Control Wildfire? | | | | Treatments that changed fire behavior and/or helped control wildfire | | | |
| | | No | | Yes | | No | | Yes | | | | | |
Agency	Fire	#	%	#	%	#	%	#	%	#	%	Total Records	Total Number of Fires
USFS	1181	0	0	1	100	0	0	1	100	1	100	1	
USFS	Prong Creek	0	0	1	100	0	0	1	100	1	100	1	
USFS	Glade Top	0	0	1	100	0	0	1	100	1	100	1	
USFS	Devreaux	0	0	10	100	9	90	1	10	10	100	10	
USFS	Union Grove	0	0	1	100	0	0	1	100	1	100	1	
USFS	Prieskon Ridge	0	0	13	100	7	53	6	47	13	100	13	
USFS	Kitchell	1	50	1	50	1	50	1	50	1	50	2	
USFS	Bennett	7	77	2	23	7	77	2	23	2	22	9	
USFS	Poison	0	0	1	100	0	0	1	100	1	100	1	
USFS	Piney	0	0	1	100	0	0	1	100	1	100	1	
	Total	8	20	32	80	24	60	16	40	32	80	40	10

*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 8: Summary of 2023 Missouri Fuel Treatment Effectiveness on Wildfires

Summary Created: 3/21/2025, 11:33:49 AM

User Name: Bennie Terrell

Total Records: 25

		*Did Treatment Change Fire Behavior?				Did Treatment Help Control Wildfire?				Treatments that changed fire behavior and/or helped control wildfire			
		No		Yes		No		Yes					
Agency	Fire	#	%	#	%	#	%	#	%	#	%	Total Records	Total Number of Fires
USFS	Panorama	0	0	1	100	0	0	1	100	1	100	1	
USFS	Green	0	0	1	100	0	0	1	100	1	100	1	
USFS	South Fork	0	0	4	100	0	0	4	100	4	100	4	
USFS	Barn Log	0	0	4	100	4	100	0	0	4	100	4	
USFS	Fairview	0	0	1	100	0	0	1	100	1	100	1	
USFS	AD	0	0	2	100	2	100	0	0	2	100	2	
USFS	Steam Hollow	0	0	1	100	0	0	1	100	1	100	1	
USFS	Little Barren	3	100	0	0	3	100	0	0	0	0	3	
USFS	Tidwell	0	0	1	100	0	0	1	100	1	100	1	
USFS	Crossing Hollow	0	0	4	100	4	100	0	0	4	100	4	
USFS	426	0	0	2	100	2	100	0	0	2	100	2	
USFS	Bar K	0	0	1	100	1	100	0	0	1	100	1	
USFS	446	5	100	0	0	4	80	1	20	1	20	5	
USFS	Totality	0	0	8	100	4	50	4	50	8	100	8	
USFS	Spring	0	0	9	100	9	100	0	0	9	100	9	
USFS	Devils Backbone 1	1	25	3	75	4	100	0	0	3	75	4	
USFS	Devils Backbone 2	0	0	3	100	3	100	0	0	3	100	3	
USFS	Rose	0	0	2	100	2	100	0	0	2	100	2	
USFS	Beretta	1	50	1	50	0	0	2	100	2	100	2	
USFS	Young	0	0	4	100	0	0	4	100	4	100	4	
USFS	Young 2	0	0	4	100	0	0	4	100	4	100	4	
USFS	Butler Cave	0	0	2	100	0	0	2	100	2	100	2	
USFS	Union Grove Church	0	0	1	100	0	0	1	100	1	100	1	
USFS	Embree	2	100	0	0	2	100	0	0	0	0	2	
USFS	7640	0	0	3	100	0	0	3	100	3	100	3	
	Total	12	16	62	84	44	59	30	41	64	86	74	25

*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 9: Summary of 2024 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/

Question 8: Are lentic ecosystems providing habitat for fish and other aquatic species? (File Code 2600)

Last Updated
The 2021-2022 Mark Twain National Forest (MTNF) monitoring evaluation report included natural and man-made lakes, backwater formations created when water overtops riverbanks, karst fens, and vernal pools. The Forest Plan Goal 1 and components 1.1-1.4 are justifications for our efforts. The lentic (lake or non-flowing aquatic areas) ecosystem management and aquatic surveys are listed in Tables 1-3. The primary lake management activity was controlling aquatic vegetation and stocking fish on the numerous MTNF lakes to promote healthy and a balanced fish population. The

primary backwater management was fish sampling. The karst fens management is part of our Natural Community habitat with management of the federally endangered Hine's emerald dragonfly. The design to create and manage our vernal pools is centered on providing this habitat, often man-made aquatic habitat, across the landscape for the life stage requirements of a variety of wildlife species. Species that benefit from our lentic ecosystem management include aquatic insects, amphibians, reptiles, numerous vertebrates (bats, birds, and mammals) and water-loving aquatic plants.

Aside from decreasing the number and density of aquatic nuisance plants, these lake management activities improve angling and recreational experiences albeit the public does not have boat access to the lake during the drawdown. Common aquatic plants, such as muskgrass, milfoil, and watershield all have the potential to be nuisance aquatic plants within our forest lakes, as well as our constructed lakes originally intended for flood control. These man-made lakes typically have many acres of shallow water that the impounded water extends into remnants fields. These shallow water areas allow sunlight to easily reach the bottom which then encourages excessive vegetation growth if left unchecked. Unfortunately, the overgrown aquatic plants in these shallow areas lead to a challenging angling and boating experience, as well as allowing for an unbalanced structure in fish populations. Freezing winter temperatures during a drawdown removes a lot of the nuisance aquatic vegetation and promotes healthier plant growth the following year.

Aquatic vegetation is essential to a healthy aquatic ecosystem by providing dissolved oxygen for fish and other organisms. Managing seasonal drawdowns effectively mimic natural processes to promote healthy native aquatic plant and fish populations. This management approach can improve water quality, nutrient distribution, and can promote a balanced fish population and varying age classes and sizes. The aquatic plants are a source of food for some of the lake inhabitants, and a source of shade and shelter for small fish and other prey species. Our managed forest lakes often contain largemouth bass, channel catfish, and sunfish, such as bluegill.

Monitoring Indicator(s)
Number of lakes stocked with fish; Acres of aquatic vegetation controlled; Duration of lake drawdown; Number of dragonflies surveys; Number of vernal pools constructed and surveyed; and Number of acres with improved watersheds, including removal of feral hogs by active management.

Monitoring Frequency
Annually

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).

MDC is responsible for the management of fish and wildlife species in Missouri, and they have conducted the most fish and aquatic species surveys in the state, including many of our lakes and ponds within the MTNF. They also stock several MTNF small lakes and ponds with channel catfish to encourage public fishing. Management results and recommendations are provided to us annually. Feral hog reporting, as an indicator of improving watersheds, is also a multiagency strategy with MDC reporting annual accomplishments.

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 are 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.

Monitoring Indicator 1
Number of lakes stocked

Results and Discussion
During the monitoring report dates, numerous lakes and ponds were stocked. Lakes were predominantly stocked with channel catfish. 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 MTNF need an updated lake management plan. During this time, numerous lakes were surveyed by MDC and one was surveyed by USFWS. Surveys are completed to document and correlate changes in the catch per unit effort (CPUE). Annual aquatic vegetation control is necessary to balance fish populations. 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 will continue to increase the public's use of our Forest waters.

In 2023, electrofishing surveys were conducted on three Mark Twain National Forest lakes: Sterling Hollow in the Ava/Cassville/Willow Springs District, Pinewoods in the Poplar Bluff District and USFWS conducted electrofishing surveys on Crane Lake on the Potosi District. In 2023, channel catfish were stocked in 11 lakes across the Districts, which included Bateman and Deer Hunter Pond in Ava/Cassville/Willow District; Fourche and Ripley Lakes in Eleven Point District; Beaver and Pinewoods, in Popular Bluff District; and Council Bluff, Loggers, Palmer, Timberlane, and Howell Lakes in Salem/Potosi/Frederickton Districts. Aquatic herbicides were utilized on only Pinewoods Lake in the Poplar Bluff District. Management recommendations for Beaver and Crane Lake included improved area access, improved boat access, improved dam integrity, shoreline angling access and full lake renovation. Pinewoods lake recommendation was to control aquatic vegetation and Council Bluff Lake management recommendations were to control aquatic vegetation and to improve area access.

In 2024, electrofishing surveys were conducted on four Mark Twain National Forest lakes: Fourche and Ripley Lakes in the Eleven Point District, Roby Lake in the Houston/Rolla/Cedar Creek District and Howell Lake in the Salem/Potosi/Fredericktown District. In 2024, channel catfish were stocked in 12 lakes across the Districts; included were Noblett Lake and 5 Area Ponds in Ava/Cassville/Willow Springs District; Roby Lake in Houston/Rolla/Cedar Creek District; Fourche and Ripley Lakes in Eleven Point District; Pinewoods in Popular Bluff District; and Council Bluff, Howes Mill, Loggers, Palmer, Timberlane, and Howell Lakes in Salem/Potosi/Frederickton Districts. District. Aquatic herbicides were utilized on only Pinewoods Lake on the Poplar Bluff District.

Most of the lakes, backwater areas, karst fens, and vernal pools within the MTNF proclamation boundary will require an updated management plan. Currently, there is no rubric or time-specific strategy for lentic ecosystem management on the MTNF. Observations of when to control nuisance aquatic vegetation is often prioritized and conducted by the forest district biologists, along with public input. Historically, the management process involved the MTNF staff purchasing the aquatic herbicides and Missouri Department of Conservation (MDC) applying the appropriate treatments to the lakes. In conjunction with herbicide treatment, some lakes are also drawn down to control nuisance aquatic vegetation. This seasonal maintenance drawdown approach is an effective method during the winter season to manage aquatic vegetation and reduce the amount of herbicide needed.

Monitoring Indicator 2
Number of vernal pools constructed

Results and Discussion
No additional vernal pools were constructed in 2023-2024.

From 2023-2024, no additional vernal pools were constructed. The availability and management of the vernal pools across the forest has a long history for many common and specialized forest dwelling species. There are many species of amphibians, but other wildlife species too, that require freely available water for development of life stages. Maintaining this balance of freely available water where historically it was present is needed to maintain the population viability of a species to withstand environmental changes. A vernal pool is typically a natural, temporary to semi-permanent body of water occurring in a shallow depression on the landscape. These pools typically recharge during the spring or fall but may become dry during the summer. Vernal pools are small, often less than one acre, have no permanent inlets and no viable populations of predatory fish which allows these sites to be important refugia for salamanders, frogs and aquatic insects. Creating vernal pools was an early adopted plan by many state and federal land managers to meet the needs of many wildlife species. Several bat species are observed foraging across aquatic habitats within the forested landscape. The Mark Twain National Forest Plan allows for the construction of "waterholes" only where natural or constructed water sources

are limited or lacking. These vernal pools are prohibited within a riparian or watercourse. Rehabilitation of vernal pools should be maintained as irregular in shape and as natural in appearance as possible. Placement of one or more brush piles or rock piles along the north bank of artificial ponds as needed to provide amphibian habitat. However, much remains relatively unknown about vernal wetlands, ecological functions, and productivity over time on the MTNF.

Recommendations
It would be useful to have a specific monitoring indicators (8.1) to address the impacts that fish stocking and assess to determine the overall public use and satisfaction and (and 8.2) to inform visitors about the amphibian species that utilize vernal pools, or wildlife species such as invertebrates that utilize freely available water, particularly given that many vernal pools have been constructed and maintained over time. Future monitoring of vernal pools could be beneficial in monitoring wildlife species too. One of our wildlife monitoring databases is from a long-term training site for state and forest biologists improving skills on amphibian and reptile identification and capture techniques. Occasionally, the MTNF receives feedback from anglers about the lack of fish in lakes and ponds. Sometimes, it does positively correlate to lakes that receive a large amount of fishing activity. In addition, information regarding the use of vernal pools by wildlife species and changes in their populations over time would be useful, particularly given that many of the vernal pools across the forest have been constructed over the decades. As a result of interagency efforts, there has been a significant decrease in the number of feral hogs across the landscape due to interagency efforts had improved the recovery of some of our watersheds and vegetation (University of Missouri Extension Service). We anticipate some natural recovery of our watersheds, vernal pools, and moist soil areas but some sites may need further restoration efforts.

Evaluation of Monitoring Question and Indicator(s)
Monitoring questions that are site specific would provide information on selected fish and/or aquatic species population trends in lakes and vernal pools. Monitoring these changes to populations of amphibians or invertebrates in areas where the pools were created could indicate when additional restoration efforts are necessary. To answer this question an increase in funding and staff may be necessary.

References
Missouri Department of Conservation, Annual Activities and Suggested Management Reports for 2021 and 2022.

U.S. Department of Agriculture, Forest Service. Mark Twain National Forest Plan. 2005.

U.S. Department of Agriculture, Forest Service. Mark Twain National Forest Plan. 2005.

Question 9: Are lotic ecosystems providing habitat for fish and other aquatic organisms? (File Code 2600)

Last Updated
The 2021-2022 report focused on Sampling conducted by U.S. Fish and Wildlife Service (USFWS) on two streams within the forest.

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, and 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 monitored with fish and mussel surveys.

Results and Discussion
During the 2023-2024 monitoring period, no mussel surveys were performed. Fish sampling techniques follow the Missouri Department of Conservation (MDC) Resource Assessment and Monitoring (RAM) Program and standardized procedures to determine survey lengths that are specific to the stream size. In 2023, monitoring consisted of two fish surveys conducted by the USFWS on Crane Pond Creek in the Potosi District and Spring Creek in the Eleven Point District. In 2024, monitoring consisted of two fish surveys conducted by U.S. Forest Service personnel on the East Prong of Indian Creek on the Poplar Bluff District and on Bull Creek in the Ava District.

During the June 2023 sampling, fish communities from 4 sites were surveyed on Crane Pond Creek with 2,535 fish collected that comprised 7 families and 17 species. None of the 17 fish species were Regional Forester Sensitive Species (RFSS), Missouri species of conservation concern (MO SOCC 2025) nor federally listed threatened or endangered species. Using the faunal regional classification (Pflieger 1989), 71% of the species captured are classified as Ozark while the remaining 29% were classified as Widely Distributed.

During the July 2023 sampling event on Spring Creek, six sites were sampled, capturing a total of 9,179 individuals representing nine families and 28 species. None of the species encountered were RFSS, MO SOCC, or federally listed. According to the faunal regional classification, species were described as 89% Ozark and 11% Widely Distributed.

In 2023, the Missouri Department of Conservation conducted electrofishing surveys in the Eleven Point River on the Eleven Point District and Little Piney Creek and Spring Creek, both on the Houston/Rolla/Cedar Creek District. In 2024, the Missouri Department of Conservation conducted electrofishing surveys on the Eleven Point River of the Eleven Point District and on Little Piney Creek and Mill Creek, both on the Houston/Rolla/Cedar Creek District.

During October 2024, both East Prong Indian Creek and Bull Creek were sampled. East Prong Indian Creek sample site yielded 422 individuals representing eight families and 17 species. Sampling at Bull Creek yielded 890 individuals representing six families and 13 species. None of the fish captured from East Prong Indian Creek or from Bull Creek were RFSS, MO SOCC or federally listed species. Fish caught from East Prong Indian Creek could best be described as 56% Ozark, 44% Widely Distributed and less than 1% Lowland species. Fish captured from Bull Creek could be described as 88% Ozark and 12% Widely Distributed.

Recommendations
Continue to monitor on a defined schedule and add stream reaches to ensure fish communities, and fish species of conservation of concern are managed at a resilient population. As for the mussel species, it is imperative to continue monitoring on a systematic timeline to assure present, stable and desired aquatic conditions and streambanks exist within the riparian areas for all mussels as well as other aquatic organisms.

Evaluation of Monitoring Question and Indicator(s)
We plan to continue monitoring the effectiveness and all impacts of our management action over time. Utilizing the best available science, such as the biological criteria in the fish communities was based off the earlier study on assessing those variables (Doisy, K.E., C.F. Rabeni, M.D. Combes, R.J. Sarver 2008). Stream habitat stability and biotic indicators, such as fish communities, will be utilized to assess stream health and resiliency. Several habitat management recommendations

were provided within the U.S. Fish and Wildlife Service reports.

Monitoring Indicator 2
Aquatic Species Monitoring

Results and Discussion
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. An Interagency Agreement with the U.S. Fish and Wildlife Service's Fish and Wildlife Habitat Conservation Office to complete fish community and mussel surveys on various smaller streams. Along with a challenge cost-share agreement 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).

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.

Continuing with public outreach programs are an integral part of our conservation education. For example, the historic fishing derbies at Stone Mill Spring branch that is cooperatively managed by Forest Service, Missouri Department of Conservation, and Department of Defense Fort Leonard Wood. The stream continues to be stocked with rainbow trout for the winter fish-for-fun season, host of the annual kids' trout derby, and provides a stream for the regular fishing season. The area and the fishing events continue to be popular with the public.

Recommendations
Only a limited number of aquatic surveys were conducted during this monitoring period, so we have a strong need to continue partnering with Missouri Department of Conservation and U.S. Fish and Wildlife Service to assist with some in-house fish and mussel surveys across the Mark Twain National Forest. By increasing our aquatic sampling efforts, we will strengthen our baseline data information as well as better understand when significant changes in populations or apparent changes within their habitats occur and bellwether those changes regarding our stream health and habitats.

Evaluation of Monitoring Question and Indicator(s)
Fish and mussel population and habitat surveys can provide information on stream health and for restoration needs.

References
Cox, E., T. Olinger, E. Sterling, and J. Kallis. 2022. Crane Pond Creek, Crane Lake, and Spring Creek 2023 Fish Community Sampling. 49 pages.

Doisy, K.E., C.F. Rabeni, M.D. Combes, R.J. Sarver. 2008. Biological criteria for stream fish communities of Missouri. Final Report to the Environmental Protection Agency. 83 pp.

Fowler, A., and J. Anderson. 2015. Arkansas wildlife action plan. Arkansas Game and Fish Commission, Little Rock, Arkansas.

Missouri Department of Conservation. 2025. Missouri Species and Communities of Conservation Concern Checklist (MO SOCC).

Missouri Department of Conservation. 2011. Resource assessment and monitoring program: standard operation procedures – fish sampling. Missouri Department of Conservation, Jefferson City, Missouri.

Missouri Department of Conservation. 2021a. Missouri fish and wildlife information system [web application]. Missouri Department of Conservation, Jefferson City, Missouri. Available

https://mdc12.mdc.mo.gov/applications/mofwis.

Pflieger, W. L. 1989. Aquatic community classification system of Missouri. Aquatic series #19. Missouri Department of Conservation, Jefferson City, Missouri.

U.S. Department of Agriculture, Forest Service. National Resource Management -Watershed Improvement Tracker (WIT) database.

Status of Focal Species to Assess the Ecological Conditions Required Under 219.9

Question 10: 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 past Mark Twain National Forest monitoring evaluation reports addressed pre-and post-treatments on two landscape scale project areas, Pineknot and Cane Ridge (Missouri Pine-Oak Woodland Project, a Collaborative Forest Landscape Restoration Project). Both sites are primarily shortleaf pine and pine-oak woodland natural communities, and both sites have undergone continues maintenance at the landscape-scale management for the longest time. The outcome of these efforts show that basal area and percent canopy have both decreased, and ground cover has increased, because of management treatments. These treatments included timber sales (overstory removal), understory removal, and use of prescribed fire. These tools have successfully allowed the timber management objectives to achieve the restoration of mixed shortleaf pine and oak woodlands that historically dominated this landscape.

Specific to the 2021-2022 monitoring evaluation report, no nest success data were conducted within the Cooperative Forest Landscape Restoration Project (CFLRP) area. Partly because the trends in abundance the Eastern Wood-Pewee and Pine Warbler was relatively unchanged from the 2013 to 2020. And partly because the focus on avian responses to forest management had shifted to conducting long-term bird studies within the Missouri Pine-Oak Woodlands area on the Mark Twain National Forest (MTNF) and the focused attention on the reintroduction of Brown-headed Nuthatch. These efforts continue to align with the need to improve our assessments of habitat suitability needs of the ongoing habitat restoration and recovery efforts. As summarized over the past 7 years, our monitoring evaluation reports concluded densities of two bird species, the Eastern Wood-Pewee and pine warblers, were positively related to the combined effects of timber harvest and prescribed fire activity in these habitats.

The reintroduction effort of an extirpated bird species, the Brown-headed Nuthatch, was initiated in 2020-2022. This is a significant advancement in ecological restoration because this bird species requires specific habitat conditions within shortleaf pine and pine-oak forest types that consist of a less cluttered midstory and a less dense stocking of canopy trees. Unfortunately, the Brown-headed Nuthatch was likely extirpated from Missouri in the early 1900s because of habitat loss through extensive logging.

Monitoring Indicator(s)
Abundance of Eastern Wood-Pewee and Pine Warbler in cooperative forest landscape restoration (CFLRP) and nest success for Eastern Wood-Pewee and pine warbler in CFLRP area.

Forest bird trend analyses have continued within the CFLRP utilizing point count data through 2023. Assessing forest bird trends are relevant for the forest land managers, and these trends do provide comparisons from site specific areas with the larger landscapes. For example, the Breeding Bird Survey data that indicate trends for a region, such as the Ozark Highlands, can be compared to a more focal area, such as the CFLRP. Meaningful comparisons from the CFLRP site to the larger landscape may provide insights into the differences between other forest management and how bird species respond over time.

These long-term bird studies within the Missouri Pine-Oak Woodlands area on the MTNF are needed to make an accurate assessment with ongoing management activities to how conditions may improve bird reproduction, nest success, and site fidelity. This approach beyond bird abundance and nest success monitoring is critical for determining the forest

management objectives to restore mixed shortleaf pine and oak woodlands that historically dominated this landscape. Especially now with a significant reintroduction of an extirpated bird species, the Brown-headed Nuthatch, our understanding of changes to management will determine the best methods to achieve the necessary habitat conditions. This is significant because this forest bird species requires very specific features across the forest type found within the CFLRP. Failing to meet those needs probably will contribute to repeating the extirpation of the nuthatches from Missouri as happened in the early 1900s as a result of habitat loss.

The monitoring indicator species are part of a suite of birds that represent regional or range-wide species of concerns because of the declining numbers; included species are the Bachman's Sparrow, Prairie Warbler, Red-headed Woodpecker, and Northern Bobwhite (North American Bird Conservation Initiative, 2025). This project highlights preliminary data in two publications which demonstrated that nesting-success of six focal bird species and the densities of eight focal bird species were positively related to the restoration efforts (Roach et al. 2018, 2019) conducted on the MTNF. Overall, the early seral stage habitats would be representative as having more shrubs and fewer dominant trees. It is this habitat type that is characteristic for the bird communities preferred for the species listed in Table 1.

Monitoring Frequency
Eastern Wood-Pewees and Pine Warblers were monitored between 2020 and 2023, but a shift in the CFLRP monitoring approach occurred in 2024 to focus on the reintroduction and restoration of the Brown-headed Nuthatch.

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). The picture (within this section) demonstrates an active management practice of prescribed burning within this area.

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."

Monitoring Indicator 1
Response of birds within shortleaf pin and pine-oak woodlands.

Results
We monitored abundance of Eastern Wood-Pewees and Pine Warblers, along with 16 other focal bird species, in 2013, 2014, 2015, 2020 and 2023 (Table 1). We surveyed abundance of singing males each year by using point counts at 250 points within the CFLRP. We attempted to fit computer models to estimate abundance each year and in relation to select habitat features and management practices. The models accounted for variation in the probability of detecting birds and their availability for detection by considering distance to detections and time of detections.

Table 14: Number of singing male birds detected on 250-point counts in 2013, 2014, 2015, 2020, and 2023.

Species	2013	2014	2015	2020	2023
Acadian Flycatcher	129	95	59	96	133
Black and White Warbler	37	37	61	19	95
Blue-winged Warbler	6	18	20	25	26
Eastern Towhee	94	100	91	51	26
Eastern Wood-Pewee	177	238	208	168	224
Indigo Bunting	.	.	.	217	332
Kentucky Warbler	21	23	34	49	42
Northern Bobwhite	1	0	0	2	2
Ovenbird	138	137	146	100	143

Pine Warbler	234	222	183	324	308
Prairie Warbler	84	63	95	87	105
Red-headed Woodpecker	56	37	24	57	23
Summer Tanager	108	151	178	85	139
White breasted Nuthatch	.	.	.	86	110
White-eyed Vireo	34	39	55	59	88
Worm-eating Warbler	58	43	50	31	63
Wood Thrush	18	14	18	29	36
Yellow-breasted Chat	216	203	180	121	152

We were able to successfully fit models and estimate the density (birds/ha) of 12 species (Figure 1). We summarized trends in density from 2013 to 2023 and the most supported relationships between abundance and vegetation structure, fire, and thinning.

Black and White Warbler, Eastern Wood-Pewee, Pine Warbler, Prairie Warbler, and White-eyed Vireo had significant increases in density from 2013 to 2023. Eastern towhee and Yellow-breasted Chat significantly decreased in density. Acadian Flycatcher, Kentucky Warbler, Ovenbird, Summer Tanager, and Worm-eating Warbler had no significant trend in abundance (Figure 1).

Disturbance dependent species such as Eastern Towhee, Prairie Warbler, Yellow-breasted Chat, and White-eyed Vireo generally responded positively to woodland restoration and the structure it created as evident by higher densities in associations with at least some of the following habitat factors for each species: low to moderate canopy cover, low number of years since fire, lower basal area of pole and sawtimber, a greater number of small woody stems, and positive association with thinning. Several of these species were also positively associated with greater basal area of pine (Figure 2).

Woodland species such as Eastern wood Pewee, Pine Warbler, and Summer Tanager were associated with habitat factors reflecting woodland to closed forest. Eastern wood Pewee and Pine Warbler were most abundant at around 75% canopy cover and lower basal area of pole and sawtimber. Eastern wood-Pewee density was positively associated with thinning and Pine Warbler with greater basal area of pine (Figure 3). Summer Tanager was most abundant at higher canopy cover and basal area typical of forest but also in areas with recent fire.

Forest species included Acadian Flycatcher, Black and White Warbler, Kentucky Warbler, Ovenbird, and Worm-eating Warbler. These species were generally, but not all, associated with higher canopy cover and basal area of pole and sawtimber. Kentucky Warbler and Worm-eating Warbler are associated with understories in forest and were more abundant where there were high small woody stem densities and associated with thinning.

Overall, our findings indicate species are not statistically benefiting from pine thinning alone. However, with the addition of other management activities, such as prescribed fire and timber stand improvement techniques (thinning), the habitat conditions are meeting the needs of species requiring woodlands.
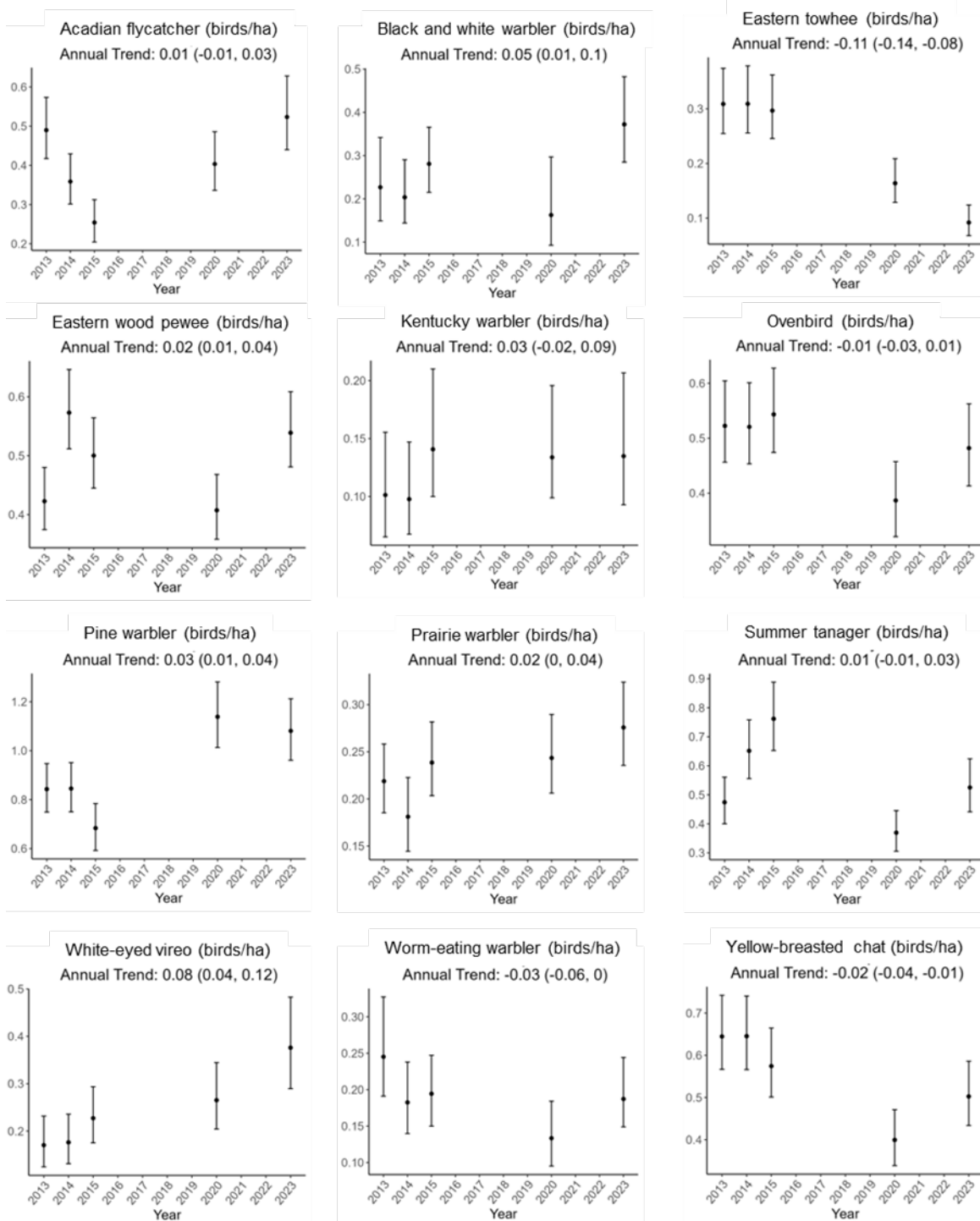
Figure 10: Predicted density of birds in 2013, 2014, 2015, 2020, and 2023 and estimated trend (+ 95% credible interval) expressed as proportion change/year (Thompson and Bonnot, unpubl.).
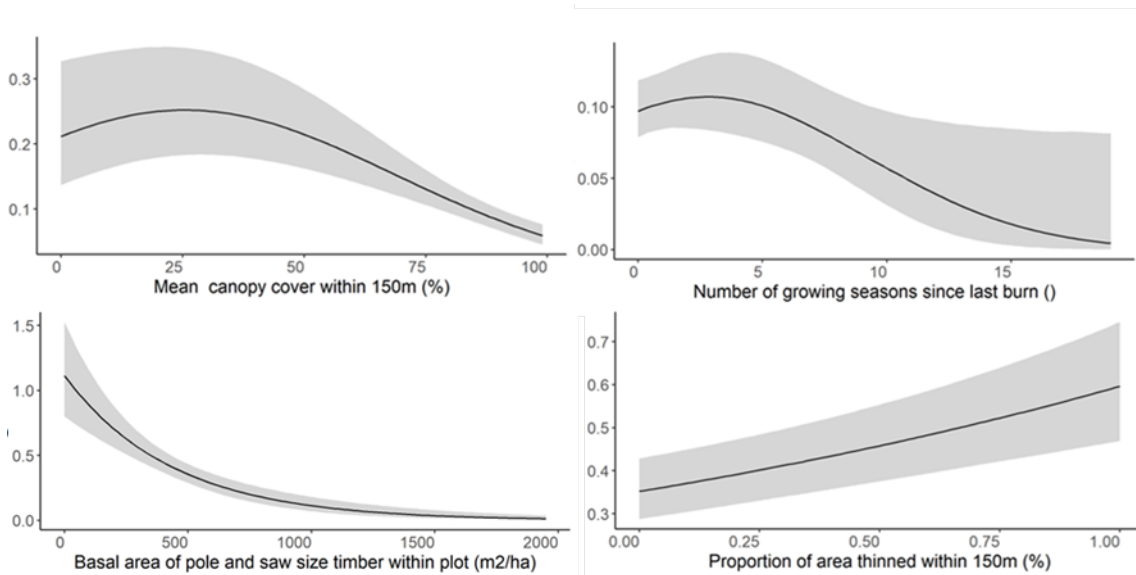
Figure 11: Prairie Warbler density (birds/ha) was greatest at low canopy cover, a low number of years since fire (frequent prescribed fires), low basal area of pole and sawtimber, and positively associated with thinning. These relationships were seen in several disturbance-dependent birds.
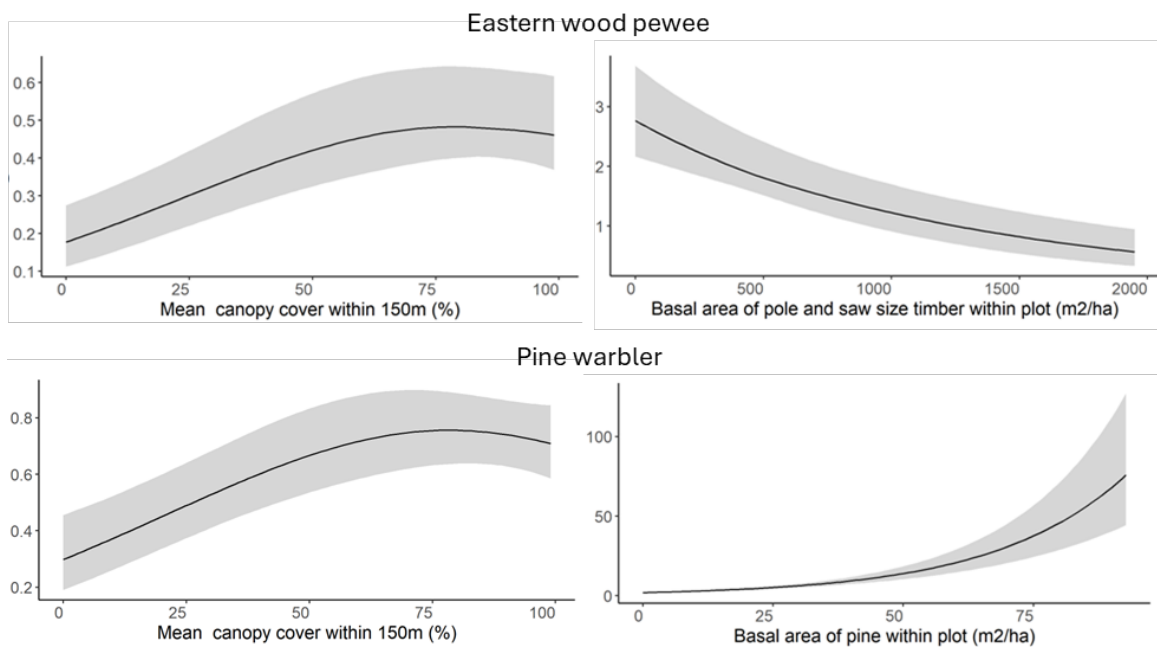
Figure 12: Eastern Wood-Pewee density (birds/ha) was associated with moderate canopy cover and lower basal area typical of woodlands. Pine Warbler density was also positively associated with moderate canopy cover but also positively related to basal area of pine.

Discussion

The objective of the CFLRP is to restore overstocked and deteriorated shortleaf pine woodland communities to more open woodland structure that these communities once represented under a higher fire disturbance regime for the purpose of improving early and mid-seral habitat for a suite of bird species that require this habitat. The project area is 444,088 acres and includes 127,008 acres of MTNF. The plant structure and composition were studied across thousands of acres and included expansion of sampling units that utilize the Community Health Index to rank sites.

Additionally, with our conservation partners, including the Missouri Department of Conservation, University of Missouri, and other volunteers, we initiated a reintroduction project for the Brown-headed Nuthatches within the CFLRP. We relocated 102 birds from Ouachita National Forest in Arkansas to Mark Twain National Forest in Missouri in 2020 and 2021 to establish a localized population. To address an array of monitoring questions, approximately half the birds each year were fitted with a radio transmitter that permitted radio-tracking post release.

The monthly point count surveys of Brown-headed Nuthatches were initiated in November 2020 and continued through August 2023. We searched for nests, and monitored nests during the spring of 2021, 2022, 2023 and 2024. The summary of those data is shown in Table 2 (below). Apparent nest success has averaged 69%, which is reasonable for a resident songbird. However, it is of concern that we could not find more than 3 nest attempts in 2023. One possible explanation is that birds are nesting outside of our core search area. In addition to these monitoring efforts, survival analysis including movement data allows us to focus on the importance of considering dispersal when estimating survival.

Overall successes include the safe capture and translocation of Brown-headed Nuthatches. The translocation resulted in no known mortality or signs of stress during or immediately following translocation. Although our initial findings indicate that these translocated birds moved more than expected, we have evidence that these birds can successfully nest and fledge nestlings in their historic range in southeastern Missouri. Also, we have evidence that at least some birds are leaving the core area where the monitoring has been focused. Our observations suggest birds were either undetectable or they were located outside of the searched area and grid-survey area for extended periods. In 2024, our observations of the large dispersal movements immediately following releases could indicate that we did not translocate enough birds to establish a viable core population in the release area.

Monitoring Indicator 2
Nest success of eastern wood-pewee and pine warbler in CFLR project area.

Results
No monitoring of bird nests was conducted in 2023-2024. However, nest monitoring of the reintroduced brown-headed nuthatch within the CFLRP was completed (Table 2).

Table 15: Number of Brown-headed Nuthatch nesting success

Year	Nest	Number of Successful Nest	Nest Young Fledged
2021	6	4	18
2022	4	3	11
2023	3	2	11/5*

*11 total young fledged but 6 disappeared 1 day post fledgling and likely perished

In 2023-2024, we added to the Brown-headed Nuthatch population. An additional 95 birds were translocated from Ouachita National Forest in Arkansas to the release sites in the MTNF. To improve our monitoring of survival, movements, and dispersal, we added a telemetry tracking system and deployed 31 birds with transmitters. As suspected, the results showed that the birds dispersed farther than we expected, and we will try to address this movement by improving the habitat assessment analyses. Further monitoring efforts with Missouri Department of Conservation and our partners will continue in the next biennial report (Heath-Acre, 2024).

Discussion
This short-term monitoring verified our initial success of the translocation, but indicates a continued monitoring need to evaluate long-term success. Future translocations in 2025 and 2026 will build upon this investment. Additional projects will provide us with the opportunity to 1) monitor dispersal and survival more continuously using automated radio telemetry, 2) better compare habitat use between Missouri birds to the established populations in Arkansas, and 3) test the efficacy of supplemental nest snags on retention of possible nest sites at the release site.

Recommendations

MTNF and our conservation partners continue to assess results of monitoring indicators for the health and sustainability of shortleaf pine and pine-oak woodland communities. With the ongoing reintroduced projects that add to the data collection, our long-term trends should further assess how to improve the health and resiliency of the forest. Although monitoring of the reintroduction phase of the Brown-headed Nuthatches will continue, the extent of which it will be to build upon its long-term success is dependent on funding and personnel availability in the future.

Evaluation of Monitoring Question and Indicator(s)

Determining the best management practices and techniques will continue to be addressed as we strive to improve our understanding of a resilient and ecologically functioning forest type (shortleaf pine and pine-oak woodlands) to support a suite of birds (State of the Birds, 2025). Properly evaluating the practices will provide the current and future generations with the tools to meet the biologic, economic, and social benefits on this forest. Further discussions because of the monitoring program will lead us to the next steps for restoration treatments. This process, termed adaptive management, is important because the process involves purposeful collecting and analyzing data to provide meaningful results which will guide future decision making. This iterative process aids in determining if changes are needed to improve the habitat and it will assist in improving monitoring projects, such as the reintroduction of a bird species that once thrived in the shortleaf pine and pine-oak woodlands.

References

Heath-Acre, K. (lead Principal Investigator). 2024. Brown-headed Nuthatch reintroduction, monitoring, and habitat assessment. Missouri Department of Conservation in-house request for FY25 proposals. 2024.

Roach, M., Thompson, F., Jones-Farrand, T. 2018. Songbird nest success is positively related to restoration of pine-oak savanna and woodland in the Ozark Highlands, Missouri, USA. The Condor. 120: 543-556.
Roach, M., Thompson, F., Jones-Farrand, T. 2019. Effects of pine-oak woodland restoration on breeding bird densities in the Ozark - Ouachita Interior Highlands. Forest Ecology and Management. 437: 443-459.

North American Bird Conservation Initiative. 2025. The State of the Birds, United States of America, 2025. https://www.stateofthebirds.org/2025/state-of-the-birds-usa/

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

Question 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? (File Code 2600)

Last Updated

The 2021-2022 Mark Twain National Forest monitoring evaluation report concluded Forest Plan objectives were met for old growth management prescriptions (MP) 2.1 and 6.2; 60,696 acres and 21,299 acres respectively. The objective for shrub/grass/forb/regeneration across all management prescriptions were above the stated objective with the exception in regeneration MP 6.2. Also, the objective meant to provide specialized habitats. Our protections on these important habitats allow for specific needs during the critical life stages of Threatened (T), Endangered (E) and Sensitive (S) species (TES). For example, several bat species require unique habitats with physical/biological features during breeding and hibernating. Protecting these sites allows for the resilience and diversity of habitats necessary to bolster bat populations that were diminished from the spread of white nose syndrome, a fungal disease that has contributed to massive die-offs across the eastern US forests.

Monitoring Indicator(s)

- Acres of key successional habitats provided (open lands, regeneration, etc.)
- Specialized habitats (caves, fens, seeps, springs, cliffs, rock outcrops, wetlands) being protected, maintained, and restored.

- Summer roosting habitats for bats (snags)
- Bat caves gated
- Other TES Recovery Actions Implemented

Monitoring Frequency

Several of the monitoring indicators are completed annually, some occur during timber sales, whereas some are planned over time. For example, with over a thousand caves across the forest, it is impossible to routinely survey all the bat hibernacula during the winter months. Overall, the evaluation and the extent to which the contributions are needed to achieve the conservation of a particular species is based on a longer-term assessment. Monitoring will require a well-planned approach for meaningful trend analyses. Comparisons of annual accomplishments within the 2005 Forest Plan objectives over the last decade are more appropriately conducted on a longer time scale to quantify our successes.

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."

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

The number of bat caves gate installation projects are usually low. However, numerous caves require an annual inspection to ensure the protective gates are securely locked, not vandalized, and the cave habitats maintain an adequate natural flow of air and water.

Monitoring Indicator 1

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

Results and Discussion

Protecting, maintaining, and restoring acres of various seral stages across the landscape following Forest Plan's standard and guidelines addresses the objectives for conserving sensitive species.

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, FSVeg, and NRIS data sets.

Table 16: Amount of Old Growth and Shrub/Grass/Forb Regeneration Acreage

Objective	Target Acres	2022-2023 Acres
Old Growth: 2.1	53,592-100,485	62,785
Old Growth: 6.1	11,040-14,720	8,630
Old Growth: 6.2	15,712-23,568	20,861
Shrub–Grass– Forb- Regeneration*: 2.1	53,592-80,388	63,526
Shrub–Grass– Forb- Regeneration*: 6.1	736-3,680	6,611
Shrub–Grass– Forb- Regeneration*: 6.2	9,820-19,640	3,585
Grassland	55% native	80%**

* 64,148 minimum acres; 103,708 maximum acres, ** Unchanged from 2018-2024

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, Chapter 1 and goal 14 discusses special habitats. Of the unique ecosystems monitored (i.e., caves, fens, seeps, springs, cliffs, rock outcrops, wetlands), we continue with our GIS mapping, inventorying and assessments that future desired conditions and appropriate management actions are achievable. One example important to bat ecological needs is protecting winter hibernation sites (i.e., constructing and maintaining bat cave gates).

From 2023 through 2024, 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.

From 2023 through 2024, notable threats have not changed to specialized habitats, ecosystems and/or rare remnants. Historic issues that are persistent include increasing off-highway vehicle use, spread of known and new invasive plants, feral hog and woody encroachment, non-point source sedimentation into watersheds, increased visitation rates at confined areas, unapproved user created trails by human and livestock, and illegal trash dumps.

While the health and sustainability of these habitats following Management Prescription across the forest is the intent to achieving a future desired condition, the need to maintain monitoring and evaluation is critical. The MTNF strives to reach the objective to provide specialized habitats that are a healthy and ecologically functioning as part of the larger landscape that 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. In 2024, the Regional Bat Conservation Strategy provides additional conservation measures and recommendations too. While the standards and guidelines apply specifically to federally listed or sensitive bats, our approach continues to provide a continuous supply of snags that are well-distributed across the landscape, as this approach provides roosting opportunities for all bat species that require roost trees. The evaluation tools to assist in evaluating this monitoring indicator are timber harvest plans and the Forest Inventory Assessment or Grid Plot methodology.

Various species of bats require different roost niches. Naturally occurring fire-scarred trees with a small crevice are suitable for endangered non-reproductive Indiana bats. A variety of sizes and characteristics of live trees, or trees with dead limbs, are utilized by the endangered Northern long-eared bats. Similarly, live trees that retain clumps of leaves are utilized by the endangered Tricolored bats. During the non-hibernating season, female bats seek snag trees that typically have loose bark, cracks or crevices to raise their young while male bats select other snag trees that are relatively constant across the landscape and over the years. So, a diversity of tree types and sizes, especially those trees with inherent defects across the landscape provide roost habitat for bats. Although some of those microhabitats are not captured in the snag data, the snag monitoring data does provide helpful insight into past and current management activities for retaining bat roosting trees.

Results obtained from a standardized monitoring protocol (NABat) utilize stationary bat acoustic sites across the forest and mobile acoustic surveys. Our previous six years of stationary bat monitoring ranged between five (in 2018) to nine (in 2021) different species that continue to use the area for summer habitat that include forested tracts, creeks, and ponds. For this monitoring report, 6 species were confirmed in 2023 and data for 2024 is pending analyses. Our mobile surveys conducted over 8 nights in 2023 yielded 7 confirmed species. Multiple factors contribute to these slight decreases or increases in the number of bat species using acoustic techniques. First, many bat species continue to decline throughout the United States because of environmental factors, wind energy, white nose syndrome, and habitat loss. However, yearly variation can also be explained by survey effort, the timing of acoustic monitoring, weather events, and the quality of recorded echolocation files. Acoustic recording quality is essential for identifying bats to the species level, especially in

areas with species that overlap in their echolocation call characteristics. The ratio of recordings of noise to non-noise (i.e., bat echolocation) can be an indication of recording quality.

However, the last few years of mist-netting data show that trends for all bats are decreasing, some more drastically than others. In 2024, 8 nights of netting in one of the districts was conducted and a total of 47 individual bats were captured. A total of 8 species were identified, but no Indiana bats. Indiana bat capture success drastically declined, with none captured in 2023-2024. Regarding cave-dwelling bats, this population collapse is primarily due to the presence of white-nose syndrome, which was first identified in Missouri in 2011. Whereas, populations of many tree-roosting bats, including the ubiquitous Eastern red bat in North America, are declining because of high morbidity resulting from wind turbine collisions.

The MTNF continues to provide suitable habitat for the bats' life history needs by following our Forest Plan's standards and guidelines for avoiding snags, and we utilize the Forest Inventory and Analysis (FIA) program of the USDA Forest Service Research and Development Branch to assess snag densities. The FIA foresters collect, process, analyze, and compile reports on data necessary for assessing the extent and condition of forest resources on the Forest and across the United States and each forest can analyze the data as summarized below.
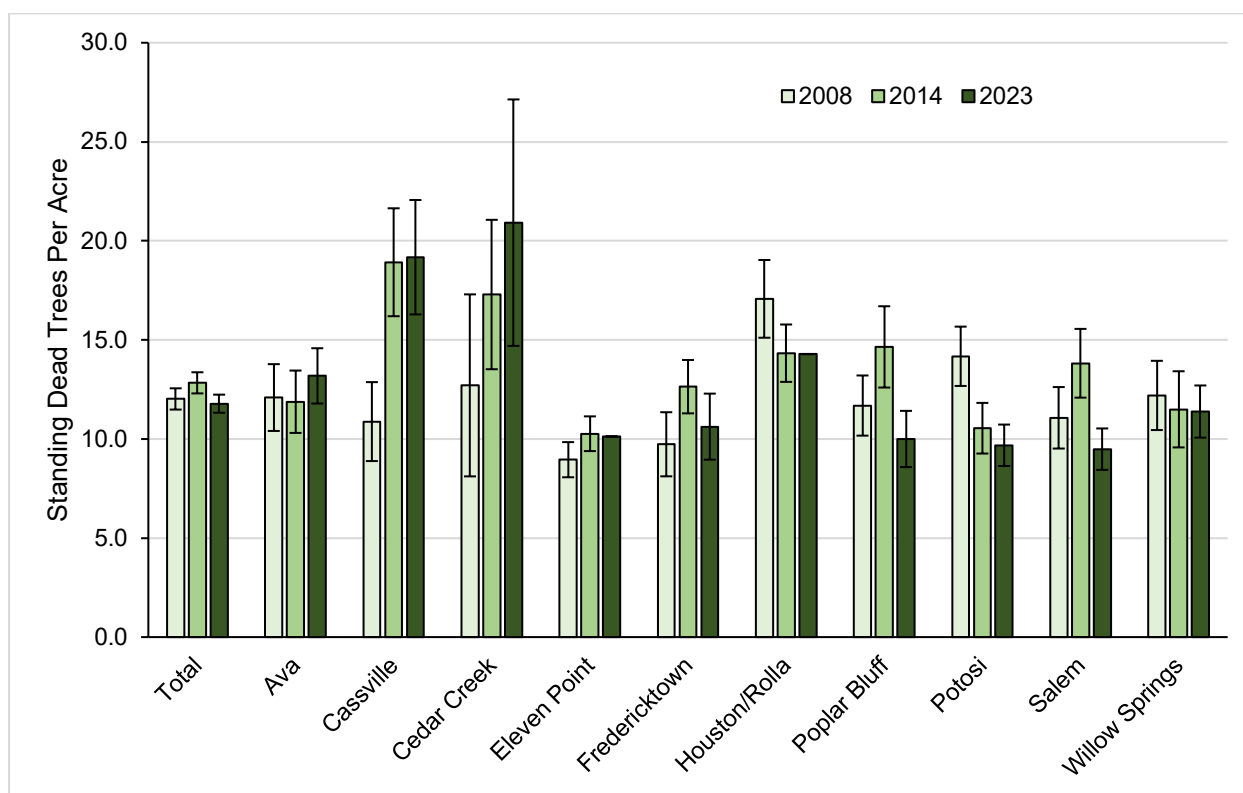
Figure 13: Forest Inventory Analysis completed at time intervals to display standing dead trees (5 inches diameter at breast height or greater) per acre on forest land; this data includes the inventory year and ranger district.

Monitoring Indicator 4
Bat caves gated

Results and Discussion
Numerous cave gates were inspected, and often repairs are required because of vandalism. During 2023 through 2024, one new cave entrance gate and another was modified due to vandalism. An agreement with the Cave Research Foundation has been an integral part in monitoring cave gate breaches and completing numerous repairs. Our agreement allows for numerous biological surveys, and this partnership is critical for our continued ability to assess this highly protected resource. Continued collaboration of bat surveys with trained and permitted biologists employed by Missouri Department of Conservation and US Fish and Wildlife Service are also critically important partnerships.

Monitoring Indicator 5
Other TES Recovery Actions Implemented

Results and Discussion
Monitoring and evaluation of the federally endangered Hine's Emerald Dragonfly and its critical habitat (i.e., fens) requires that we maintain the hydrological connectivity with clean water, assure the habitat is maintained without disturbance, and assure the life-stage requirements of the larval stages (i.e., crayfish burrows) and the adult dragonfly meet the specific needs of vegetation structure and spatial components. Understanding each of the life stage needs, and how these interact with the interdependence of crayfish and surrounding vegetation structure, is imperative for protection of species as much as its recovery efforts.

In 2023-2024, we continued our partnership with conservation biologists to assist in evaluating and monitoring the Hine's emerald dragonfly and Eastern and Ozark Hellbenders, and their associated critical habitat.

To improve federally designated critical habitat for Hine's emerald dragonfly, prescribed burns during the non-flight season are conducted to control non-native invasive and expanding plant populations. Our conservation partners continue with the extensive hog trapping efforts near fens to maintain these unique sites and aquatic components. Active management improves our maintaining the federally designated critical habitat. In conjunction with prescribed fires, we continue to utilize timber harvest/thinning and cedar tree removal within unique ecosystems. Aside from single species management, these management prescriptions have contributed to improving habitat for monarch butterflies and a host of other pollinator species. Historic surveys provided a baseline for presence of species, including monarch butterfly and support the concept that these active management practices do improve and often increase butterfly populations, as well as the overall number of butterfly and bee species in those areas.

We continue to partner with Missouri Department of Conservation to monitor and augment populations of Hine's emerald dragonflies as well as the Eastern and Ozark hellbenders. Long-term occupancy monitoring for hellbenders occurs at predetermined sampling sites and an established 10-year rotation for the priority Ozark Hellbender and Eastern Hellbender rivers. Next occupancy monitoring rotations will not begin until 2030.

Egg searches within natural and artificial (i.e., nest boxes) habitat occurred within all Hellbender watersheds. All eggs collected were transported to the Saint Louis Zoo for hatching and rearing. In 2024, four Eastern Hellbender sites served as egg collections from natural nests. These eggs were collected and transported to Saint Louis Zoo for hatching and rearing.

In 2024, there was one release of captive-reared hellbenders within the proclamation boundary of the MTNF. The release site had 110 Eastern hellbenders from two genetic clutches. Detection of 2 of the introduced Eastern hellbender tags were detected within the area. Unfortunately, both hellbenders were likely consumed by a predator (i.e., large fish or mammal).

A massive flood occurred throughout many of the Ozark rivers and streams on 05 and 06 November 2024. This flood event impacted many of the Ozark Hellbender and Eastern Hellbender rivers. Many of the PIT reader stations were removed prior to the flood or had to be repaired after the flood. As previously documented by the last historic flood in 2017, approximately 50 percent of the Ozark hellbender population was lost but the most severe habitat losses for hellbenders continue to occur outside the MTNF proclamation boundary.

Recommendations
Further needs on the old growth designation in management prescription 6.1. Specialized wildlife habitats in the Forest Plan, such as sink holes, fens, open land fields and vernal pools should be monitored continuously and reported onto a standardized form (Survey 123 or equivalent) and entered into a Database of Record with a reporting procedure. Spatial and tabular data specific for wildlife or aquatics need to follow the sites, visits, and observations format recorded into NRM-Wildlife, or something similar for NRM-AQS. The US Forest Service database of record will make data available to biologists or other specialists working on projects.

Ongoing monitoring with research by universities, non-government organizations or the research units of US Forest

Service or US Fish and Wildlife Service, needs to be tracked so final reports are readily available.

Continue implementing TES recovery actions, to aid in recovery of species. This includes our standard and guidelines for improving and protecting essential habitat features including caves, rivers, streams, fens, and forested habitat. The ability of our biologists working in tandem with our foresters will be needed to receive Perms and Trust funds. Allowing for special use permits to have citizens science or university-lead research needs to be promoted further. Ideally, to accomplish landscape scale projects to improve wildlife habitats and monitoring programs, we will need to partner and develop a well written application for Joint Chief of Staff funds and Collaborative Forest Landscape Restoration Projects to accomplish high profile and essential advances in our monitoring during times of limited operational funds.

Evaluation of Monitoring Question and Indicator(s)

Historically, our monitoring items appear to be somewhat effective in helping us understand how forest management activities are assessed. However, with the advent of spatially connected digital formats (software such as ESRI's Survey 123), our goals should be focused on moving toward electronic data formats that are readily shareable. Data collections from monitoring will advance our contributions significantly and thereby have a positive impact to the decision process to address our conservation of threatened, endangered, and sensitive species and moving toward our Forest Plan objectives.

Advancing the monitoring indicator to address all the federally listed bats may need to reassess conditions of the summer roosting sites, especially the maternal bat rearing trees for bats (i.e., snag trees), as the need for species may require varying conditions of tree bark and spatial positioning for optimized thermal exposure. To-date, most of the evaluation of monitoring relates to the hibernacula and the successful partnerships that conduct hibernacula monitoring during the winter months. Similarly, our aquatic species of fish, mussel, hellbenders, and stream invertebrates also require standardized monitoring which are often completed by formal agreements with the Missouri Department of Conservation and U.S. Fish and Wildlife Service. However, all these agreements are dependent on ongoing funding and personnel capacity.

References

Cave Research Foundation reports, 2023-2024.

https://apps.fs.usda.gov/fiadb-api/evalidator (accessed on March 25, 2025)

Interagency bat survey reports, 2023-2024.

Mark Twain National Forest GIS layers

North American Bat Monitoring Program (NABat) 2023-2024 Acoustic Survey Results, National Data Processing Lab

Specialist reports, 2023-2024.

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 Service Activity Tracking System (FACTS).

U.S. Department of Agriculture, Forest Service. Natural Resource Management (NRM)-Wildlife and NRM-AQS.

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

Status of Visitor Use, Visitor Satisfaction, and Progress Toward Meeting Recreation Objectives

Question 12: 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 2020 – 2022 Mark Twain National Forest Monitoring Evaluation Report showed no change from the 2018 National Visitor Use Monitoring (NVUM) data which was included in the 2015 – 2020 Monitoring Report. The U.S. Forest Service develops estimates of the volume of recreation use on national forests through the National Visitor Use Monitoring (NVUM) program. NVUM happens on a regular 5-year schedule and serves two concurrent goals: (1) to estimate the volume of recreation visits to units of the NFS, and (2) to describe pertinent characteristics of those visits, including activity participation, visit duration, visitor demographics, and visitor satisfaction.

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
National Visitor Use Monitoring System (NVUM) occurs on a 5-year cycle and was last completed in 2023.

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.

Monitoring Indicator 1
Annual visitation estimates by type of visit (day use, developed, general forest area)

Results
The table below displays total site visits followed by a breakdown of specific areas visited.

Table 17: NVUM Annual Visitation Estimate (NVUM 2023)

Visit Type	Visits (1,000s)	90% Confidence Level (%)
Total Estimated Site Visits*	499.5	±19.1
Day Use Developed Site Visits	92.4	±40.3
Overnight Use Developed Site Visits	36.7	±20.9
General Forest Area Visits	344.9	±25.1
Designated Wilderness Visits†	25.4	±54.8
Total Estimated National Forest Visits§	345.2	±21.9
Special Events and Organized Camp Use‡	4.8	±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."

Discussion

Visits to the National Forest decreased by 20% over the previous 5 years. Day use visitation decreased 15%, overnight site visits decreased 26%, visits to general forested areas decreased by 32%, while visits to Wilderness increased by 13%.

Monitoring Indicator 2

Description of visit – demographics, visit descriptions, activities

Results

2023 data collected indicates that 61.8 percent of visitors to the National Forest are male while 38.2 are female. Visitors are predominantly white (97.2%). Also, 47% of visitors are above the age of 40 and 23% of visitors are below the age of 16.

The average length of stay is 8.6 hours average across all visit categories.

Table 18: Visit Duration (NVUM 2023)

Visit Type	Average Duration (hours)‡	Median Duration (hours)‡
All Site Visit	8.6	2
Day Use Developed	-	-
Overnight Use Developed	-	-
Undeveloped Areas	8.6	2
Designated Wilderness	7.2	2.6
National Forest Visit	16.2	3

* 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.

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 19: Activity Participation (NVUM 2023)

Activity	% Participation*	% Main Activity‡	Avg Hours Doing Main Activity
Hiking / Walking	39.3	22.1	2.6
Relaxing	32.3	13.9	4.2
Viewing Natural Features	26.6	2.2	2.2
Viewing Wildlife	24.9	0.4	6
Fishing	23	12.2	4.3
Driving for Pleasure	21.2	5.7	2
Picnicking	15.5	3.5	4.7
Other Non-motorized	12.8	6.9	2.7
Developed Camping	10.9	4.5	24.7
Non-motorized Water	10.4	5.5	6.4
Motorized Water Activities	7.9	2.3	7.7
OHV Use	6.4	4.7	5.2
Bicycling	5.8	2.9	1.8
Visiting Historic Sites	5.4	0	.
Nature Study	5.4	0	8
Hunting	5.3	4.9	8
Some Other Activity	4.6	3.7	11
Primitive Camping	4.3	0.4	74.1
Nature Center Activities	3.8	0	.

Gathering Forest Products	3.3	0.8	3
No Activity Reported	2.2	2.2	.
Backpacking	1.6	0.7	36
Horseback Riding	0.7	0.7	4
Resort Use	0.3	0	.
Other Motorized Activity	0.3	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%.

Discussion

39% of visitors responded that hiking and walking was their main activity while on the National Forest followed by relaxing (32%), viewing natural features (26%), and viewing wildlife (25%).

Monitoring Indicator 3

Economic information – spending, substitute behavior, etc.

Results and Discussion

Visitors to the National Forest spent $110, on average per trip. Trips resulting in a stay away from home were 15% of the total visits. National Forest developed campgrounds were the most frequently used while camping is less developed areas of the National Forest was used 17% of the time.

Table 20: Trip Spending and Lodging Usage (NVUM 2023)

Trip Spending	Value
Average Total Trip Spending per Party	$110
Median Total Trip Spending per Party	$21
% NF Visits made on trip with overnight stay away from home	15%
% NF Visits with overnight stay within 50 miles of NF	14.5%
Mean nights/visit within 50 miles of NF	5.2
Area Lodging Use	**% Visits with Nights Near Forest**
NFS Campground on this NF	33.9
Undeveloped Camping in this NF	16.9
NFS Cabin	2.1
Other Public Campground	0
Private Campground	0
Rented Private Home	13.4
Home of Friends/Family	11.7
Own Home	0
Other Lodging	1.2

Monitoring Indicator 4
Visitor Satisfaction

Results and Discussion
Respondents to the 2023 NVUM were overall satisfied with developed facilities, access, and services. Between 90 and 98% of visitors felt safe across all satisfaction elements.

Table 21: Percent Satisfied Index[†] Scores for Aggregate Categories (NVUM 2023)

Satisfaction Element	Satisfied Survey Respondents (%): Developed Sites‡	Satisfied Survey Respondents (%): Undeveloped Areas (GFAs)	Satisfied Survey Respondents (%): Designated Wilderness
Developed Facilities	85.3	78.6	50
Access	97	87.8	83.8
Services	81.1	74.7	77
Feeling of Safety	96.3	98.2	90

† 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 percentage of all visitors that are reasonably well satisfied with agency performance.
‡ This category includes both day-use and overnight-use in developed sites.

Recommendations
Continue to follow National and Regional direction for monitoring recreation use through NVUM.

Evaluation of Monitoring Question and Indicator(s)
Site visits across all strata declined except for Wilderness. Declines ranged from 15%-32%. The largest decline across all strata was in general forest areas with 248,034 less visitors recorded. This may be explained by fewer survey days completed in 2023 (177 completed versus 217 scheduled) compared to 2018 (214 completed versus 222 scheduled). A small increase in Wilderness use was recorded with 8000 more visitors in 2023. The Wilderness surveys were likely all completed explaining the increase of use.

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.

Question 13: 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 2020-2022 Mark Twain National Forest Monitoring Evaluation Report concluded that all 2005 Forest Plan and Missouri Department of Natural Resources protocols were followed to ensure water quality at swimming beaches and quality of drinking water at forest recreation sites.

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."

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.

The Mark Twain National Forest manages 9 public drinking water systems. 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. 177 routine water samples were taken on the National Forest between 2023 and 2024. 96.5 percent of water quality samples were bacterially safe during this monitoring period.

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

Prioritization should be placed on proactive and preemptive improvements to public drinking water systems.

Evaluation of Monitoring Question and Indicator(s)

Forest recreation facilities are inspected, and deficiencies are corrected as staff and budget allow. Water systems are maintained and tested to State regulations. Repairs to facilities and the ability to maintain water systems is driven by staffing levels. 2023-2024 staffing levels allowed for implementation of deferred maintenance tasks and acceptable operations of water systems. A decrease in staffing levels could result in the inability to meet regulations and standards.

References

Missouri Department of Natural Resources (MoDNR) Public Drinking Water.
https://www.dnr.mo.gov/DWW/DNRLogin.jsp

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

Question 14: To what extent are management activities meeting Recreation Opportunity Spectrum objectives? (File Code 2300)

Last Updated

The 2020-2022 Mark Twain National Forest monitoring evaluation report concluded that 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.

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 2023 and 2024 were reviewed to determine if ROS had been considered and evaluated for the projects. 31 projects were reviewed and were consistent with ROS.

No projects to change ROS were proposed in 2023 or 2024.

Discussion

The 2023 National Visitor Use Monitoring (NVUM) results indicate that the public is overwhelmingly satisfied with the experiences and opportunities available. Satisfaction was measured across 3 categories of Forest Service recreation settings: 1) developed sites, 2) dispersed recreation areas, and 3) Wilderness. The public was asked their satisfaction with developed facilities within each category, satisfaction with access within each category, satisfaction with services within each category, and a feeling of safety with each category of recreation setting.

71% of visitors were satisfied with facilities within recreation settings. This percent was affected by the 50% score for facilities within Wilderness. Facilities, except for rare occasions, are not present in Wilderness. 90% of visitors were satisfied with access to recreation settings. 77% were satisfied with the services offered at the recreation settings. 94.8% of visitors felt safe while visiting.

Recommendations

ROS objectives should continue to be considered 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).

Question 15: How are management activities affecting unauthorized OHV use? (File Codes 2300 and 5300)

Last Updated

The 2020-2022 Mark Twain National Forest monitoring evaluation report concluded "vehicle off-road" is consistently in the top five highest issued violations yearly. These citations include 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, has been identified at both ATV trail areas (Sutton Bluff and Chadwick) and in general forest areas.

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 2022 and 2023, there were 323 incident reports issued. Ten of those incident reports were written for travel management violations. 130 violation notices were issued during the same time period. 35 violation notices were issued for travel management violations. The number of violation notices has decreased at the same rate as violation notices written for travel management violations. This is likely due to vacancies of law enforcement personnel.

Monitoring Indicator 2
Documentation of resource damage

Results and Discussion
The Forest Service developed a Survey123 tool called Trail Assessment and Condition Overview Survey (TACOS) in 2023 to identify and track user created trails. The creation of this survey will provide a consistent method to report and document resource damage from unauthorized use along with providing visual representations for map making purposes. This tool is the Forest Service standard to capture existing trail spurs (system or non-system trails) efficiently. The Mark Twain has adopted this tool and has hosted training for Forest Service staff and volunteers of the Forest.

Work will continue to identify problem areas and to restore the resources and prevent future occurrences.

Monitoring Indicator 3
Public complaints to areas of management activities

Results and Discussion
Complaints are received regarding ATV and OHV use in the Mark Twain National Forest. Complaints are of two types – too much off road use or too few places to ride off road.

A series of complaints in the Hazel Creek Watershed prompted 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 and reported in the previous monitoring report. Signs were torn down and boulders moved within the first 3 months. Local management cites the lack of follow-up and enforcement on the ground due to staffing vacancies.

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. Patrols and issuance of citations will occur as appropriate and as funding and personnel allow.

Evaluation of Monitoring Question and Indicator(s)
To identify whether management actions are affecting how or why people illegally use OHVs, then these indicators are not answering that question.

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

- 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 unauthorized use of OHVs?
- What management actions have we taken to discourage OHV unauthorized use?

The Forest Service developed tracking of trails will assist in further understanding how management actions are affecting OHV use.

References
U.S. Department of Agriculture, Forest Service. Law Enforcement Officer reports

Measurable Changes on the Plan Area Related to Climate Change and Other Stressors that may be Affecting the Plan Area

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

Last Updated
The 2020-2022 Mark Twain National Forest monitoring evaluation report showed the beginning of a trend where mortality was decreasing, and net growth was increasing. This trend continued in 2023 and 2024.

Monitoring Indicator(s)
Acres of mortality

Monitoring Frequency
Annual

Background & Driver(s)
This question is tied to the second part of the 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 regularly been subject to a wide variety of disturbances which can result in mortality of overstory trees. The affected trees provide resources for people and the structure for a healthy, sustainable forest. 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. The data in the following tables was obtained from the Forest Service Forest Inventory and Analysis Unit. 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 the Forest Service's Northern Research Station (NRS). Since 2013, NRS has conducted an annual flight in July or August. In recent years the forest has used "change detection" satellite imagery from the Forest Service Geospatial Technology and Applications Center (GTAC) to track disturbance events such as windthrow. This will likely become another tool to track tree mortality in the future.

Monitoring Indicator 1
Acres of mortality
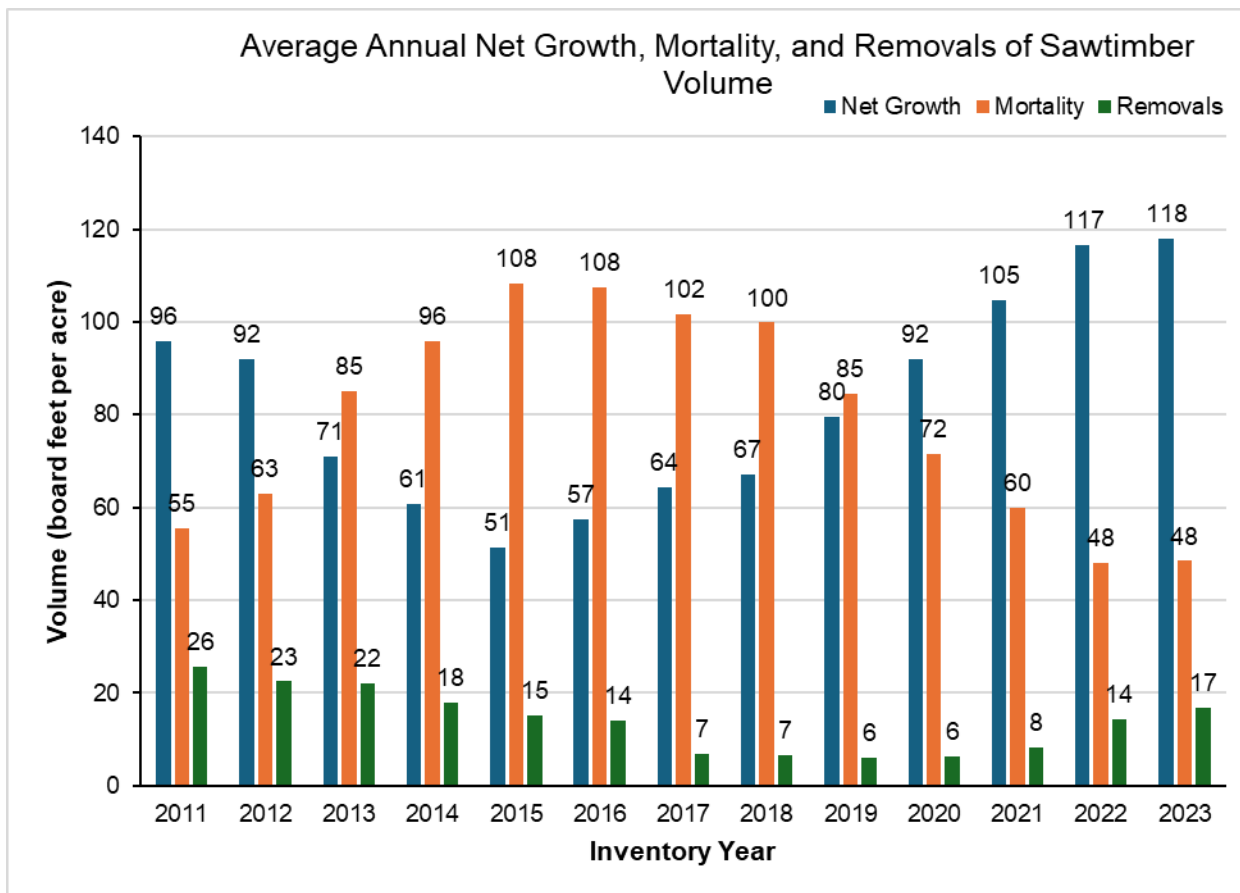
Figure 14: Average Annual Growth, Mortality, Removals in Board Feet Per Acre
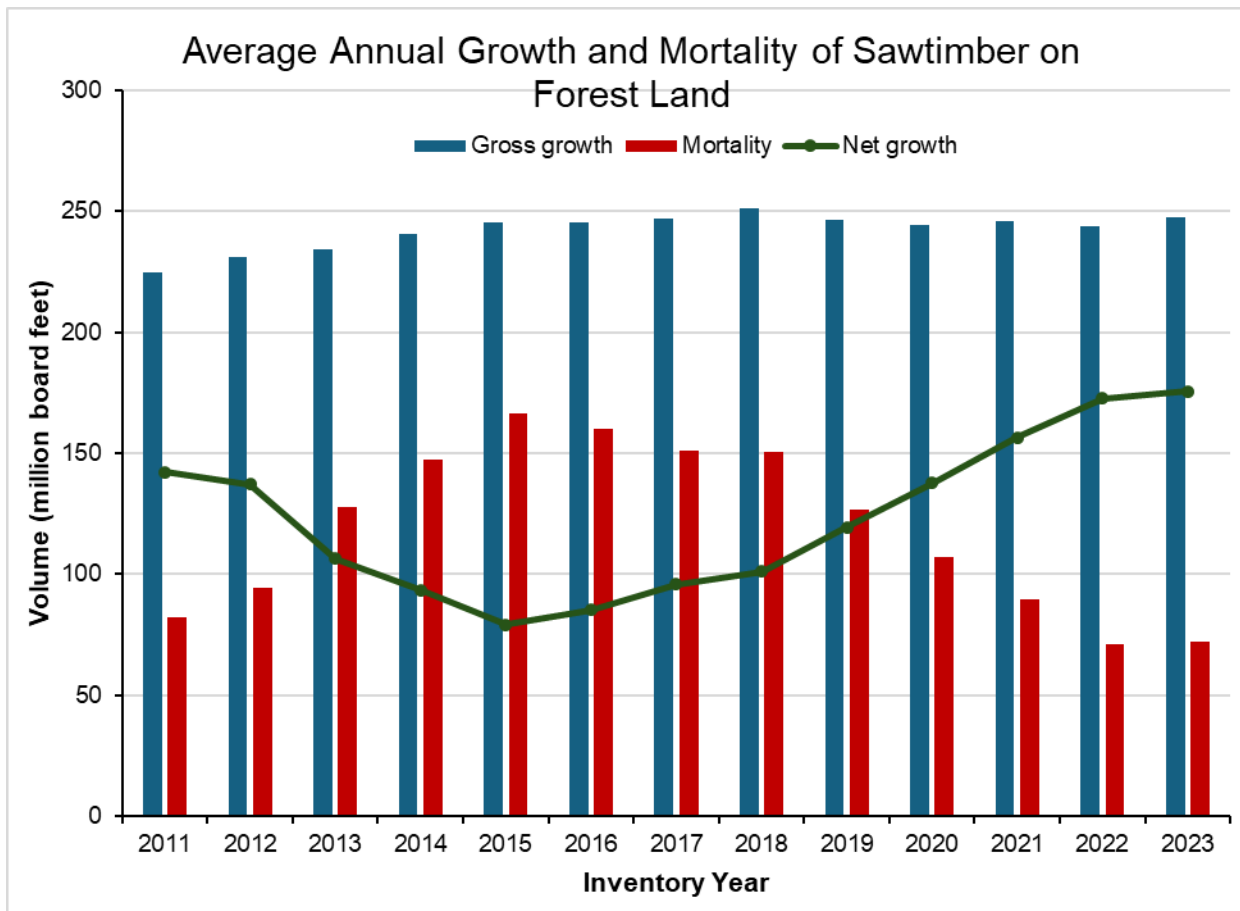
Figure 15: Average Annual Growth and Mortality of Sawtimber on Forestland

The following is a tabular representation of the data captured in Figure XX.

Table 22: Average Annual Growth and Mortality of Sawtimber on Forestland data displayed in figure 18

Year	Gross Growth in MMBF	Mortality in MMBF	Net Growth in MMBF
2011	224,531,427	82,283,765	142,247,676
2012	231,291,092	94,103,752	137,187,350
2013	234,017,475	127,493,748	106,523,739
2014	240,686,373	147,334,856	93,351,532
2015	245,516,768	166,498,117	79,018,667
2016	245,208,241	159,923,638	85,284,614
2017	246,881,271	151,124,842	95,756,436
2018	251,429,151	150,434,809	100,994,349
2019	246,232,540	126,820,055	119,412,495
2020	244,532,899	106,974,651	137,558,253
2021	245,729,046	89,369,150	156,359,900
2022	243,634,867	71,092,139	172,542,729
2023	247,693,820	72,173,548	175,520,273

Discussion

We have taken steps over the past decade 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 2019 mortality outpaced net sawtimber growth. Timber outputs have continued to increase over the past decade to capture mortality and treat the landscape. Mortality has continued to decline after a peak in 2015. The positive trend continues with net growth outpacing mortality through the last data set available for 2023.

As of 2023, the forest wide estimated mortality volume has settled at approximately 72 MMBF while net growth has increased to nearly 175 MMBF.

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. This project is still ongoing in 2025.

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. In the last few years, the forest has experienced severe wind disturbances on the Willow Springs, Eleven Point, and Poplar Bluff Ranger Districts resulting in multiple salvage projects. These salvage projects are ongoing under the Disturbance and Recovery EA.

In September of 2023, the Forest Inventory and Analysis (FIA) program published a new modeling system for predicting tree cubic-foot volume, biomass, and carbon attributes, completing a goal of the 2015 FIA Strategic Plan. This system, termed 'National Scale Volume and Biomass Estimators' (NSVB), provides a more consistent and accurate accounting of structural components of trees. This change in estimators may have caused a slight variance in reported volumes from past monitoring reports. See below references for more information.

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 the 2005 Forest Plan objectives, including consideration of local needs. We have had drought events in the last few years and their possible effects won't be seen for a few more years. Typically, the majority of mortality has been in the red oak group. There have been anecdotal indications that as the white oak group starts to reach maturity, there may be a shift from red oak to white oak group mortality.

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. We have had drought events the last few years and their possible effects won't be seen for a few more years. Typically, the majority of mortality has been in the red oak group. There have been anecdotal indications that as the white oak group starts to reach maturity, there may be a shift from red oak to white oak group mortality.

Evaluation of Monitoring Question and Indicator(s)

We will continue to cooperate with NRS scientists and researchers to conduct field and aerial surveys to identify areas affected by mortality. We will also use imagery from GTAC as available.

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 environmental factors 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). https://research.fs.usda.gov/programs/fia/nsvb

Progress Toward Meeting the Desired Conditions and Objectives in the Plan, Including Providing Multiple Use Opportunities

Question 17: How close are projected outputs and services to actual? (File Code 2400)

Last Updated
In 2016, the Mark Twain National Forest entered the second decade of the Forest Plan. The SPECTRUM model, which was used to help determine ASQ during the first and second decade of the Forest Plan, projected outputs of sawtimber to around 49 million board foot and roundwood to be around 54 million board feet in the second decade. There is a decline in acres cut and sold starting in 2006 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 can mimic 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 the 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
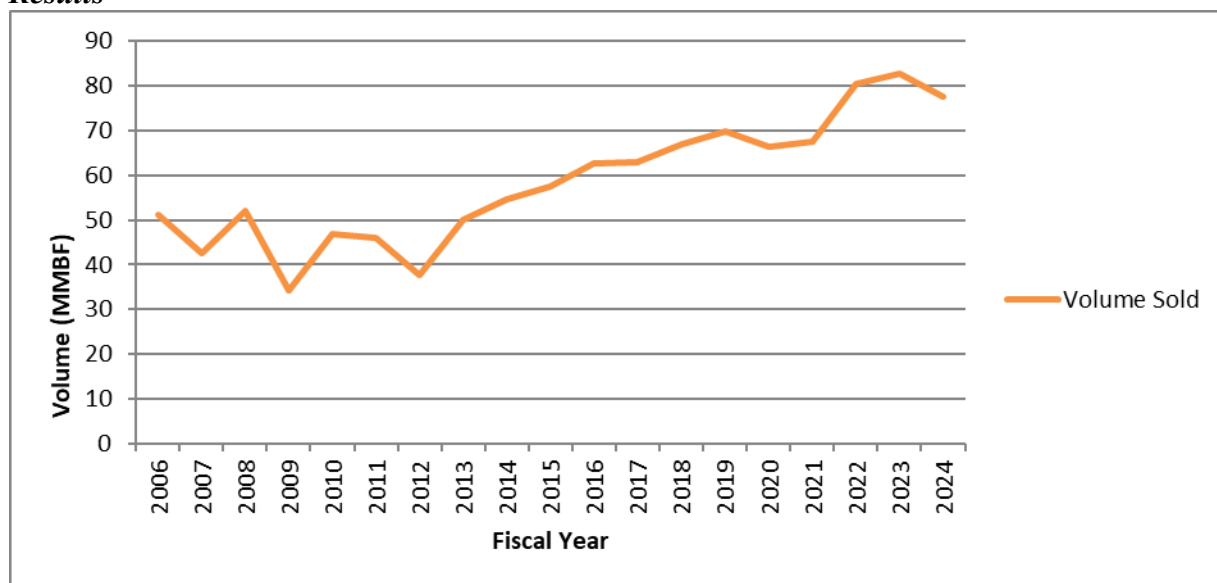
Figure 16: Total Sold Volume in Million Board Feet (MMBF)

Discussion

The total volume sold during the period since the 2005 Forest Plan was implemented has varied but has increased overall. The ASQ under the Forest Plan is 103 million board feet (MMBF). In fiscal year 2022, there was an increase in volume sold over the prior two years. This was the result of salvage sales sold from a wind disturbance event that occurred in 2020 on the Poplar Bluff, Doniphan, and Willow Springs units. This increase continued in fiscal years 2023 and 2024 to capture the merchantable material from the wind disturbance event.

Monitoring Indicator 2

Acres harvested

Results
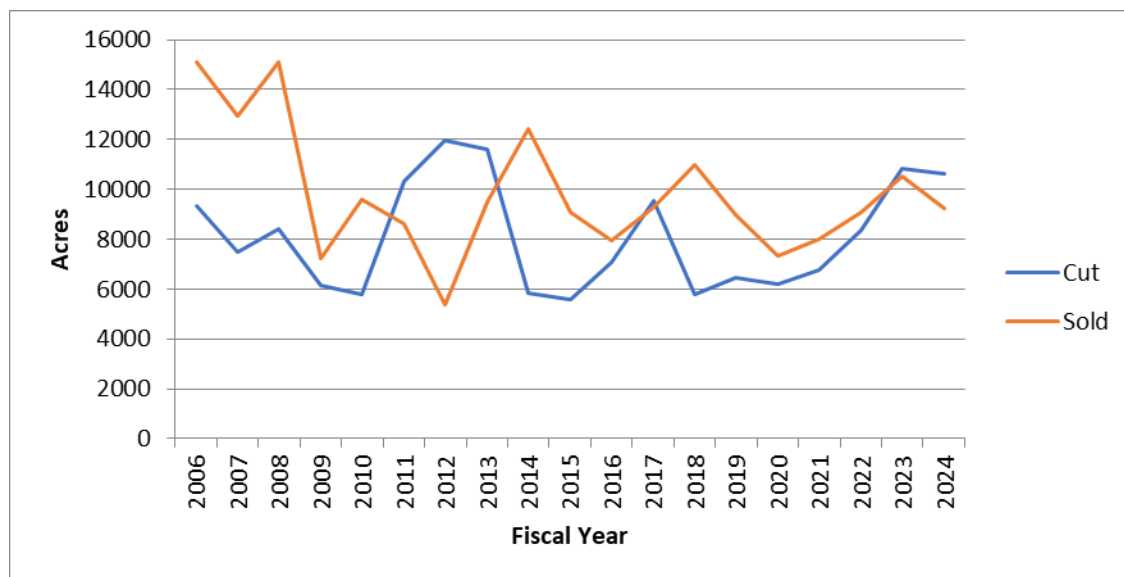
Figure 17: Acres Sold and Acres Harvested by Fiscal Year

Discussion

Acres of timber harvest acres sold and cut each year tend to follow the same trend as volumes. There is some variation from 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). From 2022 through 2024 there was an increase in acres sold and cut due to the salvage of timber from the wind event of 2020. Acres harvested are largely driven by markets and volume per acre. Harvests range between 6,000 to 10,000 acres per year.

Monitoring Indicator 3

Product mix

Results

The following figures display the amount of timber sold in the first and second decade of Forest Plan implementation.
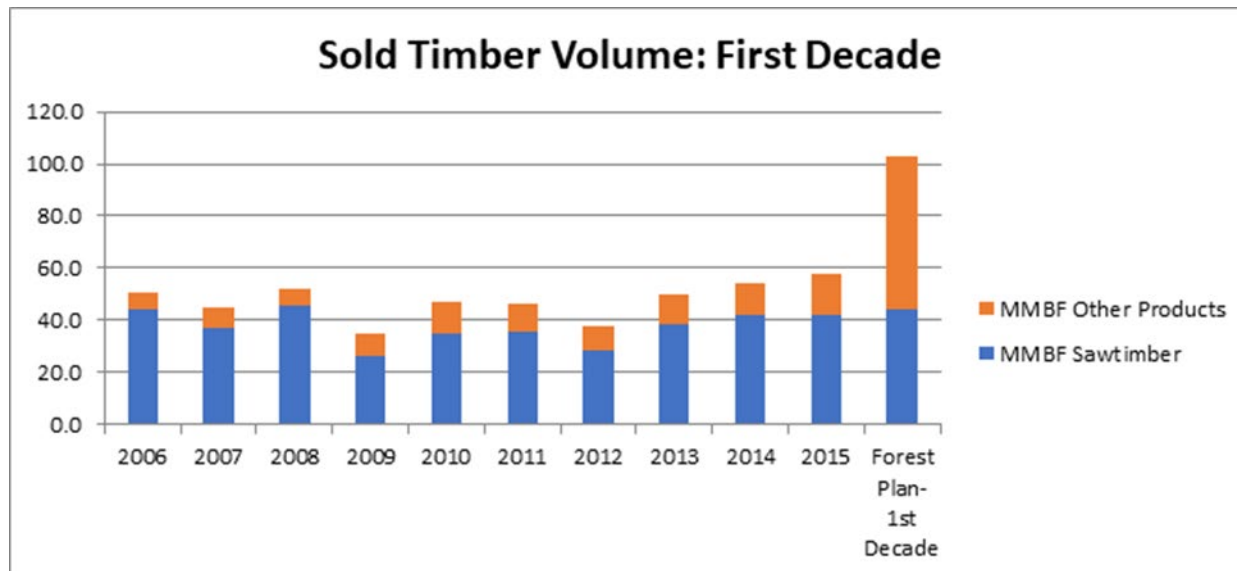
Figure 18: Timber Sold in First Decade of 2005 Forest Plan
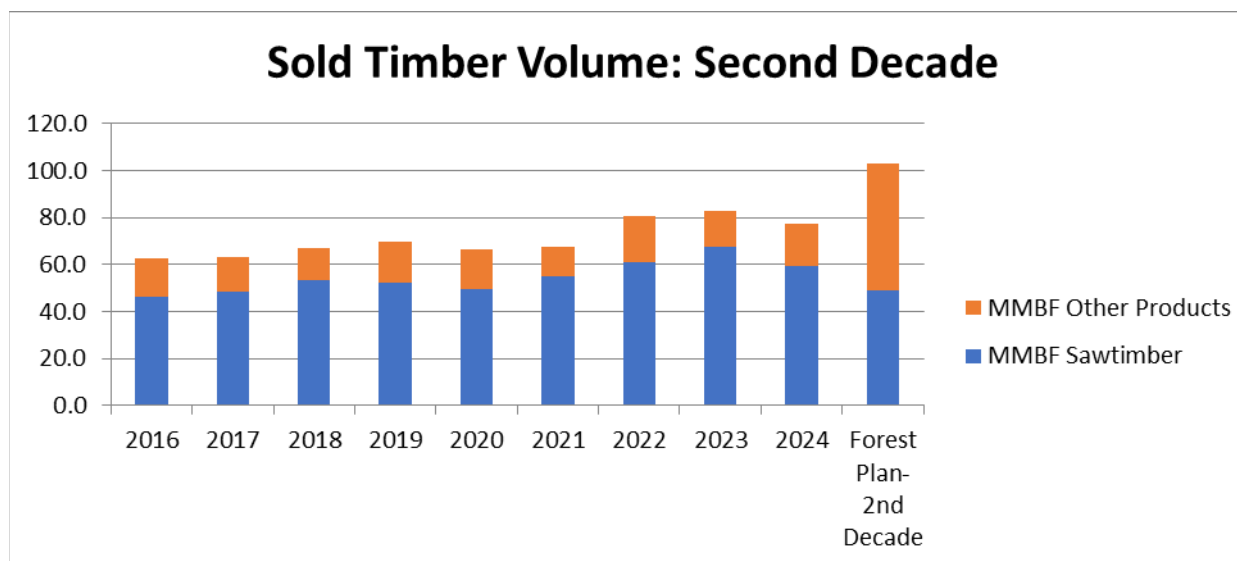
Figure 19: Timber Sold in Second Decade of 2005 Forest Plan

Discussion

According to the 2005 Forest Plan, for the first decade (2006-2015) it was modeled that 44 million board foot in

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sawtimber was anticipated. Beginning in the second decade (2016), the model showed an increase of sawtimber to around a 49 million board foot.

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 currently. We continue to work with industry to try to develop markets.

The level of sawtimber sold has remained generally stable over the second decade with an increase in 2022 through 2024 due to the salvage of timber from the wind event of 2020. After salvage operations from the blowdown event are completed, it is expected that the level of sawtimber sold will return to levels seen earlier in the decade (2016-2020). 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.

The market demand for Shortleaf Pine has remained weak locally and presents a challenge for commercial treatment. The Missouri Department of Conservation was awarded a grant from the Forest Service to conduct an economic study on Shortleaf Pine. The study, currently underway, is to understand the Shortleaf Pine resource within the state of Missouri and to develop a market analysis to determine both current and possible future markets to better utilize the pine resource.

We need to continue tracking the ASQ for all products by the decade.

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.

U.S. Department of Agriculture, Forest Service. Forest Service Activity Tracking System.

Question 18: What progress has been made towards meeting objectives in the plan? (File Code 1900)

Last Updated
Goal 1.1 is to maintain, enhance, and restore natural community vegetation and structure. Previous reports have identified the need for a more robust analysis of geographic information system data to assess the acres of each terrestrial natural community that have been treated and restored in each ecological subsection.

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 do not 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.

For goal 2.2, we have made progress toward implementing growing season and fall prescribed burns. We need to decide whether to change the acreage objective or plan to continue towards implementing it. Since 2021 we have met the objective of prescribed burning 45,000-acres per year.

Monitoring Indicator(s)
Quantitative objectives from Chapter 1 of the 2005 Forest Plan
1. Objective 1.1a: Table 1-1 (Restoration objectives for Management Prescription 1.1)
2. Objective 1.1b: Table 1-2 (Restoration objectives for Management 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 determine 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.

These "Monitoring Indicators" 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 23: 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
In areas with a 1.1 management prescription the Mark Twain National Forest completed about 18,000 acres of restoration work in FY23-24. Activities used for restoration include vegetation management and prescribed burning.

Recommendations
The original thought of the forest planners was to thin forest stands as much as possible at the 2005 Plan onset. We have found that opening the overstory drastically creates a thicker understory of undesirable species. We have adapted our management to open these stands more gradually.

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

Table 24: 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

In areas with a 1.2 management prescription the Mark Twain National Forest completed about 24,000 acres of restoration work in FY23-24. Activities used for restoration include vegetation management and prescribed burning.

Recommendations

The original thought of the forest planners was to thin forest stands as much as possible at the outset. We have found that opening the overstory drastically creates a thicker understory of undesirable species. We have adapted our management to open these stands more gradually.

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. 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 over 30,000 acres.
Throughout the Mark Twain National Forest, NNIS plants are most abundant in regularly disturbed areas such as

roadsides, grazing allotments, and old fields.

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 and Discussion
Infestations of non-native invasive species (NNIS) increasingly threaten tree regeneration, biodiversity, and the integrity of natural communities on the Mark Twain National Forest. NNIS includes terrestrial and aquatic plants and animals. Throughout the forest, NNIS plants are most abundant in regularly disturbed areas such as roadsides, grazing allotments, and old fields. Of particular concern are those species successful at invading natural habitats.

Invasive Plant Species Inventory
The Forest Service's invasive species inventory database includes known, mapped populations of individual invasive species. There are 46 species of NNIS (45 plants and feral hogs) known to exist in the Mark Twain National Forest. The table below lists the plant species and the number of inventories where the species is identified. There are 5,563 mapped and inventoried invasive plant infestations across approximately 74,000 acres of the forest. Within those 74,000 acres the actual infested acres are lower. Some areas may be highly infested with multiple species (e.g., road corridors, old fields) present while others that have been routinely treated may only have sparse populations. The current estimate of infested acres is 49,000, but the varying densities and overlapping inventories make it difficult to calculate the actual number of acres impacted on the forest by invasive species.

The diagram below attempts to illustrate how invasive species are mapped. A polygon is drawn for each invasive species infestation and a percent infested is assigned to each polygon. In this example, Species A is found across 100 acres, but at low density and so it is estimated that only 5% are infested (5 acres). Species B covers 50 acres and is 100% infested (50 acres). Species C is found across 100 acres, but approximately 85% is infested (85 acres). If this is queried from the inventory database it would tally as 140 infested acres, but with the overlapping polygons it would actually be fewer acres impacted. However, given the limited capacity to map new infestations, 49,000 acres is likely an underestimate of the extent of invasive species on the forest.
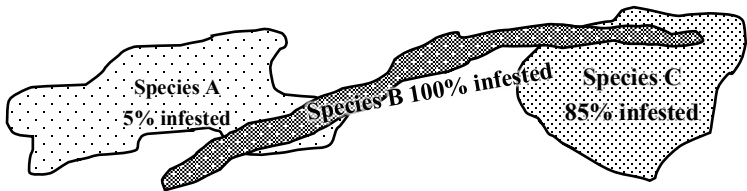
Figure 20: Illustration of three invasive plant populations with varying levels of infestation and overlapping population boundaries.

Certain species are commonly encountered (e.g., sericea lespedeza has 2,068 inventory records). Other infestations are not included in the inventory due to a lack of capacity to conduct invasive species inventory and the limitations of the mapping/database technology. 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, callery pear and autumn olive are being found in forest and woodland understories.

Table 25: The invasive species included in the inventory database. The # of inventories represent the number of times that species has been included in an inventory. The infested acres will vary in the density of the infestation.

	Scientific Name	Common Name	# of Inventories	Infested Acres
1	Acer ginnala	Amur maple	1	<1
2	Ailanthus altissima	tree of heaven	77	319
3	Albizia julibrissin	silktree	120	112
4	Alliaria petiolata	garlic mustard	7	65
5	Bothriochloa bladhii	Caucasian bluestem	1	1
6	Bromus tectorum	cheatgrass	8	21
7	Carduus nutans	nodding plumeless thistle	84	1,280
8	Celastrus orbiculatus	Oriental bittersweet	1	1
9	Centaurea biebersteinii	spotted knapweed	223	1,641
10	Cirsium arvense	Canada thistle	14	41
11	Cirsium vulgare	bull thistle	22	148
12	Citrus trifoliata	hardy orange	1	2
13	Coronilla varia	crownvetch	56	796
14	Dioscorea oppositifolia	Chinese yam	2	1
15	Dipsacus laciniatus	cutleaf teasel	10	116
16	Echium vulgare	common viper's bugloss	1	0
17	Elaeagnus angustifolia	Russian olive	3	18
18	Elaeagnus umbellata	autumn olive	94	760
19	Euonymus fortunei	winter creeper	7	3
20	Glechoma hederacea	ground ivy	2	4
21	Hedera helix	English ivy	3	1
22	Humulus japonicus	Japanese hop	1	89
23	Lespedeza cuneata	sericea lespedeza	2068	23,199
24	Ligustrum obtusifolium	border privet	11	8
25	Ligustrum ovalifolium	California privet	1	1
26	Lonicera japonica	Japanese honeysuckle	392	989
27	Lonicera maackii	Amur honeysuckle	1	4
28	Melilotus albus	sweetclover	53	280
29	Microstegium vimineum	Nepalese browntop	324	550
30	Myriophyllum spicatum	Eurasian watermilfoil	10	528
31	Onopordum acanthium	Scotch cottonthistle	2	14
32	Paulownia tomentosa	princesstree	6	<1
33	Perilla frutescens	beefsteakplant	656	1,528
34	Potamogeton crispus	curly pondweed	3	45
35	Prunus mahaleb	Mahaleb cherry	6	15
36	Pueraria montana var. lobata	kudzu	22	303
37	Pyrus calleryana	Callery pear	89	184
38	Rosa multiflora	multiflora rose	1058	15,834
39	Rubus armeniacus	Himalayan blackberry	3	210
40	Rumex crispus	curly dock	3	0
41	Saponaria officinalis var. glaberrima	bouncingbet	1	1
42	Securigera varia	crownvetch	11	8
43	Sonchus arvensis	field sowthistle	1	0
44	Sorghum halepense	Johnsongrass	102	591

	Scientific Name	Common Name	# of Inventories	Infested Acres
45	Vicia sativa var. nigra	garden vetch	2	5
	Total		5,563	49,714

In 2023-2024, 37 new infestations of 9 species were mapped totaling 809 acres. Some areas include multiple species and so the footprint of infestation is smaller and often multiple species can be treated during the same visit (e.g., sericea and Japanese honeysuckle growing along a roadside). The species and newly mapped acreage are displayed in the table below. These mapped acreages include two large rangeland areas that have invasive species present.

Table 26: The newly mapped populations of invasive species identified in 2023 and 2024.

Scientific Name	Common Name	Acres Infested
Ailanthus altissima	tree of heaven	12.9
Centaurea biebersteinii	spotted knapweed	14.5
Elaeagnus umbellata	autumn olive	9.0
Lespedeza cuneata	sericea lespedeza	714.8
Lonicera japonica	Japanese honeysuckle	7.2
Microstegium vimineum	Japanese stiltgrass/ Nepalese browntop	29.6
Paulownia tomentosa	princesstree	<0.5
Rosa multiflora	multiflora rose	7.2
Sorghum halepense	Johnsongrass	13.7
Grand Total		808.9

One important trend to note is the decreased number of inventory acres being recorded. The chart below tracks the acres of invasive species inventory since 2015, which was the highest inventory year since the 2005 Forest Plan was finalized. The chart shows a decline in new inventory acres over the last 10 years. This could be, in part, due to a focus on treating already inventoried acres. However, it is assumed that invasive species populations have been increasing over the last 10 years rather than declining and the loss of several key staff has further impacted the forest's ability to remain current with addressing this threat.
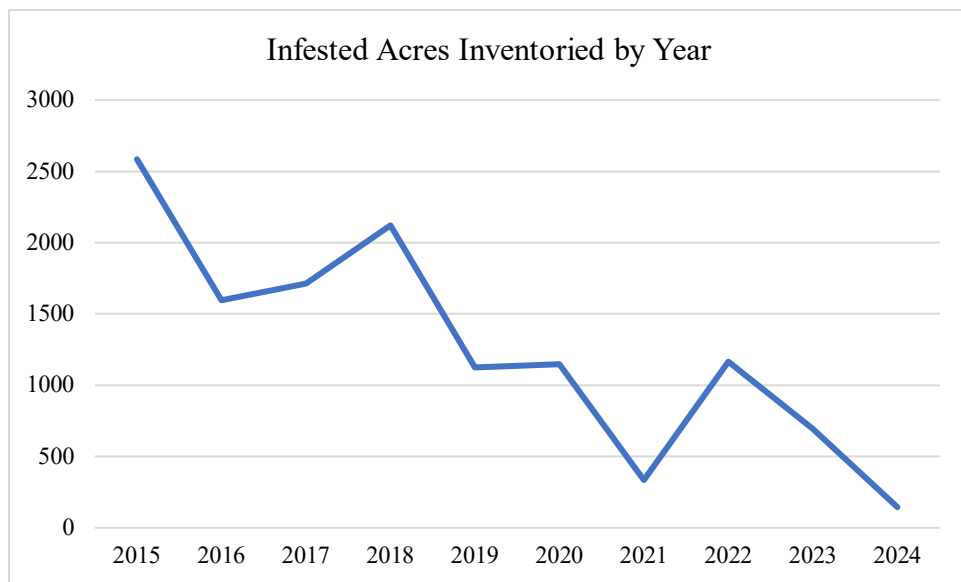
Figure 21: This chart shows the acres of invasive species inventoried each year. 2015 was the highest year for inventory since the forest plan was finalized and the trend has been decreasing.

Invasive Plant Species Treatment

As discussed in previous monitoring reports, the 2005 Forest Plan objective to treat 2,000 acres of NNIS has been exceeded. 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. After signing this decision, the forest has usually treated over 2,000 acres per year of NNIS, but this has varied with personnel, funding, and contracting/partnering capacity.

NNIS can be treated with a variety of methods (e.g., mechanical, chemical). The 2012 decision also included a method to evaluate and monitor the effectiveness of non-native invasive species treatments. Since that time, 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. Herbicide continues to be the primary tool used to treat most invasive plant infestations.

The treatment data for invasive plants dates back to 2007 and over 22,000 acres have been treated at least once for one or more invasive plant species. For fiscal year 2023-2024, treatment areas covering approximately 8,000 acres received partial or full treatment for invasive species. The most-treated species is Sericea lespedeza, and that is likely to continue to be the case. However, numerous other species are increasing in priority as they become more frequently observed. Examples include Asian honeysuckle (*Lonicera morrowii and L. maackii*), Japanese stiltgrass (*Microstegium vimineum*), Spotted knapweed (*Centaurea stoebe micranthos*), and Callery pear (*Pyrus calleryana*).

Invasive Animals – Feral Hogs
Feral hogs have been tackled directly by the multi-agency Feral Hog Elimination Partnership. Those efforts are covered extensively in separate reporting. The number of hogs killed each year is going down as they are eliminated from places on the landscape. This website contains additional information about this cross-boundary effort: https://extension.missouri.edu/programs/feral-hog-elimination-partnership

Recommendations
The 2005 Forest Plan goal is to "control" 2,000 acres of NNIS. This objective has been met and exceeded many times when measured by acres treated. However, "control" and "eradiction" are two separate goals for invasive species and while some places will need continual control, eradication may be the preferable goal in many places to reduce the actual number of infested acres. This will take additional resources for inventory and treatment, as well as measures to prevent future introductions.

The gap between the inventoried (49,000) and the treated (22,000) acres indicates the need for capacity is only growing. While some of the difference can be attributed to mapping and inventory issues, the need is still great. Recent staff changes and resource constraints have limited the forest's ability to detect, map, and treat new infestations. The forest needs to continue with aggressive identification and treatment of NNIS 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. The forest should also continue to seek out new treatments and technologies to assist in the control of these species.

Evaluation of Monitoring Question and Indicator(s)
A program evaluation, aligned with the 2012 record of decision, should be completed to summarize the work conducted under that decision and to recommend the next steps in addressing invasive species on the forest. This document could inform any changes to the objective for non-native invasive species. Future forest plans should consider refining goals around control and/or eradication of invasive species based on management prescription, location, threat to natural communities, and likelihood of success.

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 have limited perennial streams, most of the bottomland areas are in private ownership. Currently, no monitoring data has been collected on the Mark Twain National Forest to determine if stream reaches are stable. Few projects are proposed, and currently proposed projects are a result of priority watershed work, stream crossing replacements due to aquatic passage and/or safety concerns and stream reach stabilization in project areas. The only stream project started in FY21-22 was the Brickey Slab project which replaced a barrier to aquatic organism with a bridge in the Huzzah Creek Drainage. This project was a partnership between Crawford County, US FWS. local landowners and the Mark Twain National Forest. The new bridge resulted in over seven miles of improved aquatic organism passage (AOP) upstream and a reduction of in stream erosion. The project also included streambank stabilizations efforts which were completed in 2023. Two projects that have been proposed during FY24 will be included in the future monitoring report and have streambank stabilization components included in the project proposal.

Since 2006, there have been a few aquatic organism passages (AOP) and stream stabilization projects on the Mark Twain National Forest. Total stream miles stabilized with these projects is approximately five miles. We are not on target to meet this objective. These types of projects are expensive for the relatively small accomplishment that can be claimed. The design and implementation of these projects often take specialized experience that is not readily available within 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)

Results and Discussion

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.

Available GIS data indicates there are approximately 97,000 acres of bottomland forest types across the Mark Twain National Forest. These could be dry-mesic, mesic, wet-mesic, wet, or riverfront forest types. See table below. Some percentage of these forests were likely converted or cleared for subsistence living when the Ozarks were settled, but are no longer managed as open areas. At least 400 acres continue to be managed as range and another 6,000 acres are known

to have been formerly converted to agricultural uses and have varied conditions because of the past land use. This is likely an underestimate of the former agricultural use in bottomland areas, but due to limitations in readily available historical and forest-wide data, the extent and condition of those converted forests is not available for including in this report at this time.

Table 27: The table provides a summary estimate of the acreage for each bottomland forest type. *These are modeled forest types rather than mapped in the field. The actual acres are expected to be different than what the model predicts. Areas that have been converted to agriculture are not excluded from the model.

Bottomland Forest Type*	Estimated Acres
Dry-Mesic Bottomland Forest	55,932
Mesic Bottomland Forest	7,668
Riverfront Forest	30,502
Wet Bottomland Forest	13
Wet-Mesic Bottomland Forest	3,005
Total	97,120

According to the forest activities database, approximately 26,000 acres of bottomland forests have been included in management activities since 2005. The remaining acres have not yet had activities planned or are excluded from management to protect riparian areas, wetlands, fens, sensitive soils, and other areas that would be degraded by disturbance. Activities include prescribed fire, invasive species treatments (especially in old agricultural areas), timber harvest, thinning, tree planting, and wildlife habitat improvements. The harvest areas are most often in the dry-mesic type, which would typically be a small, ephemeral drainage without flowing water. In these areas, best management practices to protect stream courses are still implemented. Below is a summary table highlighting a few types of activities that have been implemented and enhanced bottomland forest types. Approximately 79,000 acres of treatments have occurred on these 26,000 acres because multiple activities take place on the same acres and some treatments, like prescribed fire, occur more routinely than things like harvest and tree planting.

Table 28: A summary of some of the activities that occurred on bottomland forest types on the Mark Twain National Forest.

Activity Type	Acres Impacted
Prescribed Fire	51,228
Invasive Species Treatment	7,812
Harvest	6,393
Thinning	3,447
Tree Planting	793

The trapping of feral hogs and elimination of this damaging invasive animal from certain parts of the landscape has impacted bottomland forests. Hogs are known to be especially destructive in wet soils and eliminating them will allow those places to recover. It is estimated that 76,000 acres of bottomland forests were positively impacted by the removal of feral hogs.

Recommendations
Overall, the objective to improve 125 acres of bottomland forest have been far exceeded based on the data available for mapping bottomland forest types. Management should continue, as appropriate for each site. Future activities could consider restoring bottomland forests in those areas that were converted to agriculture, where success would be most likely and as resources allow.

Evaluation of Monitoring Question and Indicator(s)
It is unclear in the Forest Plan how bottomland forest types were to be defined. Available GIS data for ecological site descriptions were used to best approximate the location of bottomland forest types and where management activities

intersected those types. Better mapping would aid in answering this question. Previous reports have noted that activity reporting methods do not lend themselves to easily answering progress towards this objective.

This objective should be reviewed and clarified during Forest Plan revision. The question and indicator should consider how treatments are tracked to ensure it can readily be monitored.

References
Missouri Department of Conservation. 2017. Ecological Site Description GIS layer.

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
During this monitoring period, there have been no projects initiated or completed to add large woody material to streams. Currently, no monitoring is being conducted to estimate loading of woody material in streams across the Mark Twain National Forest. The lack of a hydrologist has largely contributed to the lack of projects in the near past. For the next monitoring period, there are a couple projects proposed to either add wood directly to sections of destabilized streams or to manage the riparian area in a way that promotes recruitment of large woody materials into the stream reaches.

Recommendations
In 13 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). Surveys to assess current stream loading of woody material and an assessment to determine if the 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 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 numerous kinds of wetlands in the Mark Twain National Forest, including karst related wetlands such as sinkholes, fens, and spring channels. In addition, there are wetlands in various bottomland and riparian settings, including wet sloughs and wet bottomland forests. A recently identified wetland type currently in development by the TEUI program is related to fen-spring-bottomland sequences: beaver wetland complexes. These kinds of wetlands are related to karst discharge (spring) environments and produce perpetual large marsh fen complexes. While we have a number of impressive wetland areas, most wetlands on the Mark Twain are small and scattered across the landscape but provide important niches 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

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 and fens are designated state natural areas (such as Cupola Pond, Greer Spring, Grasshopper Hollow, Tupelo Gum Pond, Marg Pond, and Brushy Pond). We have moved substantially toward meeting this 2005 Forest Plan objective by treating the large wetland complexes of Grasshopper Hollow, Kaintuck Fen, Barton Fen. Additionally, the recent increase in wetland inventory adds to our ability to protect wetlands and more effective follow wetland-related standards and guidelines identified in the 2005 Forest Plan.

Starting in 2018, a considerable effort by the MTNF Ecology Program was initiated to develop a Terrestrial Ecological Inventory for the Forest. This important inventory work allows staff to better protect and prescribe improvement measures to important wetland areas. Below is a summary:

- Soil Mapping Update: wetland soils on the Eleven Point District are being prioritized for re-mapping in partnership with USDA Natural Resources Conservation Service. Field work was completed between 2018 and 2023 and new maps are anticipated to be published starting in FY25-FY27. Many new areas of wetland soils will be mapped, and a new soil map unit and soils series for karst fens is being developed.

- Sinkhole Inventory: a Forest wide sinkhole inventory using LiDAR is being completed in partnership with Missouri State University. As a part of this, a focus will be to identify sinkholes with wetland properties and to develop a sinkhole forest use classification to help guide better stewardship of various kinds of sinkholes. This effort is scheduled to be completed in FY25.

- New Element Occurrence Records: between 2018 and 2022, 25 new wetland records were completed in partnership with MDC. These new wetland records included karst fens, beaver-wetland complexes, sinkhole ponds, sinkhole flatwoods, spring channels, and wet bottomland forests.

- Karst Fen Project: between 2020 and 2022, we partnered with the MTNF Minerals Program, NatureCITE and MDC to flesh out various questions about fens in the Ozarks. This project studied soils, hydrology, and plant communities at 30 reference sites throughout the Ozark Highlands Section. A new state-and-transition model will help classify fens in different conditions (from reference to degraded) and prescribe recommended management actions for specific situations. A key product of the project will be a new Ecological Site Description that will be used a reference for local Districts and managers to use to help protect and restore fen wetlands.

Other notable wetland inventory efforts: between 2018 and 2025, approximately 1,438 springs and seeps, 176 ponded sinkhole wetlands, and 115 fens were mapped.

Recommendations

Wetland management and protection needs should continue to be reviewed and determined during project-level environmental analyses. Districts should utilize resources from the recent efforts listed above to guide and plan for management and protection. Following completion of the aforementioned sinkhole inventory and classification project, it

is recommended that an integrated MTNF team pursue an effort to revise Forest Plan sinkhole Standards and Guidelines, with a focus on sinkhole wetlands.

Evaluation of Monitoring Question and Indicator(s)
Additional comprehensive inventory of wetlands should be pursued with MDC, including revision of National Wetland Inventory. A Forest wide mapping and classification of beaver-wetland complexes should be pursued. Integrated Resources staff should work with GIS staff to develop and make available a "special features" layer showing important ecological features, such as springs and sinkholes. Integrated Resources staff should work more closely with MDC and Districts to update and document new Element Occurrences.

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. To assess trends in male birds calling, the North American Breeding Bird Survey for the Central Hardwoods provides data that would be part of this community, or parsing the 74 routes within Missouri could provide further insight.

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. https://www.batcon.org/ (viewed on March 25, 2025)

U.S. Department of Agriculture, Fish and Wildlife Service. North American Breeding Bird Survey. Review raw data. https://www.pwrc.usgs.gov/bbs/RawData/Choose-Method.cfm (viewed on March 25, 2025)

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)

Results and Discussion

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. 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.

In the supporting documents for the 2005 Forest Plan, it notes that the allotment acres available for continued use at the time of plan revision was 52,092. The preferred alternative that was selected anticipated a decrease to 10,820 allotment acres. Previous reports have noted that most of the acres have been at least partially returned to native warm season grasses. However, there is no standardized monitoring in place to assess this accurately. Reports from district staff indicate that many old allotments were too costly to convert and those that are unmaintained have started the successional process, with native trees, shrubs, and non-native invasive species encroaching into formerly open lands. The estimate is that 9,500 – 10,000 acres are maintained as open land. Some of these areas continue to be grazed, other are hayed, and others are maintained open with prescribed fire, mowing, or other means to reduce woody encroachment. Exotic cool-season grasses and invasive plants are common. The old, unmanaged allotments increasingly occupied by woody and invasive plant species.

Table 29: The table summarizes the estimated open acres on the Mark Twain National Forest. These estimates are based on GIS data of old allotment location with input/verification from District staff.

District	Allotment/Open Acres (approximate)	Estimate of % Native
Ava/ Cassville/ Willow Springs	2,133*	Minimal
Houston/Rolla	1,120*	Minimal
Cedar Creek	4,473*	Minimal
Salem	1,114	Minimal
Potosi/Fredericktown	319	Minimal
Eleven Point	277 (123 grazed)	Minimal
Poplar Bluff	315	Mixed native and invasive
Total	**9,751**	

*Open grazing acres. There may be additional hay acres not accounted for on these districts.

The progress towards this objective has been limited. Even in those areas where habitat could be suitable for bobwhites, the success may be limited by the surrounding landscape condition and overall declining population trends. According to the North American Breeding Bird Survey and the State of the Birds in the USA report (2025), Northern Bobwhite and other grassland birds have steadily declined in Missouri and range-wide over the last 50 years. Many conservation efforts target improving habitat for Northern Bobwhite and have been locally successful in Missouri.

Recommendations

While the open-land management on the Mark Twain may not be achieving the percent native grass cover anticipated during forest plan revision in 2005, there are other natural communities, like open woodlands, savannas, and glades, with important grassland components that may also be benefitting quail. 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. Continued work on improving open lands as well as other natural communities with grassland components could help support healthier quail and other grassland bird populations.

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 are only 3.3 percent of the state of Missouri and is more heavily forested than quail habitat would require. 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.

North American Breeding Bird Survey. https://www.pwrc.usgs.gov/bbs/ (viewed on March 25, 2025).

State of the Birds in the USA report. www.stateofthebirds.org (viewed on March 25, 2025).

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)

Results and Discussion

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

The Missouri Pine-Oak Woodlands Restoration Project (MOPWR, Figure 1) is an example of long-term active forest management approach across 444,088 acres, of which 127,008 acres are on the MTNF. Creating and maintaining this habitat for the Worm-eating Warbler (focal species, American Ornithological Union #6390) have shown a slight increase in the Central Hardwoods trends across the U.S. from 1993 to 2023; with a slightly higher rate of increase for 2023 to 2024. Similar data for birds within Missouri, the Worm-eating Warbler populations increased overall from 1993 to 2024 but have shown variability over the period 2020 to 2024. Since the percentage of the MTNF is forested, the amount of closed woodland and open woodland has not changed substantially from 1993 to 2023, it is difficult to correlate the Missouri difference to any changes in landscape composition within MTNF.

We have been working toward achieving the conservation outcomes using multiple treatment tools, such as mechanical thinning, prescribed fire, and non-native invasive species (NNIS) control to approximate the range of historical conditions for pine-oak woodlands, as defined by the MTNF Land and Resource Management Plan (MTNF 2005). Successful incorporation of restoration treatments and tools conducted on the MTNF and the other public lands across the MOPWR landscape are leading toward this landscape aligning as a functional ecosystem. As discussed, the focal bird, and numerous bee species, are responding positively to the treatments. Ground cover of native plants and key indicator groups have increased as discussed with previous monitoring indicators.

Overall, the remaining overstory stocks of shortleaf pine and white oak species have been released to grow with less competition, which should increase drought resiliency based on both lower stocking and better adapted species remaining in the stands. This will assist with forest resilience to changes over time. The treated stands may burn more readily (i.e., contain more fine fuels), but will have lower intensity overall, versus those non-treated timber stands that are overstocked and drought-stressed. Those deteriorating conditions result in increased susceptible to overstory mortality. The restored

timber stands should also experience less soil sterilization, as fuel loads are reduced with an increased fire frequency. In addition, the treated timber stands will be less susceptible to southern pine beetle (Dendroctonus frontalis), a potentially emerging threat to Ozark shortleaf pine-oak sites (USFS 2022).
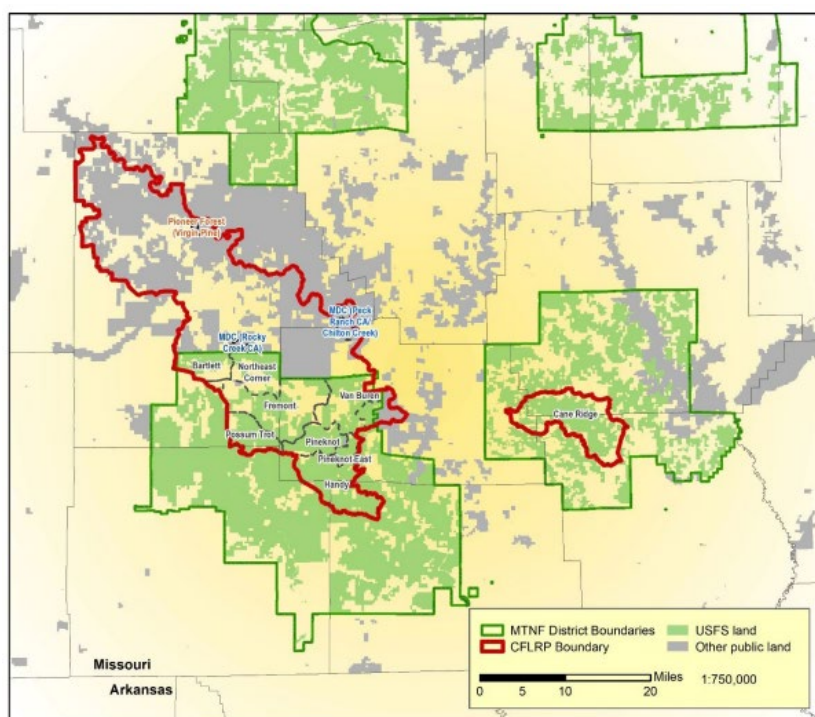
Figure 22: Missouri Pine-Oak Woodlands Restoration Project boundary and associated areas on the Eleven Point and Popular Bluff Ranger Districts on the Mark Twain and other public lands.

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
Mark Twain National Forest. 2005. Land and Resource Management Plan. FS-0905. Washington, DC: USDA Forest Service, Mark Twain National Forest, Rolla, Missouri, USA. 234 pages.

Mark Twain National Forest. 2011. Missouri pine-oak woodlands restoration project. USDA Forest Service, Mark Twain National Forest, Rolla, Missouri, USA. 55 pages.

North American Breeding Bird Survey. 2024 Release - North American Breeding Bird Survey Dataset (1966-2023), https://www.sciencebase.gov/catalog/item/66d9ed16d34eef5af66d534b (Accessed March 25, 2025).

U.S. Forest Service. 2023. Monitoring in the next round of collaborative forest landscape restoration projects. Available at https://www.fs.usda.gov/restoration/CFLRP/overview.shtml (Accessed March 25, 2025).

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

U.S. Department of Agriculture, Forest Service. Monitoring the ecological response to restoration treatments in the

Missouri pine-oak woodlands restoration project of the Mark Twain National Forest.
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1165848.pdf (accessed March 25, 2025).

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)

Results and Discussion
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. The Bachman's sparrow as a monitoring indicator for our glades is undoubtedly a representative of a bird on the outer portion of its' current range (Figure 1) but the management practices and landscape functioning glade outcomes provide some hope that other unique plants and animals will thrive within the glades maintained on the Ozarks' landscape.
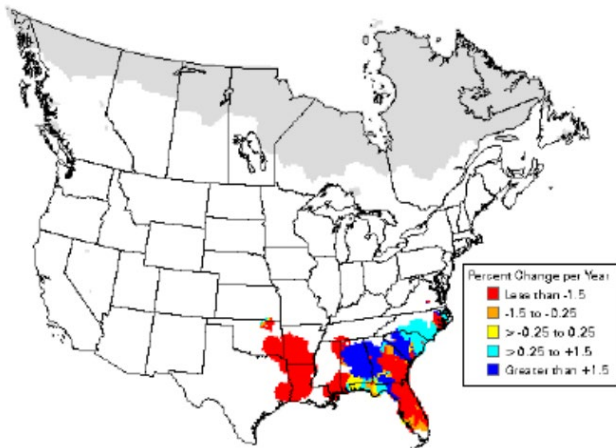
Figure 23: Distribution map of Bachman's sparrows from the Breeding Bird Survey data from 1994-2003 (Sauer et al. 2005).

A FACTS activity query was performed for glade restoration. This layer is embedded within statewide natural community types, so cross-referencing is somewhat tedious. There are six different glade types in the MTNF. In 2023 and 2024, 3,855 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 exceeded this target in the first decade of Forest Plan implementation.

The Breeding Bird Surveys (BBS) for Bachman's sparrows in MO is basically nonexistent since the history of the surveys dating back to 1966. The last BBS that reported 2 birds was in 1981; with five individuals as the most ever counted in MO and no birds counted since 1981. Beyond the BBS routes, eBird can be a source of bird location data. There are several records for Bachman's sparrows in Missouri, but many of them date to the 1980s, 90s, or 2000s. The most recent recorded sighting of the Bachman's sparrow in Missouri was in 2013, on private land south of the Ava District.

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. Perhaps consider changing the Bachman's sparrow to something else.

Evaluation of Monitoring Question and Indicator(s)
We continue to surpass this objective, exceeding the minimum for the life of the 2005 Forest Plan.

References

Cornell Lab of Ornithology. eBird: Bachman's Sparrow. https://ebird.org/species/bacspa (Accessed March 27, 2025).

North American Breeding Bird Survey. 2024 Release - North American Breeding Bird Survey Dataset (1966-2023), https://www.pwrc.usgs.gov/BBS/PublicDataInterface/index.cfm (Accessed March 25, 2025).

Sauer, J. R., W. A. Link, J. D. Nichols, and J. A. Royle. 2005. Using the North American breeding bird survey as a tool for conservation: a critique of Bart et al. (2004). Journal of Wildlife Management 69:1321–1326.

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 30: Designated Old Growth Acres by Management Area for 2024

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 2024	62,785 acres	8,630 acres	20,816 acres
Avg. Age	108 years	105 years	105 years

In addition to acres designated, it is useful to look at the average stand age of those designated acres to determine if we are progressing toward having actual old growth conditions on the ground. Across the three management areas, the average age ranges from 105-108 years. Designated stands greater than 100-years old comprise nearly 50 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 2,400 acres short of meeting the minimum for management prescription 6.1. That gap has been closed by about 600 acres since 2020 when it was reported that we were about 3,000 acres short.

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)

Results and Discussion

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.

The 2021-2022 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 2023 and 2024 results show, we have not made any headway toward meeting this objective. No prescribed burns were conducted from May through September in either 2023 or 2024.

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.

What is the true intent of burning during these designated time periods? 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 for implementation 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)

Results and Discussion
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.

We achieved prescribed burning of 63,376 acres in 2023 (total) and 53,187 acres in 2024(total). It appears that for the second decade of the Forest Plan, we're achieving the desired goal of more than 250,000 acres burned.

The reasons for achieving this objective vary from year to year but include:

- Weather conditions were right to achieve burn plan objectives and there were enough days that meet those conditions
- Sufficient staff and equipment were available
- Conflicts with wildland fire suppression availability needs were minimal
- Units were prepared over the fall and winter seasons

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 areas that have been treated over the past ten years for a total of 422,847 acres and which are planned for continuing treatment on a fire interval consistent with the ecological history of each area.
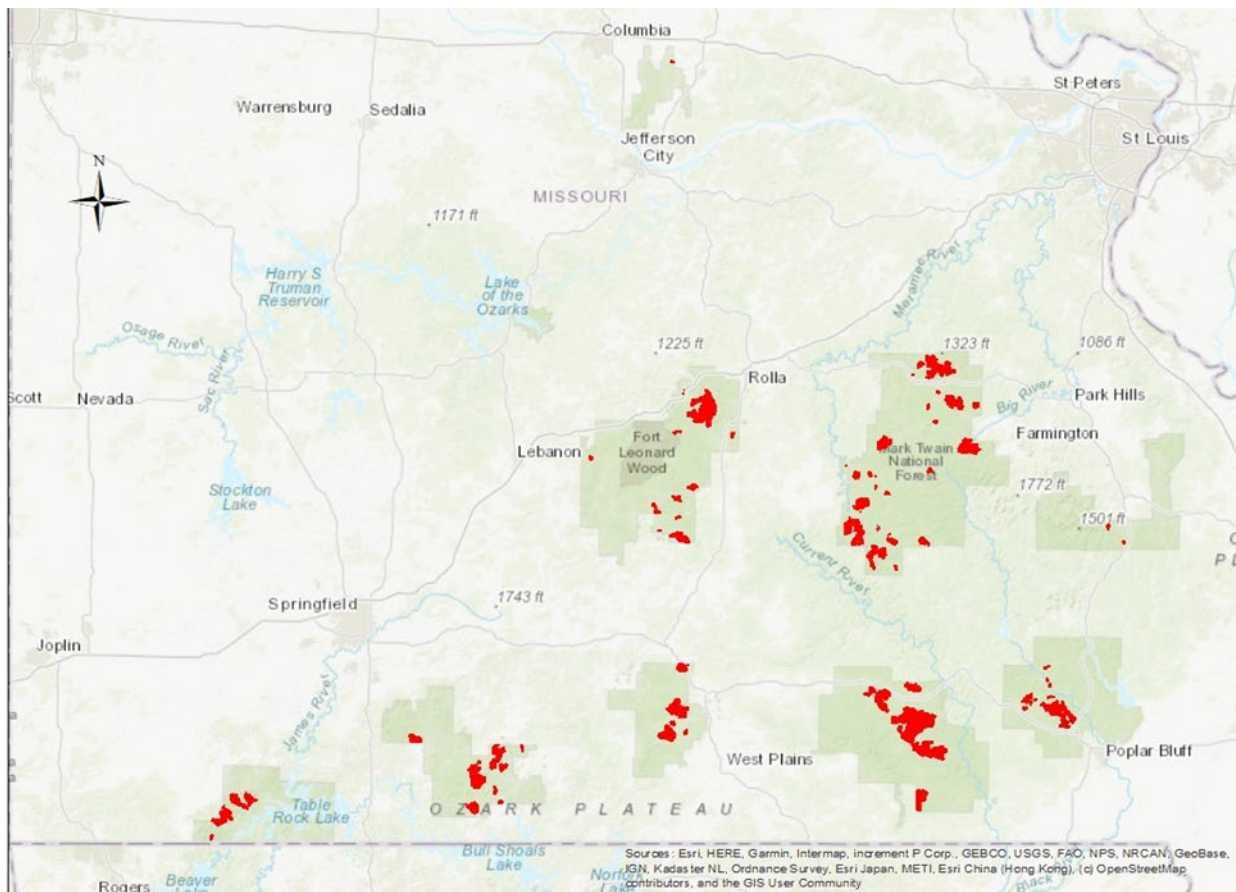
Figure 24: Total Prescribed Fire Acreage Completed 2016 through 2024

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.

Evaluation of Monitoring Question and Indicator(s)
During the next Forest Plan revision, this objective may need to be reviewed and revised.

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

The Effects of Each Management System to Determine that they do not Substantially and Permanently Impair the Productivity of the Land

Question 19: Are the effects of forest management, including prescriptions, resulting in significant impairment to productivity of the land? (File designation 2550)

Last Updated
The 2021-2022 Mark Twain National Forest monitoring evaluation report published in Spring 2024 included results through the first five years of soil disturbance monitoring on MTNF.

Monitoring Indicator(s)

Summary of results of using the National Soil Disturbance Monitoring Protocol (National Soils Protocol)

As of 2017, MTNF had no data on soil disturbance monitoring utilizing the National Soils 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 established. In 2018, Forest Ecologist/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 new sites have been added each year. 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 annual, but somewhat variable, and based on available funds and trained personnel. With full funding, MTNF collects pre- or post-treatment data collection on up to six sites per year.

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 and to what extent it can recover. It uses primarily visual and physical 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 (soil structure); level of penetration resistance (compaction); 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

Below is a six-year summary of results and activities completed since 2018.

Year 1 (2018)
- National Soils Protocol monitoring conducted at six pre-harvest sites.
- Pre-harvest sites were not disturbed, except where roads already existed.

Year 2 (2020)
- National Soils Protocol monitoring conducted at six post-harvest sites, 3 – 12 months after harvest activities concluded.
- Post-harvest activity results showed increases in the amount of woody debris, rutting, and compaction at the harvested sites.
- The severity of the disturbance appears to be due to several factors, including the size of the payment unit,

the presence of a main haul road within the payment unit, and the amount of rock content within the soil profile.

- A preliminary flowchart 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. If there were no disturbance indicators (rutting) on the surface there were no disturbance indicators (compaction, O-horizon missing) in the soil profile.

Year 3 (2021)

- National Soils Protocol monitoring conducted at six post-harvest sites and three pre-harvest sites.
- Significant forest floor recovery was observed in three of the five sites evaluated for this project with greater than one-year of recovery time since timber harvest activities. Sites at Warthog, Swayback, and Wild Coyote all had less observed rutting and compaction compared to the previous post-activity evaluation.
- Post-harvest activities such as TSI, storm damage, and firewood gathering can influence the outcome of the protocol by increasing the observed disturbances within a payment unit. This is especially true at Fox Hollow, where there were signs of disturbance that were due to storm damage that occurred at the site. However, these post-harvest activities are not associated with timber harvest but may prolong the recovery period at this location.

Year 4 (2022)

- National Soils Protocol monitoring conducted at eight post-harvest sites and one pre-harvest site.
- Sites at Swayback, Warthog, Sterling Hollow, Fox Hollow, and Wild Coyote were evaluated over 2-years after timber harvest activities. Significant forest floor recovery was observed at all of these sites with only 7 of the evaluated points greater than disturbance class "0". Generally, rutting and compaction decreased at these sites and at Monterey.
- At the two new post-activity sites, Garner Hollow and Hellroaring Springs, disturbance indicators were mainly found along the main haul roads and otherwise disturbances across the sites were low.
- The pre-activity survey of Tabor Cave found no disturbance indicators present within the payment unit.

Year 5 (2023)

- National Soils Protocol monitoring conducted at eight post-harvest sites.
- The following sites were evaluated more than two years after the timber harvest activities, Monterey, Wild Coyote, Warthog, Garner Hollow, and Hellroaring Springs, with only the disturbed points from the previous survey monitored.
- Disturbance indicators (rutting, compaction, forest floor impacted) at these sites have reduced in presence since the previous survey indicating forest floor recovery. Warthog no longer had any disturbance indicators remaining and Wild Coyote only had one disturbed point remaining. The other sites had less than 10 disturbed points each.
- Although this is the fifth year of monitoring the Fox Hollow site, timber harvesting of trees damaged in storms four years after the initial harvest caused further disturbance to the site – with the most rutting observed at the site thus far.
- Tabor Cave and Huckleberry Ridge were found to be disturbed at log landing sites and along primary and secondary logging roads. Mapping of disturbed areas at Fox Hollow, Tabor Cave, and Huckleberry Ridge showed less overall disturbance compared to the sample point protocol.

Year 6 (2024)

- National Soils Protocol monitoring conducted at one pre-harvest site and seven post-harvest sites.
- The only pre-harvest site was at the Timberline sale and no soil disturbance was found.
- Two sites were resampled one year after post-harvest: Tabor Cave and Huckleberry. At Tabor Cave, 75% of the previously disturbed points showed complete recovery and only three points showed continued signs of rutting and topsoil displacement. At Huckleberry, 19% of the previously disturbed points showed complete recovery. The additional points showed signs of topsoil displacement, rutting, and compaction.
- Two sites were resampled two years after post-harvest: Garner and Hellroaring. Garner showed continued recovery with 25% of the previously disturbed points completely recovered. The remaining areas were still showing sign of rutting, topsoil displacement, and compaction. Overall Garner is taking longer to recover than other sites studied. Hellroaring only had two points showing continued disturbance.
- One site was resampled three years after post-harvest: Monterey. The previously documented points

showing disturbance remain in recovery mode. Some of these lost all their natural soil surface and some had recovering ruts. These remaining disturbed locations will continue to recover but over a long period of time.

- Two sites were resampled four years after post-harvest: Fox Hollow and Wild Coyote. Fox Hollow, which received two harvest periods, continued to show slowly recovering soils. Rutting is still evident at 82% of the points and topsoil displacement at 35%. Only three points showed complete recovery. Wild Coyote shows near complete recovery, with only one remaining point showing a sign of rutting.

Table 31: Summary of the sites evaluated for this project.

Site	MTNF District	County	Area (ha)	Pre-Assessment Date	Harvest Date	Year 6 Survey	Year 6 Survey Date
Fox Hollow	Ava/Cassville/Willow Springs	Douglas	38.6	Aug. 2, 2018	Sept. 9, 2019	Post-V	Nov. 1, 2023
Monterey	Doniphan/Eleven Point	Oregon	27.8	Dec. 16, 2019	Dec. 9, 2020	Post-IV	Nov. 6, 2023
Sterling Hollow	Ava/Cassville/Willow Springs	Howell	7.9	July 31, 2018	Sept. 23, 2019	Retired	NA
Swayback	Poplar Bluff	Butler	5.8	Sept. 26, 2018	April 25, 2019	Retired	NA
Warthog	Doniphan/Eleven Point	Carter	22.3	April 5, 2018	Dec. 28, 2018	Retired	NA
Wild Coyote	Poplar Bluff	Wayne	6.4	Sept. 27, 2018	Aug. 20, 2019	Post-V	Nov. 6, 2023
Hellroaring Spring	Ava/Cassville/Willow Springs	Douglas	5.2	Feb. 3, 2021	Aug. 16, 2021	Post-III	Nov. 29, 2023
Huckleberry Ridge	Ava/Cassville/Willow Springs	Barry	9.7	March 4, 2021	Nov. 25, 2022	Post-II	Nov. 9, 2023
Garner Hollow	Ava/Cassville/Willow Springs	Barry	7.2	March 24, 2021	Sept. 30, 2021	Post-III	Nov. 9, 2023
Tabor Cave	Ava/Cassville/Willow Springs	Howell	16.6	Feb. 10, 2022	Aug. 25, 2022	Post-II	Nov. 29, 2023
Timberline	Potosi/Fredericktown	Washington	13.8	March 11, 2024	NA	Pre-Survey	March 11, 2024

Table 32: Number of Year 6 assessment points evaluated by disturbance class (Class 0 is the least or no disturbance and Class 3 is the most disturbance).

Site	Total	Class 0		Class 1		Class 2		Class 3	
Fox Hollow	17	3	18%	9	53%	5	29%	0	0%
Monterey	4	0	0%	2	50%	2	50%	0	0%
Wild Coyote	1	0	0%	0	0%	1	100%	0	0%
Hellroaring Springs	6	4	67%	1	17%	1	17%	0	0%
Huckleberry Ridge	21	4	19%	10	48%	7	33%	0	0%
Garner Hollow	8	2	25%	1	13%	5	63%	0	0%
Tabor Cave	12	9	75%	2	17%	1	8%	0	0%
Timberline	34	34	100%	0	0%	0	0%	0	0%

Recommendations

Overall, our monitoring of logging sites is showing that in most cases, soil damage is limited in extent and recovers quickly. There are areas of more significant damage, but these appear to be isolated in nature. Factors influencing significant soil damage include complete or nearly complete overstory removal, multiple logging events over a short duration (as in the case of Fox Hollow), localized weather conditions (wetness), issues with sale administration (such as not checking in with purchasers regularly during times of wet weather), or purchasers failing to comply with contractual requirements.

Evaluation of Monitoring Question and Indicator(s)

We need to continue the progress implementing the National Soils Protocol with our partner Missouri State University, focused on Districts not sampled yet. Our partnership with Missouri State 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 their 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

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.

7. Recommendations Overview & 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 Reports

As of 2025, the Mark Twain National Forest is on track to make our biennial reporting schedules as outlined in the 2012 Planning Rule. However, completion of this report took time, dedication, coordination, and planning across all resource areas. The Mark Twain made this report a priority and will need to continue in this pattern to complete future reporting needs.

To better capture the work being accomplished across the Mark Twain, certain monitoring indicators need updated. This can only be achieved by updating Chapter 4 of the Land and Resources Management Plan which will also need time, dedication, coordination, and planning from Mark Twain staff. With current staffing capacities, this could present a challenge for completion.

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
- The Fire Risk Assessment (Appendix G of Forest Plan) needs reevaluated
- Lentic ecosystem management requires an updated management plan.
- 45,000 acres prescribed fire per year

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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 with 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

- 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 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:

  o Where and when specifically does unauthorized use occur (hunting season, year-round, old woods roads, temporary roads, etc.)?
  o Are we creating unauthorized "user-friendly" trails by our management actions (like fireline construction, temporary road construction without adequate obliteration)?
  o Do our management actions encourage unauthorized use?
  o What management actions have we taken to discourage unauthorized use?

- Whatever question or indicator is used for Question 15, 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. 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 for Question 15, 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.

8. Appendix

List of Tables

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