



L-A-D Foundation's
2023 Ecological Management Plan for Pioneer Forest



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Table of Contents

Executive Summary	5
1. Introduction	7
1.1 Overview and Alignment with Strategic Plan.....	7
1.2 Plan Development Process	8
2. Goals of the Pioneer Forest Ecological Management Program.....	10
2.1 Conservation Targets.....	10
2.2 Threats and Management Implications	11
2.3 Conservation Outcomes	13
3. Recommended Management Actions.....	15
3.1 Proposed Priority Resource Areas.....	15
3.2 Future Priority Resource Areas	23
3.3 Karst Communities and Species of Conservation Concern	23
3.4 Invasive Species Management	28
4. Natural Communities of Pioneer Forest	32
4.1 Terrestrial Natural Communities.....	32
4.2 Aquatic Community Types	35
5. Priority Resource Areas.....	37
5.1 Background	37
5.2 Current Priority Resource Areas	39
5.3 Old-Growth Representations of Terrestrial Natural Communities	43
5.4 Missouri Natural Areas	44
6. Other Species and Natural Communities of Conservation Concern	47
6.1 Shortleaf Pine-Oak Woodlands.....	47
6.2 Fens and Glades	48
6.3 Bird Species of Conservation Concern	49
7. Natural Features Inventory	51
7.1 NFI Process Overview	52
7.2 NFI Reporting Tool.....	53
7.3 Timeline	53
8. Monitoring.....	54
8.1 Vegetation Monitoring in Priority Resource Areas.....	54
8.2 Other Monitoring Needs.....	54
9. Partnerships: Research, Demonstration and Regional Conservation Goals	57

9.1 L-A-D Foundation Scenic River Lands and Legacy Lands 57

9.2 Regional Conservation Partnerships 57

9.3 Research and Demonstration Partnerships 59

References 61

Appendix 1: Management for Bat Species of Conservation Concern 64

Appendix 2: Bat Species of Conservation Concern..... 68

Appendix 3: Maps of Cave Priority Resource Areas..... 73

Appendix 4: Designated Priority Resource Areas Template 74

Cover Photo: Martin Bluff overlooking the Current River, Neal Humke, 2021.

List of Abbreviations and Acronyms

CFI	Continuous Forest Inventory
CHI	Community Health Index
COA	Conservation Opportunity Area
CRF	Cave Research Foundation
dbh	diameter at breast height
EDDMaps	Early Detection and Distribution Mapping System
GIS	Geographic Information System
LiDAR	Light Detection And Ranging
MDC	Missouri Department of Conservation
MTNF	Mark Twain National Forest
NFI	Natural Features Inventory
NPS	National Park Service
PRA	Priority Resource Area
SAF	Society of American Foresters
SRISP	Scenic Rivers Invasive Species Partnership
SRSD	Special Resource Stewardship Designation
TMA	Timber Management Agreement
USFS	United States Forest Service

EXECUTIVE SUMMARY

The L-A-D Foundation and its founder, Leo A. Drey, helped create a legacy of conservation in the Ozarks. Leo began acquiring forest land in the Missouri Ozarks in 1951 with the intention of demonstrating land stewardship in the region that was economically, ecologically and socially responsible. Pioneer Forest has become a model for uneven-aged forest management by demonstrating that those outcomes can be achieved simultaneously. The forest sits at a critical intersection between public and private land conservation, serving a unique role in the conservation landscape, as an example locally, regionally, and nationally of long-term, multi-use, sustainable forest management by a private entity.

The ecological management program for the forest has its origins in the designation and protection of natural areas and forest reserves on the forest. Current River Natural Area, recognized by the Society of American Foresters program in 1955, was the first designation of its kind in the state of Missouri and paved the way for other such designations. In 1995, the forest reserve designation was created by the foundation board and staff to recognize characteristic Ozark natural, geological, and cultural features on Pioneer Forest.

The program evolved in 2008 with the introduction of prescribed fire and implementation of restoration management of the virgin pine/shortleaf pine-oak woodland on the Randolph tract along Highway 19. Since then, the program has significantly expanded to include active restoration and management of high-quality terrestrial natural communities, including glades, fens, and woodlands.

The foundation board formalized a five-year vision as part of its 2020 Strategic Plan. The strategic plan included goals and initiatives to expand staff resources to support stewardship activities, inventory and identify areas meriting special designation, encourage appropriate research, and expand collaboration and leadership on key projects to advance forest conservation in the Ozarks. The board hired a staff ecologist in 2021 and has continued to allocate more resources to the growing ecological management program.

This *Ecological Management Plan for Pioneer Forest* is the first comprehensive plan focused on defining ecological goals and objectives to maintain and promote healthy and resilient natural communities on Pioneer Forest. The plan establishes the Natural Features Inventory for systematically surveying the forest for natural communities and other features, which will support identification and designation of new Priority Resource Areas. The plan expands acreage under ecological management through the designation of new Priority Resource Areas and describes areas for potential expansion in the future. It adds clarity to the designation process to ensure all areas have clear, site-specific desired future condition goals based on their varying management needs. There are also goals for developing more robust partnerships for research and demonstration. Through these initiatives, the plan takes significant steps towards achieving the goals identified in the strategic plan and will support Pioneer Forest's work to become certified by the Sustainable Forestry Initiative. In addition, this plan will support future communications planning and the development of outreach and education materials. The Priority Resource Areas described in this plan provide a variety of opportunities to educate audiences about natural communities in the Ozarks and share the story of Pioneer Forest.

Three-year goals include:

1. Develop and implement a forest-wide Natural Features Inventory and continue important monitoring:
 - Deepen the understanding of the diverse resources on the forest through systematic inventory.
 - Continue routine monitoring of ecological outcomes in Priority Resource Areas and implement new protocols, as appropriate, to inform adaptive management.
 - Partner with agencies developing the Community Health Index and consider ways to use it for monitoring.

2. Expand terrestrial natural community restoration and management:
 - Increase land under prescribed fire management by at least 2,000 acres.
 - Identify a minimum of 500 – 1,000 acres in one or more areas to protect and/or manage for old-growth forest types.
 - Protect habitat for species of conservation concern through identification, designations, and implementable forest management guidelines.
 - Implement the strategy for mapping, tracking, and treating problematic invasive species on the forest.

3. Develop research, demonstration, and regional conservation partnerships:
 - Work with Conservation Opportunity Area partners, the Scenic Rivers Invasive Species Partnership, and others to identify and expand collaborative work in areas of mutual interest and seek opportunities to guide and advance conservation efforts across the broader landscape within which Pioneer Forest resides.
 - Develop relationships with researchers and academic institutions to cultivate opportunities for research on Pioneer Forest.
 - Working with partners, develop a strategy for conservation of whip-poor-wills and articulate the foundation's role in supporting a broader conservation effort for the species.

1. INTRODUCTION

The L-A-D Foundation and its founder, Leo Drey, helped create a legacy of conservation in the Ozarks. Pioneer Forest is situated at a critical intersection between public and private land conservation.

As stated in its mission, the foundation is:

dedicated to exemplary stewardship of Pioneer Forest and other natural and cultural areas, and to scientific research, education, public recreation, and encouragement for projects and policies that have a positive influence on the Missouri Ozarks and beyond.

Much of Pioneer Forest lies in the heart of the Current River watershed in the Missouri Ozarks, an ecoregion known for its resilience over millennia of change. For millions of years, flora and fauna have had an opportunity to colonize the Ozarks and adapt through periods of isolation caused by changes in sea level or the climatic influence of periodic glacial advance and retreat. As a result, the ecoregion is home to many endemic species and provides refugia for numerous species that are otherwise disjunct from their predominant ranges in North America (The Nature Conservancy, 2003). Until relatively recent changes in the landscape, the Ozarks region has provided a resilient place for natural communities and their associated characteristic species to persist through times of significant change. For example, hellbenders (*Cryptobranchus spp.*) have a fossil record spanning millions of years and have persisted in the Ozarks, indicating a certain stability within the dynamics of a climate and terrestrial landscape that was changing around them.

Early logging practices of the late 1800s and early 1900s, followed by land conversion, open-range grazing, and changes in fire regimes, have altered the Ozarks landscape and resulted in a loss of important habitats. Species that were once numerous have been locally extirpated, are at risk of being lost in Missouri, or even globally extinct. The resilience of the Ozarks is threatened with continued pressure that diminishes natural integrity and fragments habitats. However, dedicated conservation efforts over the last century have sustained and restored many important natural communities. The Current River watershed provides one of the best opportunities for conservation within this region given the relatively intact land cover, protected river systems, and habitat connectivity.

Pioneer Forest has a unique role in the conservation of this landscape, serving as an example locally, regionally, and nationally of long-term, multi-use, sustainable forest management. As the largest privately-owned forest of its kind in Missouri and being primarily located in the Current River watershed, the forest significantly impacts conservation outcomes for the region. It is in Tier 1 and Tier 2 areas under the Missouri Department of Conservation's Comprehensive Conservation Strategy (MDC, 2022), providing connectivity between adjacent public ownerships, thus aiding in habitat connectivity and conservation across this important landscape.

1.1 Overview and Alignment with Strategic Plan

As the first comprehensive *Ecological Management Plan for Pioneer Forest* its purpose is to define ecological goals and objectives to maintain and promote healthy and resilient natural

communities on the forest. This plan summarizes available data about the terrestrial and aquatic natural communities found on the forest, highlights important natural communities and species of conservation concern, provides management guidelines to support those communities and species of concern, and prioritizes areas for expansion of ecological management activities. It also addresses monitoring protocols to support adaptive management and highlights strategic places for partnering on research and demonstration of exemplary forest management.

The plan was developed to support Strategic Goals 1 and 2 of the L-A-D Foundation's 2020 Strategic Plan:

Strategic Goal 1: Maintain a diverse, healthy, vigorous and resilient forest by applying uneven-aged management and securing monitoring and research to respond adaptively to problems.

Ecological management activities will be used to support the forest's management practices by identifying opportunities to enhance diversity, resiliency, and connectivity across the landscape. Additional areas will be identified for natural community restoration (e.g., pine-oak woodlands). Activities will support resistance and resilience to extreme weather, disease, insect outbreaks, and invasive species effects. Management and monitoring will result in measurable impacts, thus aiding in the adaptive management of the forest.

Strategic Goal 2: Demonstrate exemplary stewardship of L-A-D Foundation lands, special resource stewardship designations on Pioneer Forest, and other significant natural and cultural features, while providing public access to suitable recreation opportunities on our lands.

Ecological management activities will demonstrate stewardship of the forest's natural communities by identifying areas and features for implementing additional natural community protection and restoration (e.g., glades, fens, woodlands, streams). Ecological management activities will ensure the long-term integrity of a variety of natural resources in designated areas of the forest. Increased stewardship capacity, monitoring, and research will support this goal.

The Natural Features Inventory (NFI) will search for and spatially identify significant ecological and geological features and biodiversity elements on the forest. Data from the inventory will inform the priorities for managing species and/or natural communities of conservation concern, and will direct further stewardship, monitoring, research, and restoration efforts. The inventory will identify areas for more focused investigation and support designations of Priority Resource Areas (PRAs).

1.2 Plan Development Process

The ecology and forestry staff of the foundation are primarily responsible for the development, implementation, and periodic revision of this plan. The planning process for this first plan took approximately 18 months. The process was initiated in winter 2021, with a narrative outline shared with the L-A-D Foundation Board of Directors for preliminary feedback. Data review, writing and team meetings continued through 2022. In the spring of 2023, a substantially complete draft was reviewed by staff and the board for final input. The final draft was reviewed

and approved by the board on May 18, 2023. Below is a brief description of the roles and responsibilities of those that support the development of this and future versions of this plan.

Roles and Responsibilities

- Forestry and ecology staff – responsible for drafting the plan, implementing plan recommendations, and proposing revisions for future plans.
- L-A-D Foundation Board of Directors – responsible for establishing funding priorities, guiding staff activities, reviewing draft plan documents, and approving the final plan.
- Drey Family Council – responsible for providing guidance and advice to staff and the board on many aspects of managing the lands of the foundation and the forest.
- L-A-D Foundation Advisory Council, partners and outside advisors – supporting the plan development by providing data, guidance, and professional expertise to inform the content of the plan, and partnering on critical implementation of the plan to achieve beneficial conservation outcomes across the landscape.

While this iteration of the plan is a separate document from the *2019 Management Plan for Pioneer Forest, LLC* (the 2019 management plan), it was developed in close collaboration with the forestry staff and is intended to complement and enhance the ongoing work of the forestry team to manage a healthy, uneven-aged demonstration forest that is sensitive to site-specific management needs of certain features and natural communities, where appropriate. Future plans may integrate the separate management plans into a single guiding document for managing the diverse resources of the forest.

The foundation also owns significant lands that are under scenic easement to Ozark National Scenic Riverways and other Legacy Lands that are managed through long-term partnerships with state agencies. These are briefly described in section 9.1, but given the different management structures and locations, are beyond the scope of this plan.

2. GOALS OF THE PIONEER FOREST ECOLOGICAL MANAGEMENT PROGRAM

2.1 Conservation Targets

Pioneer Forest was founded on the principle of demonstrating better forest management in the Ozarks. In the 1950s when Leo Drey purchased most of the forest, he and his foresters decided to continue an uneven-aged, single-tree selection harvest method that was state-of-the-art among many professional foresters in the first half of the century, even as the prevailing approach for managing mixed hardwoods began shifting to more intensive even-aged management. Pioneer Forest began creating ecological conditions in uneven-aged stands that were different in structure and function from even-aged stands in agency-managed lands, thus setting a higher standard for conservation-based forestry. In addition, Leo took steps to protect and set aside important natural areas on the forest. Current River Natural Area, recognized by the Society of American Foresters program in 1955, was the first designation of its kind in the state of Missouri and paved the way for other such designations.

In 1995, the forest reserve designation was created by the foundation board and staff to recognize characteristic Ozark natural, geological, and cultural features on Pioneer Forest. This includes caves, old-growth stands, rare plant populations, unique stream systems, sinkholes, state-designated Natural Areas, and others. The program evolved in 2008 with the implementation of prescribed fire for restoration management of the shortleaf pine-oak woodland on the Randolph Tract along Highway 19. Since then, the ecological management program has expanded to include glades, woodlands, and fens. Sections 3.3, 4, 5.3, and 6 provide more detailed information about the conservation targets for the program, which are briefly summarized below.

Conservation targets for the program include, but are not limited to, the following:

- High Quality Natural Communities such as:
 - Glades – rhyolite and dolomite
 - Fens
 - Shortleaf pine-oak woodlands
 - Old-growth forests and woodlands
 - Caves and karst
- Rare, threatened, and endangered species of conservation concern such as:
 - Plant populations – e.g., showy lady-slipper orchid (*Cypripedium reginae*), tall larkspur (*Delphinium exaltatum*), savanna blazing star (*Liatris scariosa* var. *nieuwlandii*)
 - Endangered bats
 - Whip-poor-wills and other declining forest and woodland bird populations

Partners and contractors play an important role in management and monitoring activities. Botanical inventories, rare plant population counts, fire-effects monitoring, cave biological inventories, and other partner-led monitoring are important for identifying changes in condition and tracking responses to management activities. Additional monitoring programs will be developed as needed and as resources allow.

2.2 Threats and Management Implications

The threats to natural communities and species of conservation concern on the forest include non-native invasive species, altered disturbance regimes, threats to forest health, water quality degradation (e.g., sedimentation, nutrient loading), chemical spills within karst watersheds, and other adverse human use (e.g., road and trail impacts, arson). Overlaid on these proximate threats and interacting with them are the ever-increasing effects of climate change. Managing for a healthy forest in a connected landscape will help ensure the forest is more resistant and resilient to threats in the future.

Non-Native Invasive Species

Non-native invasive species are considered one of the greatest threats to global biodiversity (World Wildlife Fund, 2022). In the United States, some rank invasive species as the second greatest threat to biodiversity, following habitat loss and degradation (National Wildlife Federation, 2023). Threats range from zebra mussels to bush honeysuckle and feral hogs. One dramatic example of the impact of invasive species is the emerald ash borer. This insect has infested nearly all counties in Missouri and is known to result in 99% mortality of ash trees, resulting in significant impacts to forest products and biodiversity since hundreds of native insect species rely on ash for part of their life cycle. The threat of non-native invasive species interacts with and may be exacerbated by habitat fragmentation and altered disturbance regimes, described below.

Invasive species impact the economic, ecological, and scenic qualities of the forest. Mapping, treating, and monitoring invasive species is important for reducing these threats, as well as working in cooperation with other agencies and landowners to address the overall threat to the region. Cross-boundary efforts (e.g., Interagency Feral Hog Task Force, Scenic Rivers Invasive Species Partnership) use resources efficiently and have demonstrated success.¹

Altered Disturbance Regimes

Disturbance within the natural range of variation is a regular and important part of Ozark ecosystems. Some communities are adapted to routine disturbance, such as by fire and flooding, while other sites are more protected. Over the last two centuries, disturbance regimes were largely altered with land use changes brought on by the elimination of indigenous peoples and advancement of European settlement.

At the landscape scale, altered disturbance regimes will continue to be a significant threat to natural communities on the forest. The exclusion of fire from the Ozark landscape has resulted in the decline of fire-dependent species and natural communities. Shortleaf pine woodland communities have declined or degraded in the last two centuries due to the over-harvest of timber in the late 1800s and early 1900s, intense wildfires, open-range grazing, subsistence agriculture, and subsequent exclusion of fire on the landscape beginning in the 1950s. Fire is important for pine regeneration, maintaining woodland structural characteristics, and promoting an herbaceous understory. In the absence of periodic fire, shortleaf pine will continue to decline across its range.

¹ See pages 42 – 45 of the 2019 Management Plan for Pioneer Forest, LLC for discussion about terrestrial invasive species and management.

Glades are another example of a unique community type that used to be more common and was historically sustained with fire, which prevented the encroachment of eastern red cedar and supported a rich herbaceous plant community. Many of the known rare plant populations on the forest are associated with glade or the adjacent woodland communities. Altered fire regimes continue to threaten the persistence of these important natural community types.

Commercial timber harvests, non-commercial thinning, removal of eastern red cedar, and prescribed fire are key tools for restoring and maintaining diverse natural communities in the Ozarks. Removing eastern red cedar encroachment is important for restoring glades. Harvest and thinning restore the structural components of surrounding woodlands and prescribed fire promotes increases in native herbaceous vegetation, which supports diverse communities of flora and fauna.

Climate Change

Climate change is a long-term threat potentially impacting the location, composition, and extent of natural communities on the forest (USDA, 2014) as it can lead to deviations from the normal range of disturbance and increase the risk of drought, flooding, severe storms, and wildfire. Existing stressors such as invasive species, insect pests, and disease will also be amplified by climate change.²

Annual average temperatures are rising and the midwestern U.S. is predicted to have the greatest increases in summer season temperatures (USGCRP, 2018). Though Missouri is experiencing changes to a lesser degree than northern latitudes, records show increased seasonal warming, an unprecedented wet period, and more extreme precipitation events (e.g., increasing number of 24-hour precipitation events with 3 inches or more of rainfall). Summer droughts are also predicted to increase (Guinan, 2022).

Some components of the forest will be more adversely impacted by drought than others. The red oak component is particularly susceptible to these drought effects, given that many of the red oaks on the forest are between 80 and 100 years old and approaching natural senescence. Research indicates that drought conditions in the Ozark Highlands are correlated with oak decline, resulting in increased mortality particularly among red oak species, with cumulative drought impacts potentially lasting up to 10 years (Fan et al., 2012). Conversely, climate change may favor species such as shortleaf pine due to its resistance to drought and increased temperatures, but only if critical fire management is present.

Managing for diverse natural communities increases resistance and resilience to extreme events (Guldin, 2019). The uneven-aged approach to timber harvest on the forest is an important strategy for maintaining and restoring resilient forest and woodland ecosystems. These selection harvests reduce stocking, remove diseased trees, and improve resource availability for residual trees. Managing sites, especially exposed slopes prone to droughty conditions, for species and structural composition to increase the health, vigor, and resilience of those areas will be important to mitigating the impacts of more severe drought.

² The 2019 management plan discusses climate change and the related threats (page 46).

In addition to being an important tool for ecosystem restoration, prescribed fire can reduce the severity of effects associated with wildfire. Areas treated with prescribed fire have lower fuel loads and, in turn, reduced severity and risk of tree mortality from wildfire. In areas managed for woodland restoration, prescribed fire aids in converting fuel types from timber understory fuels to herbaceous fuels, which have lower adverse fire effects on the timber resource. While prescribed fire can cause loss of economic value in timber (0-15%), the losses could be much greater under wildfire conditions (38% in one study in Kentucky) (Mann et al., 2020).

Communities and species that are adapted to relatively narrow temperature regimes, such as caves, springs, streams and glacial relicts (e.g., *Galium boreale*), are more likely to be adversely impacted by increases in average ambient temperatures associated with climate change. Minimizing other threats to these communities will be important to reduce the cumulative stress affecting these systems and species.

Other Threats

Outbreaks from native insects and diseases are also threats to forest health. As tree stress increases under an altered climate, this may make the forest more vulnerable to increased infestation or disease. Reducing stocking either via timber harvest and or in combination with non-commercial thinning and prescribed fire increases the health and vigor in residual trees by reducing competition for resources and growing space. Increased vigor contributes to overall forest health, reducing susceptibility to insect infestation and disease.³

At the local scale, there are direct threats from adverse human use. Examples include arson, unauthorized vehicle use in sensitive areas, unauthorized collection of plants (e.g., root digging) and animals, timber theft, illegal dumping, and other activities that could cause environmental damage. These direct threats are managed on a case-by-case basis with a variety of tools to reduce or mitigate impacts and may require partnering with law enforcement agencies.

Aquatic communities face continuing threats from disruptions in natural process regimes (e.g., altered floodplain connectivity) and adverse human use. Sedimentation, nutrient loading, and fish passage barriers degrade and fragment aquatic habitats. Reducing adverse vehicle impacts, maintaining the integrity of the surrounding landscape, and implementing best management practices will continue to minimize the threat of sedimentation and provide stability to these systems. Evaluating and improving road stream crossings can improve habitat connectivity and stream function.

2.3 Conservation Outcomes

In support of the L-A-D Foundation's mission of exemplary stewardship of Pioneer Forest, the goals of the ecological management program during the three-year implementation of this plan include:

1. Implement the Natural Features Inventory and continue important monitoring:
 - Deepen the understanding of the diverse resources on the forest by completing a full systematic inventory on 6,000 – 10,000 acres.

³ Pages 9 and 12 of the 2019 management plan discusses single-tree selection and marking to address damage from insects or disease.

- Continue routine monitoring of ecological outcomes in Priority Resource Areas and implement new protocols, as appropriate, to inform adaptive management.
 - Partner with agencies developing the Community Health Index (CHI) and consider ways to use it for monitoring.
 - Partner with appropriate resource professionals to improve monitoring of aquatic communities, bats, and cave resources.
2. Expand terrestrial natural community restoration and management:
- Conserve, restore, and maintain important natural communities on the forest, seeking opportunities to expand management to improve resilience and habitat connectivity.
 - Increase the land under prescribed fire management by at least 2,000 acres.
 - Identify a minimum of 500 – 1,000 acres in one or more areas to protect and/or manage for old-growth forest types. This could include woodlands, protected forests, or other natural communities.
 - Seek opportunities for new types of management demonstrations on the forest.
 - Protect habitat for species of conservation concern through identification, designations, and implementable forest management guidelines.
 - Implement the strategy for mapping, tracking, and treating problematic invasive species on the forest.
3. Develop research, demonstration, and regional conservation partnerships:
- Work with Conservation Opportunity Area partners, the Scenic Rivers Invasive Species Partnership, and others to identify and expand collaborative work in areas of mutual interest and seek opportunities to guide and advance conservation efforts across the broader landscape within which Pioneer Forest resides.
 - Develop relationships with researchers and academic institutions to cultivate opportunities for research on Pioneer Forest that will improve understanding of the forest's resources and inform management.
 - Working with partners, develop a strategy for conservation of the Eastern Whip-poor-will and articulate the foundation's role in supporting a broader conservation effort for the species.

The management actions in the following section are intended to achieve progress toward these goals.

3. RECOMMENDED MANAGEMENT ACTIONS

The recommended management actions described in this section are aimed at furthering the goal of exemplary stewardship of the forest by enhancing existing management and expanding the scope of restoration management activities during the next three years. Information about the target natural communities and species of conservation concern is provided in subsequent sections of the plan (see sections 3.3, 4, 5.3, and 6). Management goals include:

- Increase the acreage under prescribed fire management by at least 2,000 acres.
- Identify a minimum of 500 – 1,000 acres in one or more areas to protect and/or manage for old-growth forest types. This could include woodlands, protected forests, or other natural communities.
- Seek opportunities for new types of management demonstrations on the forest.
- Protect habitat for species of conservation concern through identification, designations, and implementable forest management guidelines.
- Implement a strategy for mapping, tracking, and treating problematic invasive species on the forest.

3.1 Proposed Priority Resource Areas

The goal in designating Priority Resource Areas is to identify important biological, geological, or cultural areas on the forest and aid in prioritizing appropriate resources to ensure those areas are managed, conserved, and/or restored. PRAs may represent places that are unique locally to the forest, or of regional, statewide, and/or global conservation value. For additional background and discussion, see section 5 about Priority Resource Area designations. The areas described below are proposed for new or expanded designation as PRAs with an estimated acreage targeted for designation. The associated maps highlight the region targeted for designation and management (as appropriate). Staff will complete site-specific planning to outline the desired future condition, management activities to achieve that condition, and specific boundaries within which management will occur (e.g., prescribed fire units).

Shortleaf Pine-Oak Woodland Management Priority Resource Areas

- Virgin Pine/Randolph Shortleaf Pine-Oak Woodland – expand fire management within existing designated area on an additional 250 – 350 acres (Figure 1).
- Himont Shortleaf Pine Management – expand designated area and fire management on at least an additional 500 acres (Figure 2).

Desired Future Condition: The desired future condition for these PRAs is a restored shortleaf pine-oak woodland with sufficient natural regeneration of pine and oak species, a rich herbaceous understory, and structural characteristics appropriate for the natural communities at the selected sites. Glades and other natural communities that may be part of the matrix of natural communities will also be restored.

Potential Management Activities: Management activities are likely to include commercial thinning, timber stand improvement, prescribed fire, cedar removal and monitoring.

Igneous Knobs Priority Resource Areas

- Jerktail Mountain – expand designated area and partner with National Park Service (NPS) on proposed expanded fire management on an additional 1,500 –1,700 acres (Figure 3).
- Wildcat Mountain and Blair Creek Glades – no management planned due to ownership constraints. Designate area for future expansion if partnerships and resources allow on an estimated 1,100 – 1,300 acres (Figure 4).

Desired Future Condition: The desired future condition for these PRAs is to restore natural communities in the igneous knob regions of the forest, including rich herbaceous plant communities and appropriate structural characteristics. Target natural communities include igneous and dolomite glades and woodlands and fen communities.

Potential Management Activities: Management activities are likely to include commercial thinning, prescribed fire, cedar removal, and monitoring.

Old-Growth Priority Resource Areas

- Schoolhouse Hollow – protect existing old-growth trees and foster retention of old-growth forest into the future on approximately 400 acres (Figure 2).
- Tick-A-Chig Ridge – honor the legacy of Leo Drey, who personally set aside this area from harvest, protect scenic values associated with the hiking trail and Bee Bluff overlook, and evaluate future potential for restoring glade habitats (450 – 500 acres, Figure 5).
- Black River Reserve – protect 35 – 50 acres on the steep, mesic slopes above the Black River as part of the scenic viewshed of the river (Figure 6).

Desired Future Condition: The desired future condition for these PRAs is an old-growth natural community, including the protection of existing old-growth trees and fostering conditions that will support continued old-growth character of appropriate species composition through time.

Potential Management Activities: Management activities are expected to be minimal and could include thinning to enhance structural characteristics and support the health and retention of old-growth trees. Prescribed fire may be used where compatible with terrestrial natural communities.

Cave Priority Resource Areas

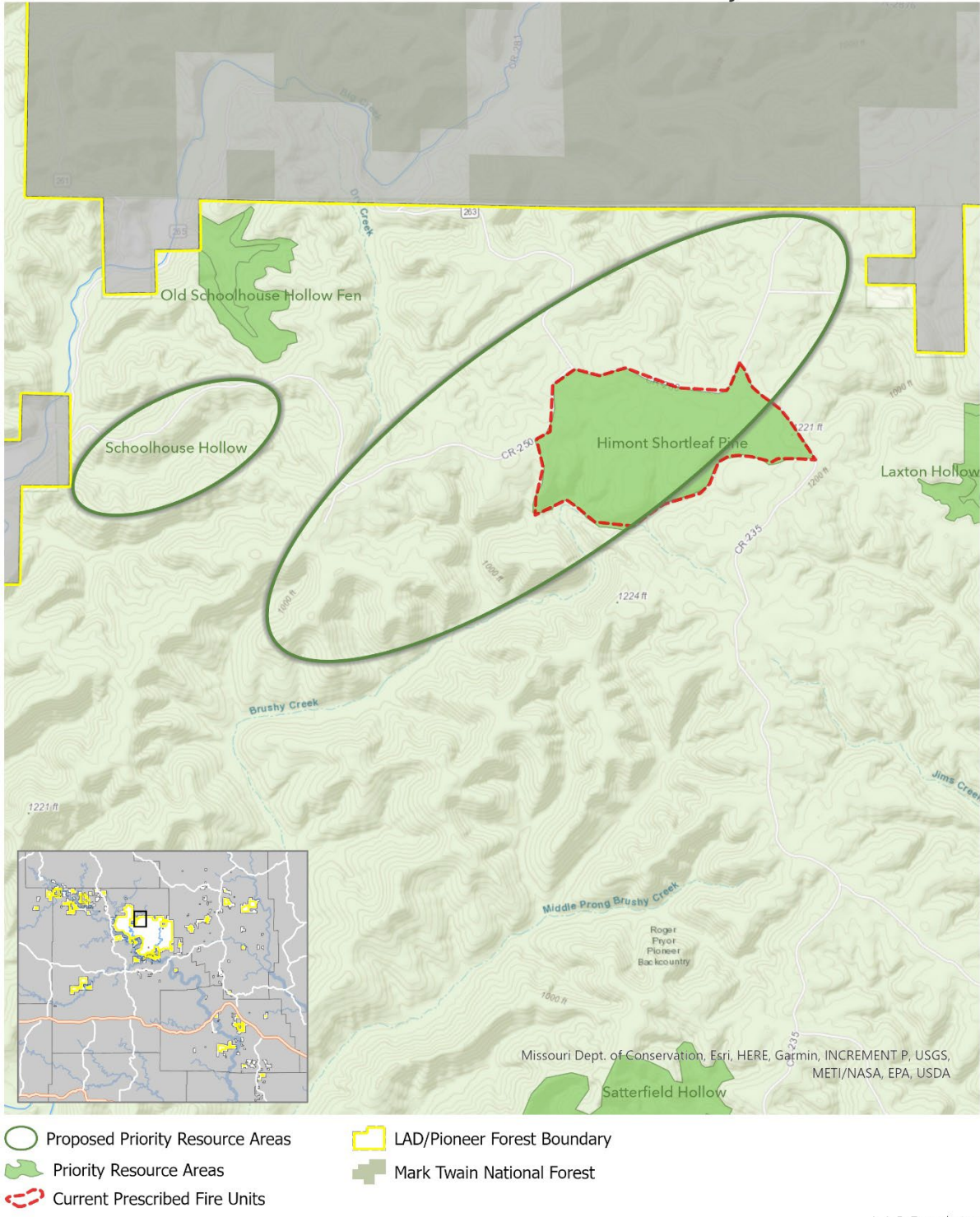
See section 3.3.2 for detailed discussion.

- Tiers 1, 2, and 3 buffer areas around caves

Desired Future Condition: The desired future condition goal for PRAs around caves is a mature, restored terrestrial natural community with no adverse human activities.

Potential Management Activities: Management activities are likely minimal and could include modified commercial harvest and timber stand improvement with buffers and seasonal restrictions. Activities to deter adverse use could include road closure.

Schoolhouse Hollow & Himont Shortleaf Pine Priority Resource Areas



L-A-D Foundation
R. Landewe, April 2023

Figure 2.

Jerktail Mountain Priority Resource Area

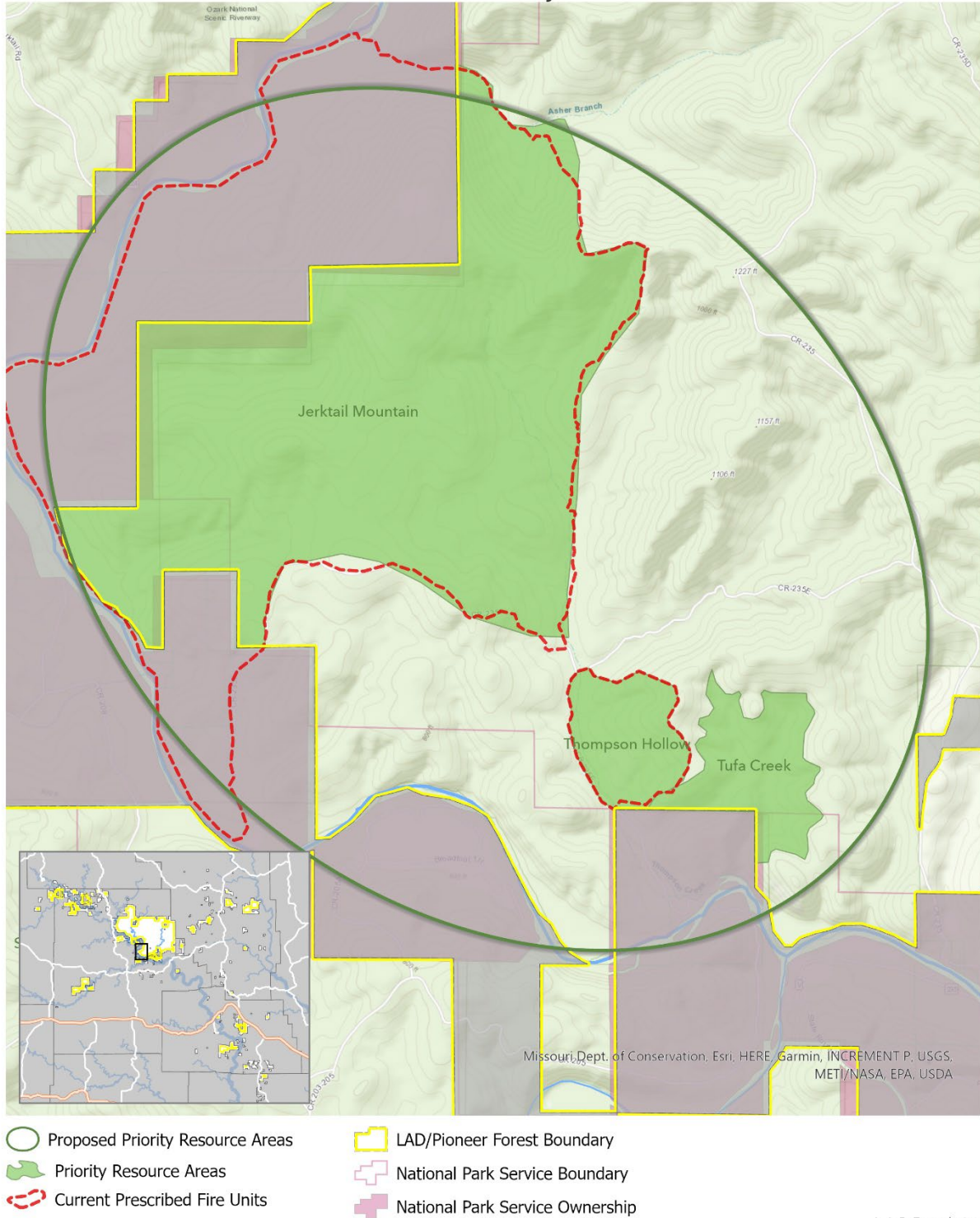
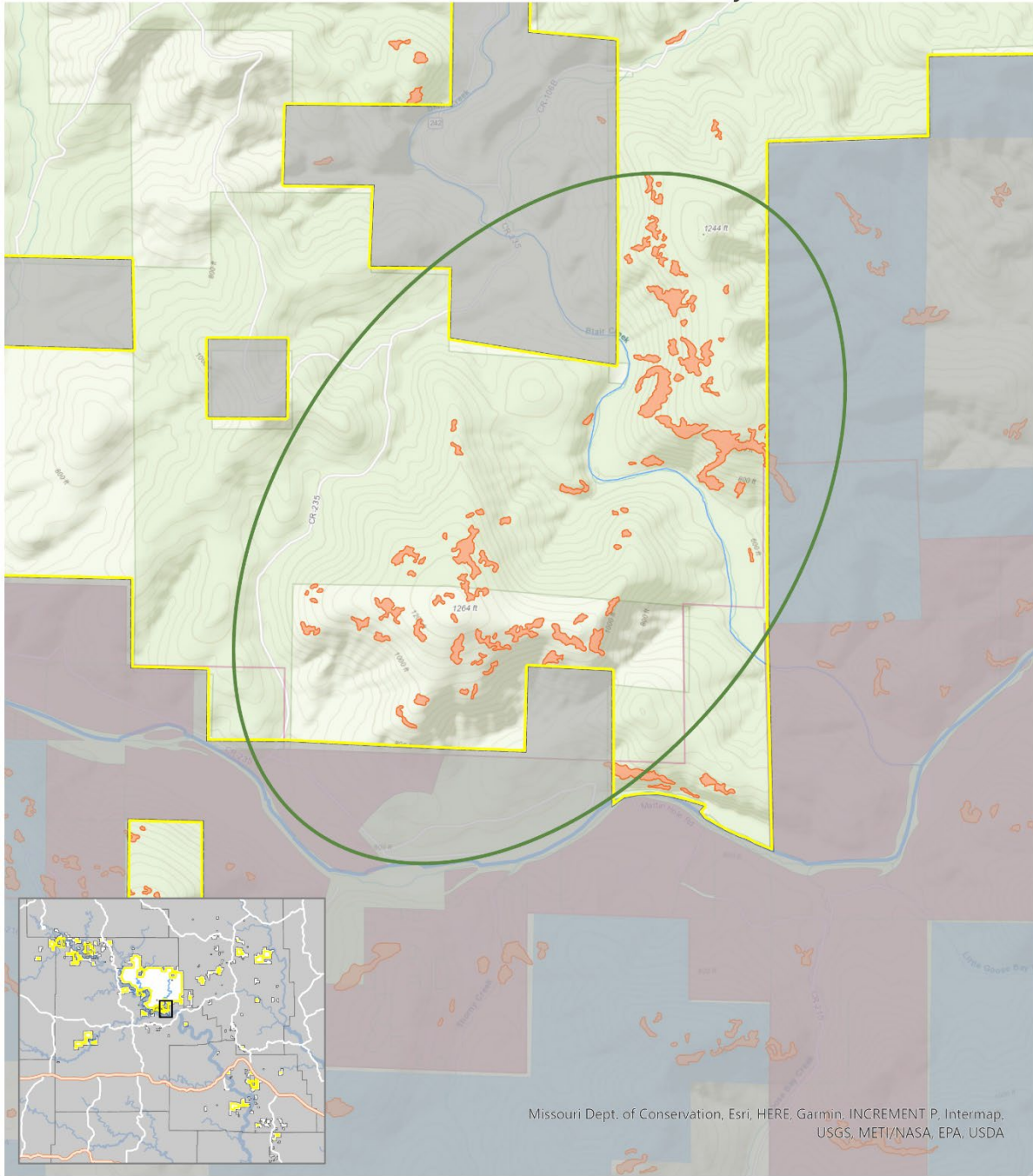


Figure 3.

Wildcat Mountain & Blair Creek Glades Priority Resource Area

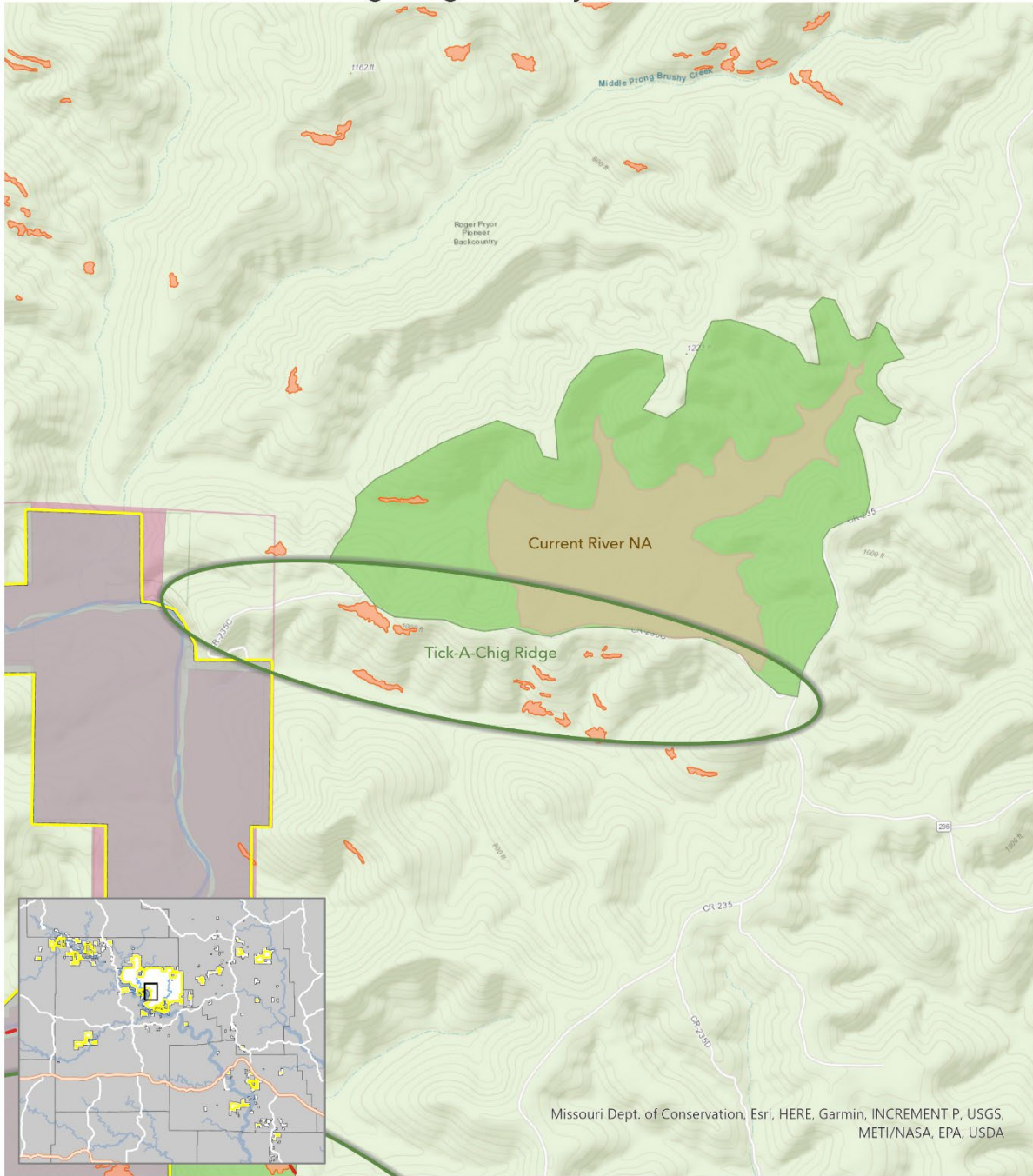


-  Proposed Priority Resource Areas
-  Glades
-  LAD/Pioneer Forest Boundary
-  National Park Service Boundary
-  National Park Service Ownership
-  MO Department of Conservation

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Figure 4.

Tick-A-Chig Ridge Priority Resource Area

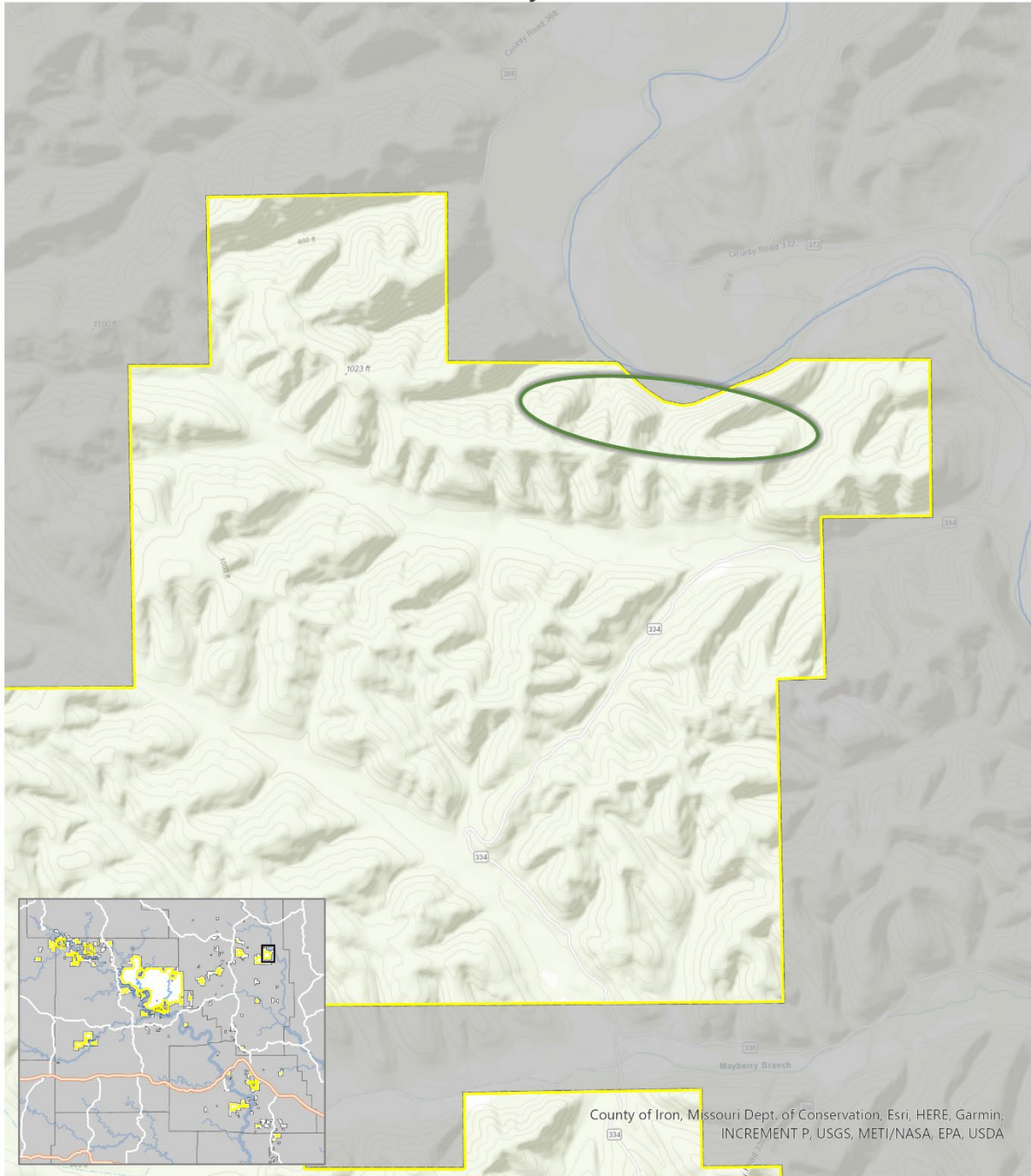


- Proposed Priority Resource Areas
- Glades
- MO Natural Area
- Priority Resource Areas
- LAD/Pioneer Forest Boundary
- National Park Service Boundary
- National Park Service Ownership

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Figure 5.

Black River Priority Resource Area



- Proposed Priority Resource Areas
- LAD/Pioneer Forest Boundary

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Figure 6.

3.2 Future Priority Resource Areas

The Natural Features Inventory will look for natural features on the forest, providing fine-scale information to aid in identifying places needing restoration or management (see section 7). The implementation of the NFI is ongoing and staff anticipate identifying additional Priority Resource Area designations during the implementation of this plan. One example is the proposed future old-growth PRA along the Black River (see section 5.3.3), which was identified by staff during initial NFI field work. In the next three years, staff will propose other features and/or natural communities for PRA designation, defining a desired future condition(s) and outlining the anticipated management activities. Future PRAs will be presented to the board for review and approval and included in future versions of this plan.

Staff will identify and propose areas for using prescribed fire as a tool for silvicultural and ecological outcomes. For example, prescribed fire could be used in an area where competition from maple and other non-merchantable species is impacting forest regeneration, or to reduce fuels to decrease the risk of wildfire. These areas will inform adaptive management and serve as additional demonstrations of exemplary stewardship of the forest.

3.3 Karst Communities and Species of Conservation Concern

Foundation staff are committed to demonstrating exemplary stewardship of the forest, including ensuring the most at-risk and sensitive species are supported by ongoing management. The forest has 157 known caves⁴ located primarily in Shannon County, making the foundation the largest private owner of caves in Missouri. Cave ecosystems support unique assemblages of species that are adapted to living in caves, including bats, salamanders, cave fish, cave crayfish, spiders, insects, and other troglobitic invertebrates. It is important to protect these rare and unique ecosystems from changes in water quality and human disturbance, especially for the five bat species of conservation concern found in caves. While this section of the plan focuses attention on the habitat needs for the bat species of conservation concern, the management guidelines for sinkholes and cave entrances should also provide protection for the other important cave fauna.

3.3.1 Management for Bat Species of Conservation Concern

The 2019 management plan refers to best management practices and includes other modifications to timber harvest operations to ensure retention and protection of important habitats, including snags, coarse woody debris, water quality, and other natural features. Appendix 1 of this plan is intended to supplement the guidelines for routine harvest and prescribed fire operations included in the 2019 management plan, specifically to support bat habitat.

3.3.2 Proposed Cave Priority Resource Areas

For the purposes of enhancing bat habitat, caves can be categorized by their level of bat use. Descriptions and management recommendations are provided below for the Tier 1, Tier 2, and

⁴ The number of caves is approximate and based on information contained in the cave database maintained by the Missouri Speleological Survey. As caves are located, mapped, and location data updated, it is possible there will be more caves on Pioneer Forest ownership. The L-A-D Foundation also owns several caves on lands under scenic easement for the Ozark National Scenic Riverways. In many cases, the adjacent ownership is Pioneer Forest. There are a few instances where the foundation only owns the narrow strip along the river and the adjacent land is, in large part, owned by public agencies. As such, the Foundation does not directly manage the surrounding habitat and these caves are not addressed in this plan.

Tier 3 cave categories. See Appendix 2 for background information and description of the habitat needs for five bat species of conservation concern.⁵

Tier 1 Caves

For the purposes of this plan, Tier 1 caves have known use by the gray, Indiana, and northern long-eared bats, which are all federally listed as endangered species. These caves are routinely monitored by the U.S. Fish and Wildlife Service, MDC, and/or the Cave Research Foundation (CRF) to obtain accurate winter-time population counts for tracking the status of these endangered species. Areas around Tier 1 cave hibernacula should be managed in a way that will eliminate adverse impacts on bats and enhance available habitat. There are seven caves on foundation land considered Tier 1 cave hibernacula for bat species of conservation concern. Additionally, there are five caves with entrances on adjacent ownerships, but in close proximity to the forest. It is important to ensure the forest's management around these twelve Tier 1 caves continues to support and protect the bat populations that rely on these habitats.

Those caves with only incidental observation of use by the three listed species (e.g., 1 bat) are not considered Tier 1 caves. Several of these caves have historical records of use by northern long-eared bats in small numbers (25 or fewer). Unfortunately, due to the devastation of white nose syndrome, since 2016 there have been no detections of northern long-eared bats in caves on the forest. Managing the habitat is nonetheless important should this species recover in time.

Tier 2 Caves

In addition to the Tier 1 bat hibernacula, the forest has 14 other caves where bats have been observed using the habitat in lower numbers (10 to 100 bats observed during site visits), with less frequency, or with less regularity. These Tier 2 caves could potentially be important sites for the species, but monitoring has been limited or the habitat may not be ideal for supporting larger numbers of bats. Nonetheless, managing the terrestrial habitat to continue to support bat species is important.

Tier 3 Caves

Tier 3 caves include all other caves where there may not be monitoring records to indicate bat use, the habitat may be unsuitable for bats, or available data indicates only incidental use by bats. Many caves on the forest have not been monitored (approximately 60), may not have been visited in many years, or only have incidental use by bats (fewer than 10 bats observed during site visits). However, caves provide habitat for other sensitive biota, including salamanders, cave fish, cave crayfish, and other troglobitic fauna. Providing a managed buffer will limit the visibility and prevent adverse water quality or vegetative impacts. Caves in this category may be prioritized for biotic monitoring but are assigned a lower priority for management as there is no data indicating their importance as habitat for bat species of conservation concern.

Below is a list of the management zones for each tier of caves. While the guidelines indicate a linear radius around cave entrances, efforts will be made to draw these buffers around logical landform breaks while maintaining the targeted size of the buffer area. This will prioritize habitat management in areas more likely to be used by bats (e.g., foraging areas along rivers and

⁵ The 2019 management plan includes related discussion about the cave and bat resources (pages 37 – 40).

streams). Maps (see Appendix 3) included in this plan are provisional and will be revised on a site-by-site basis as sites come into rotation for harvest or timber salvage is considered.

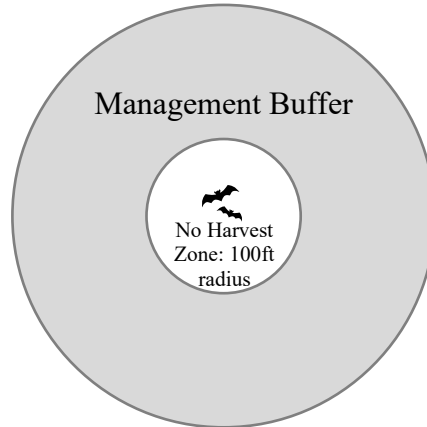
One important consideration is protecting the entrances by minimizing visibility, protecting water quality, and maintaining vegetation conditions that are suitable for bats. The desired condition goal for management around caves is a mature, restored terrestrial natural community. In forest and woodland natural communities, the desired condition is to retain more mature or old-growth character trees with dominant canopies and larger diameters. Woodland community types should have a more-open understory, which provides good flight paths around cave entrances. Current harvest practices may support these desired conditions and may only need slight modification to ensure potential roost trees are retained (e.g., keep a large canopy tree that is showing signs of decline as it could provide roosting and foraging habitat or retain a few more larger diameter trees or “legacy trees” in the Priority Resource Area).

The following management guidelines should be followed in Cave PRAs, though modifications may be appropriate to accommodate site-specific variability:

- **No Harvest Zone:** Within 100 feet of entrance (0.7-acre). The 100-foot buffer is an approximate distance. Local site conditions should be considered and the buffer adjusted to ensure safe operations.
 - Restricted Activities: No harvest, storing waste/debris/materials, refueling, or applying fertilizer.
 - Roads, Trails, Landings: Skid trails, fire lines, log landings, haul roads, and recreational trails should be avoided within 100 feet of cave entrance. Ensure cave entrance is not subjected to unnatural runoff or flooding. If deviations are needed from this guideline, mitigation measures should be installed to ensure increased sediment and erosion does not enter the cave (e.g., water diversion structures and turnouts should not be directed into cave entrance).
 - Vegetation Condition: Keep cave entrances clear of invasive species, excessive thorny or vining plants, or other objects that could obstruct bat flight paths. To prevent adverse use, do not alter the vegetation to a degree that it would make the cave more visible, especially for those located near roads and trails.
 - Gates: Some caves have cave gates installed to prevent trespass and adverse human disturbance; however, gating a cave should be considered a last resort to protect the cave, as bats can often be discouraged from using preferred habitat by the presence of a gate. Where possible, eliminate roads and trails that would provide easy access to caves.

- **Management Buffer:** Variable size, see Table 1 below. Manage for a mature, restored terrestrial natural community; monitor structure and adapt management accordingly; in forest and woodland communities, manage toward older-age characteristics and consider the following:
 - Retain all snags.
 - Retain at least 3 to 7 live den trees (trees with cavities or broken limbs that provide roosting habitat) per acre in forested areas and 25 den trees per acre in riparian areas (where available); prioritize dens located more than 20 feet above ground.

- Retain 3 trees per acre of ≥ 20 " diameter breast height (dbh); if not available, 16 trees per acre of the largest diameters present.
- **Harvest:** Follow seasonal restrictions in Table 1 below. Refer to maps for areas around Tier 1 caves where harvest is limited to the winter season. Following management activities in an area, properly close, block and obscure roads and trails.



Many caves are located on steep terrain, along riparian areas, or in rocky areas that may preclude certain management activities. As such, the guidelines are intended to be flexible to allow staff to adaptively manage as the local site conditions allow and as guided by the adjacent terrestrial natural communities.

Approximately 2,200 acres are included in Priority Resource Areas as buffers around Tier 1, 2, and 3 caves. Most of this acreage will be newly designated with board approval of this plan to ensure management around caves continues to support bat habitat and other cave biota. There are over 300 acres that are part of existing PRAs. Table 1 summarizes the no harvest, management buffer information, seasonal restrictions, and designated acres for each tier.

Table 1. The table includes the number of caves in each Tier (as defined above), the size of the no harvest zone and management buffer, associated seasonal restrictions, and the total acres in the proposed Cave Priority Resource Areas.

Cave Type	Number	No Harvest Zone	Management Buffer	Seasonal Restrictions	Acres*
<i>Tier 1 Caves</i>	12	100 feet	130 acres (1350-foot radius)	No management in entire buffer area during spring/fall swarming	1,140
<i>Tier 2 Caves</i>	14	100 feet	20 acres (525-foot radius)	None	275
<i>Tier 3 Caves</i>	136	100 feet	10 acres (370-foot radius)	None	785

*Many cave buffer areas overlap with other cave buffers, or the caves are near the property boundary and have only a partial buffer on the forest. This explains why the total acreage is less than if the number of caves is multiplied by the buffer size.

It is possible that new caves or karst features may be encountered during management operations or the NFI. When this occurs, the guidelines in this plan will be considered and new cave locations reported to the Missouri Speleological Survey for inclusion in the statewide cave database.

3.3.3 Sinkholes

Sinkholes are a karst feature formed when the subsurface collapses, leaving a depression at the surface. Sinkholes can range in size from small conical-shaped depressions that are a fraction of an acre in size, to large depressions that are several acres in size. Sinkholes are closely tied to groundwater and, as such, important for protecting groundwater quality and cave ecosystems from increased sedimentation or runoff. The Missouri Spatial Data Information Service has a 2018 geographic information system (GIS) layer with location information for sinkholes in Missouri. According to this GIS dataset, there are at least 36 significant sinkholes located on the forest and an estimated 300 – 400 acres will be covered by the management guidelines described below. However, LiDAR imagery shows several more sinkholes that are not included in that dataset, and as such, implementation of management guidelines will need to rely on additional field observations by staff.

The following management guidelines should be used in the vicinity of sinkholes:

- **Management Buffer:** 100-foot buffer should be placed around some sinkholes (based on Sinkhole Conditions described below). The purpose of this buffer is to provide stable vegetation, minimize disturbance to soils, and ensure clean infiltration of surface water into karst ecosystems.
 - Sinkhole Conditions:
 - Permanent water, soils or vegetation that differs from surrounding forest/woodland: sinkholes may have permanent standing water or soils that are saturated during much of the year. The associated vegetation may also differ in these sinkholes from the surrounding forest/woodland (e.g., different tree species or increased herbaceous growth). No harvest should

occur within 100 feet of the sinkhole, as measured from the break in slope around the sinkhole.

- No permanent water and similar vegetation types as the matrix forest: Many sinkholes do not have permanent water or wet areas and have similar vegetation types as the matrix forest. Harvest can occur within the buffer, but it should be more limited, and logs cabled out of the zone.
- **Roads, Trails, Landings:** Ensure sinkholes are not subjected to unnatural runoff or flooding. Skid trails, fire lines, log landings, haul roads, and recreational trails should be avoided within 100 feet of any sinkhole. If deviations are needed from this guideline, mitigation measures should be installed to ensure increased sediment and erosion does not enter the sinkhole (e.g., water diversion structures and turnouts should not be directed into sinkholes).

3.4 Invasive Species Management

Non-native invasive species impact the economic, ecological, and scenic qualities of the forest. These plants, animals, insects, and diseases present an ongoing and increasing threat to forest health, tree regeneration, and integrity of natural communities.

Priority Species

Feral hogs are a destructive threat to forest regeneration, natural communities, wildlife populations, soil health, and water quality. The forest has been working to directly address this threat through the hiring of a part-time trapper and allocating staff time and resources to trap and eradicate hogs.⁶ Staff continue to support and coordinate with the Interagency Feral Hog Task Force, which has successfully reduced the number of hogs in the region.

The Scenic Rivers Invasive Species Partnership (SRISP) is a local, cooperative effort to combat the threat of invasive species in the region (see section 9.2.2). It is important for staff to address invasive plant species within the forest boundaries and in cooperation with other agencies and landowners to reduce the overall threat to the region. The SRISP provides an opportunity for neighboring landowners to efficiently use resources in a coordinated effort to manage invasive species. Below is a priority list of plant species to target for the region (Table 2). The distribution and risk associated with each of these will vary across the forest and others are expected to be added as new threats arise.⁷ Mapping the locations of these species will help define the scope of the problem and allow staff to devise strategies to reduce the biggest threats.

Table 2. The priority list of species identified by the SRISP. Those marked with an asterisk are known to occur on and are a higher threat to the forest.

Common Name	Scientific Name
Amur maple	<i>Acer ginnala</i>
Japanese chaff flower	<i>Achyranthes japonica</i>
tree-of-heaven*	<i>Ailanthus altissima</i>
mimosa	<i>Albizia julibrissin</i>
garlic mustard	<i>Alliaria petiolata</i>

⁶ See pages 42 – 43 of the 2019 management plan for more information about the efforts to reduce feral hogs.

⁷ See pages 44 – 45 of the 2019 management plan for discussion about terrestrial invasive species and management.

Common Name	Scientific Name
common burdock, lesser burdock	<i>Arctium minus</i>
Japanese barberry	<i>Berberis thunbergii</i>
Caucasian bluestem	<i>Bothriochloa bladhii</i>
yellow bluestem	<i>Bothriochloa ischaemum</i>
musk thistle, nodding thistle	<i>Carduus nutans</i>
round leaf bittersweet	<i>Celastrus orbiculatus</i>
spotted knapweed*	<i>Centaurea stoebe ssp. micranthos</i>
bull thistle	<i>Cirsium vulgare</i>
Chinese yam	<i>Dioscorea polystachya</i>
common teasel	<i>Dipsacus fullonum</i>
cutleaf teasel	<i>Dipsacus laciniatus</i>
autumn olive*	<i>Elaeagnus umbellata</i>
winged burning bush	<i>Euonymus alatus</i>
winter creeper*	<i>Euonymus fortunei</i>
Japanese hop	<i>Humulus japonicus</i>
shrubby lespedeza	<i>Lespedeza bicolor</i>
sericea lespedeza*	<i>Lespedeza cuneata</i>
border privet	<i>Ligustrum obtusifolium</i>
Chinese privet	<i>Ligustrum sinense</i>
privet*	<i>Ligustrum spp.</i>
Japanese honeysuckle*	<i>Lonicera japonica</i>
bush honeysuckles (exotic)*	<i>Lonicera spp.</i>
purple loosestrife	<i>Lythrum salicaria</i>
white sweetclover	<i>Melilotus albus</i>
yellow sweet-clover	<i>Melilotus officinalis</i>
Japanese stiltgrass*	<i>Microstegium vimineum</i>
Chinese silvergrass	<i>Miscanthus sinensis</i>
sacred bamboo	<i>Nandina domestica</i>
princess tree*	<i>Paulownia tomentosa</i>
perilla mint*	<i>Perilla frutescens</i>
reed canary grass	<i>Phalaris arundinacea</i>
common reed	<i>Phragmites australis</i>
kudzu*	<i>Pueraria montana var. lobata</i>
Callery pear (Bradford pear)*	<i>Pyrus calleryana</i>
multiflora rose*	<i>Rosa multiflora</i>
Himalayan blackberry	<i>Rubus armeniacus</i>
purple crown-vetch*	<i>Securigera varia</i>
Johnsongrass*	<i>Sorghum halepense</i>
Japanese wisteria	<i>Wisteria floribunda</i>
Chinese wisteria	<i>Wisteria sinensis</i>

Aquatic communities are also at risk from invasive species. There are numerous aquatic plants (e.g., *Hydrilla verticillata*) that threaten to invade streams. Chytrid fungi are direct threats to amphibian species and endemic crayfish species are threatened by the introduction of bait species that are not native to these stream basins. Certain species could have particularly devastating impacts (e.g., zebra mussels, didymo (*Didymosphenia geminata*) algae). The forest does not currently have a program to monitor these threats. The three-year goal is to develop a better understanding of the risk to aquatic communities and support partner efforts to track, treat, and reduce these threats.

Mapping, Treatment, and Monitoring

Mapping invasive species is an important step in identifying the scope of the problem and developing a plan for strategic treatment of the greatest threats. Feral hog reporting will continue through the existing procedures outlined by the interagency task force. For other species, staff will use the Early Detection and Distribution Mapping System (EDDMaps) to map and track invasive species on the forest. Plants, animals, insects, and diseases can be reported using this tool and the data submitted will contribute to publicly available distribution maps.

Resources need to be strategically deployed to address the greatest invasive species threats. A small patch of invasive species on a roadside or log landing may present little threat to the health of the surrounding forest due to the limited ability of a species to spread beyond the disturbed area. However, if management work is expected to enter a sensitive natural community (e.g., glade, fen), then proactively treating invasive species prior to new management activities may be necessary to protect the integrity of natural communities. While the risk associated with each detection will need to be evaluated on a case-by-case basis, the following prioritized list of scenarios will serve as guidance to inform strategic use of resources to address invasive species:

High Priority

- Treat initial detections to prevent further invasion, especially those in remote locations and of species that have high rates of spread or transport.
- Treat invasive species that threaten Priority Resource Areas and Natural Areas.

Medium Priority

- Prior to management (e.g., prescribed fire, fire line construction, timber harvest, road construction) invasive species should be treated to prevent further spread into newly disturbed areas.

Low Priority

- Invasive species with limited spread along roadways and log-landings.
- Highly modified areas (e.g., old homesteads) with extensive invasions are the lowest priority, unless the invasion threatens a sensitive natural community or Priority Resource Area.

Appropriate timing of treatment, method of treatment (e.g., herbicide, mechanical removal such as hand pulling, mowing, biological control), and follow-up mapping and treatment all need to be carefully planned. Biological control agents should not be used prior to a thorough review.

Managing invasive species is an ongoing process that requires follow-up monitoring to ensure populations continue to decline. Eradication is the goal but, in many cases, may not be achievable. As such, isolating the expansion of invasives to prevent degradation of natural communities will often be the highest attainable result. In the future, more proactive steps to reduce new introductions of invasive species may be needed (e.g., equipment cleaning, managing public use, etc.).

4. NATURAL COMMUNITIES OF PIONEER FOREST

4.1 Terrestrial Natural Communities

Pioneer Forest is comprised of an interwoven matrix of terrestrial natural communities. Terrestrial natural communities are defined and described based on the assemblages of flora and fauna, and how the parent geology, soils, hydrology, slope position, and disturbance processes influence those assemblages. Identifying the natural communities on the forest provides an indication as to the potential desired future condition of a site for both timber and ecological outcomes. For example, a woodland with chert soils located on an exposed backslope or a shallow dolomite glade would not be expected to grow large volumes of high-quality timber, but may provide habitat for pollinators, insectivorous birds, and reptiles. On the other hand, a low-base chert protected backslope woodland or mesic bottomland forest would be expected to have higher site indexes, support the production of high-quality timber, and provide habitat for a different suite of flora and fauna.

The Terrestrial Natural Communities of Missouri (Nelson, 2010) provides thorough descriptions of Missouri's natural communities, including the vegetation, physical characteristics, expected natural processes, threats, and management considerations. Of the 86 natural community types described for Missouri, 23 are found on the forest (Table 3). Understanding the needs of these natural communities is an important step in planning and prioritizing expanded ecological work, including protection, restoration, and maintenance activities that are feasible to implement.

Under historical disturbance regimes, much of the forest would have been described as woodlands (~85%). Woodlands are characterized by more widely spaced trees with an open or closed canopy and an understory dominated by herbaceous plants. The structure of these woodland natural communities was sustained by periodic fire, set by indigenous people in the fall or dormant season and occasional lightning fires during prolonged summer droughts. Forest natural community types also make up a significant portion of the forest (~14%). They range from dry-mesic sites to mesic bottomland areas along the streams and rivers. Structurally, they are characterized by a closed canopy with a midstory and understory dominated by small trees, shrubs, ferns and other shade tolerant herbaceous plants. Many areas on the forest that appear to be "forest" natural community types, may in fact be woodlands that have lost their structural and herbaceous character due to decades of fire exclusion and an altered disturbance regime. Some of these areas may be good candidates for future woodland restoration management.

There are several other terrestrial natural communities on the forest that make up a smaller percentage of the acres but they include a disproportionate share of the biodiversity – glades, fens, cliff communities, and sinkhole ponds. Protection or restoration management on these natural communities can conserve numerous plant species that may otherwise be rare or uncommon in the surrounding matrix of forest and woodlands. For this reason, prioritizing natural community restoration that includes these smaller communities can have higher ecological returns on investment (see section 6.2 on fens and glades).

Table 3 summarizes the terrestrial natural communities expected to be found on the forest and includes estimated acreages. The estimates are based on provisional GIS data and have not been ground-truthed. Additionally, there are no estimates for fen natural communities due to their

small size and the difficulty in predicting where they occur. Each community is assigned a “state rank” by MDC indicating the level of concern for that community type. The ranking criteria include “total number of occurrences, number of occurrences by grade [A-D], total acres, number of counties in which the community type occurs, number of protected occurrences, and threats” (MDC, 2023). The ranks are described as follows:

- S1: Critically Imperiled** – Critically imperiled in the state because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.
- S2: Imperiled** – Imperiled in the state because of rarity due to very restricted range, very few populations or occurrences, steep declines, or other factors making it very vulnerable to extirpation from the state.
- S3: Vulnerable** – Vulnerable in the state due to a restricted range, relatively few populations or occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation.
- S4: Apparently Secure** – Uncommon but not rare; some cause for long-term concern due to declines or other factors.
- S5: Secure** – Common, widespread, and abundant in the state.

The state rank is useful in that it identifies natural communities that are a higher priority for conservation across Missouri. Upland Flatwoods, Mesic Bottomland Forest, Wet-Mesic Bottomland Forest, and Wetland community types are the highest level of concern among natural communities on the forest. If high quality examples of these Critically Imperiled (S1) or Imperiled (S2) natural communities are found on the forest, they should be considered when designating new Priority Resource Areas and expanding management.

Table 3. The table below highlights the broad categories of terrestrial natural communities found on Pioneer Forest. These data are derived spatially and are provisional, pending further ground-truthing and expert review. Acreage calculations are based on estimates from provisional GIS data, have not been ground-truthed and do not reflect deeded acres. Discrepancies are known to exist. The estimated acres in Priority Resource Areas does not include the proposed new designations of PRAs.

Pioneer Forest Terrestrial Natural Communities	State Rank	Acres in Priority Resource Areas	Acres
<i>Woodland Types</i>			<i>123,150</i>
Dry Chert Woodland	S4	1,000	53,000
Dry-Mesic Chert Woodland	S4	1,300	38,500
Dry Sandstone Woodland	S3	700	12,300
Dry-Mesic Sandstone Woodland	S3	600	12,000
Dry Limestone/Dolomite Woodland	S3	190	650
Dry-Mesic Igneous Woodland	S4	140	450
Dry Igneous Woodland	S4	90	350
Upland Flatwoods	S2	80	5,900
<i>Forest Types</i>			<i>19,630</i>
Dry-Mesic Chert Forest	S4	400	10,700
Dry-Mesic Bottomland Forest	S3	190	4,800
Riverfront Forest	S4	60	3,000
Mesic Bottomland Forest	S2	90	1,000
Dry-Mesic Igneous Forest	S4	40	100
Wet-Mesic Bottomland Forest	S2	0	30
<i>Cliff Type</i>			<i>1,000</i>
Dry Limestone/Dolomite Cliff	S5	190	600
Moist Limestone/Dolomite Cliff	S4	130	400
<i>Glade Type</i>			<i>800*</i>
Dolomite Glade	S3	20	500
Igneous Glade	S3	120	300
<i>Wetland Type</i>			<i>50</i>
Pond Marsh	S1	25	50
Ozark Fen	S2	**	**
Forested Fen	S2	**	**
Acid Seep	S2	**	**
Limestone/Dolomite Spring	S3	**	**
Total			144,630*

*The 2018 GIS glade layer for Missouri estimates 470 acres of glades, which can be considered a minimum estimate.

** Fen, acid seep, and spring natural communities are not represented in the provisional GIS data and therefore acreages are not included in this table.

References:

Terrestrial Natural Community Type in Missouri (Nelson, 2010)

Ecosystem Dynamics Interpretive Tool - Ecological Site Descriptions (USDA NRCS, 2023)

Figure 7 shows the number of acres of each natural community type on the forest and the percentages of those communities that are part of designated PRAs. This highlights that certain rare community types on the forest (e.g., dolomite glade, wet-mesic bottomland forest) may need additional consideration for designation, protection, and/or management, which can help prioritize selection of additional PRAs in the future.

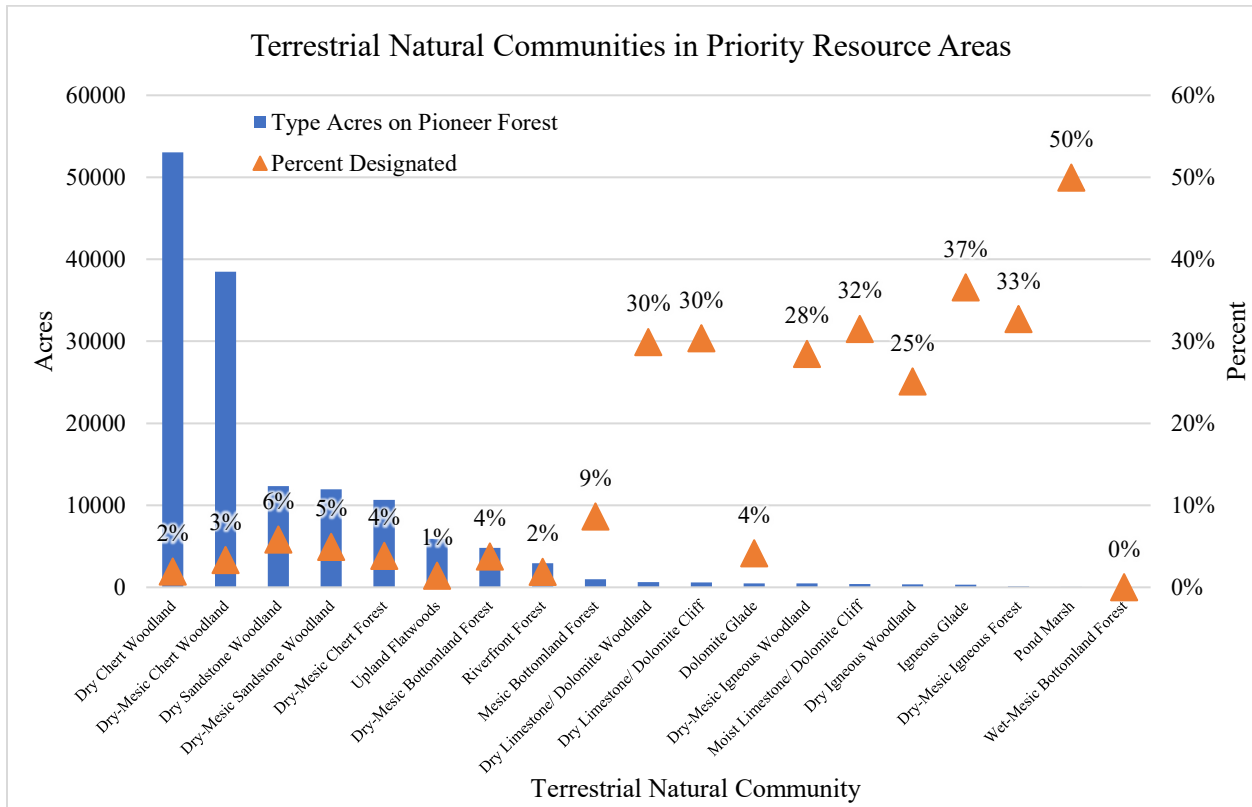


Figure 7. Chart illustrating the total acreage of each terrestrial natural community type on Pioneer Forest (blue bars) and the percent of that type that is designated as part of Priority Resource Areas (orange triangles and associated label with percentage).

4.2 Aquatic Community Types

Across the forest ownership there are numerous aquatic resources, from ephemeral headwater creeks to the large Current River system. Bedrock geology, topographic relief, intermittent or perennial flow, size, stream temperature, and connectivity all impact the distribution of aquatic organisms. There are several stream types on the forest:

- Headwater Creeks and Streams
 - Ephemeral streams – have temporary or short-duration flow in response to precipitation events.
 - Losing stream segments – lose flow to the subsurface environment and in many cases do not support surficial flow. Streams can have both losing and gaining stream segments.
 - Intermittent streams – have seasonal flow when groundwater levels are sufficiently high to provide surface flow but will cease flow during dry periods. Intermittent streams may have permanent pools or refugia.

- Perennial streams – have continuous surficial flow year-round during normal rainfall years.
- Small and Large Rivers – Jacks Fork and Current Rivers

MDC provided fish, crayfish, and mussel sampling data for stream and river segments that intersect Pioneer Forest. This included parts of Leatherwood Creek, Big Creek (upper Current), Big Creek (in the backcountry), Blair Creek, Mash Creek, Jacks Fork River, Current River, and several other small streams. Fish sampling occurred between 1941 and 2018. There were 60 different species of fish identified, including 6 species endemic to the Ozarks ecoregion (e.g., Current River saddled darter, Ozark shiner). Five species of crayfish were identified from four years of sampling (1985, 1992, 2004, 2013). Three of these species are Ozark endemics (*Cambarus hubbsi*, *Faxonius ozarkae*, and *F. punctimanus*). The virile crayfish (northern crayfish, *F. virilis*) was detected in 2013. This species is native to Missouri, but not to the basins in this region of the Ozarks and may be detrimental to species native to these river and stream systems. There were 13 native species of freshwater mussels identified from four years of sampling (1979, 1982, 2017, and 2018), including several species of conservation concern. The slippershell mussel (*Alasmidonta viridis*) is considered critically imperiled in Missouri and was located in the Jacks Fork River. See discussion on monitoring in section 8.2.2 of this plan.

Leatherwood Creek, Big Creek (in the backcountry), Brushy Creek, and Blair Creek are all significant perennial tributaries to the Jacks Fork and Current Rivers, providing important habitat for aquatic organisms. Many of these tributaries have springs, fens, and seeps that contribute to stable baseflow conditions, important for providing year-round habitat and stable temperature regimes. Adjacent land use practices have significant influence on stream conditions, as they impact infiltration, runoff, stream bank stability, nutrient cycling, temperature, and other conditions. The intact, forested landscape provided by the forest around these tributaries is a key factor for maintaining high-quality stream conditions. The greatest threats to these streams include sedimentation from adverse vehicle use, changing flow conditions associated with climate change, and land use practices beyond the forest ownership.

Protecting the condition of the aquatic habitat in tributaries to the Current River is also important for the long-term protection and restoration of numerous aquatic species of conservation concern, including mussels, snails, crayfish, endemic fish, and the federally endangered Ozark hellbender (*Cryptobranchus alleganiensis bishopi*). Some of the key threats to hellbender populations include excessive gravel loading. Continued adherence to best management practices that reduce sediment runoff from roads and skid trails is important for minimizing this threat. Maintaining intact riparian zones and implementing good erosion prevention practices are part of these best management practices.

5. PRIORITY RESOURCE AREAS

Priority Resource Areas are biological, geological, or cultural areas with high or exceptional conservation value that are unique locally to the forest, or of regional, statewide, and/or global importance. Collectively, the goal is to have PRAs represent the full range of natural communities, including old-growth forests and woodlands, that provide a valuable comparative resource of the forest's range of natural diversity, including areas restored to or representative of pre-settlement conditions. Some may be considered for elevation to the Natural Area system (see section 5.4), but that is not essential if they contribute to the range of diversity on the forest. The desired future condition for these areas is similar to that for Natural Areas, with priority focus on protection and integrity of natural processes and communities. Managing for high-quality timber products is not the highest priority but may be a compatible goal in certain areas.

5.1 Background

Prior to the development of this plan, PRAs were categorized as Special Resource Stewardship Designations (SRSDs) and included Forest Reserves, Ecological Management Areas, and state-designated Missouri Natural Areas. SRSDs are discussed in a foundation policy document, the latest version of which was finalized and approved by the board on April 23, 2015. Additionally, the 2019 management plan included relevant additions and changes to SRSD areas.

This plan combines Forest Reserves, Ecological Management Areas, and other managed areas (e.g., Himont Shortleaf Pine Management area) into one category of Priority Resource Areas. This nomenclature will simplify the designations, create a consistent and integrated process for all project areas, enable clearer priority setting among designated areas, and provide clarity to partners. See below for considerations regarding state-designated Missouri Natural Areas, which are governed by an external process.

The board-approved policy, "Pioneer Forest Special Resource Stewardship Designations: Natural Areas, Forest Reserves, and Ecological Management Areas," is applicable for designating Priority Resource Areas, as newly named under this plan. New PRA designations or changes to existing PRAs can be approved by the board with updates incorporated into subsequent versions of this plan and added to the plan appendix. Staff intend to review the policy and propose any needed changes to the board to ensure an appropriate level of oversight and alignment with board direction, while providing flexibility for adaptive management. Proposed policy revisions are anticipated in fiscal year 2023-2024.

Characteristics

Priority Resource Areas on the forest may include, but are not limited to, the following:

- High-quality, unique, or rare terrestrial natural communities (e.g., glades, fens, shortleaf pine-oak woodlands)
- Unusual concentrations of species of conservation concern
- Significant riparian areas or stream valley systems
- Buffers around cave entrances for significant bat hibernacula or other karst features
- Remnant old-growth or old-character stands
- Geological features
- Cultural sites

- Areas set aside from management due to the historical importance to the foundation

The size of PRAs will vary depending on the qualities of the particular resource(s) being targeted by the designation.

Management

Management and monitoring are critical to achieving the desired outcomes for Priority Resource Areas. Staff will develop site-specific plans outlining specific management targets, as appropriate, to ensure the desired condition or desired influence is achieved and maintained. Plan contents will vary based on the level of complexity required by each area. Timber harvest may be compatible management in certain areas but will be evaluated on a case-by-case basis and modified, as needed, to meet desired outcomes (e.g., increased or decreased volume removal, target species, shorter or longer cutting cycles). Management may also be appropriate to address disease, weather, insects, invasive species, or other unpredictable events that require follow-up mitigation to maintain the character of an area, or to restore an area to a more natural condition. Site-specific plans will be reported to the board.

Site-level plans should include the following information (if applicable):

- Statement of significance for the designation of the PRA
- Site description
- Site-level forest inventory
- Desired condition
- Threats
- Goals and/or management objectives for the planning period
- Summary of completed management activities
- Monitoring and/or research
- Recreation considerations
- Partners

Each PRA is assigned a “management level” based on the current and/or anticipated level of management and monitoring. The purpose of the management level is to provide a method for quickly identifying the scale of resource needs of each area, which will facilitate annual budgeting and resource allocation. The level of management is partially dependent upon the degree and types of management needed to achieve and maintain the desired condition for the area. Some areas will require routine, active management to restore and maintain the natural communities. Those identified as Reserves (see Table 4 below) are expected to have only minimal management, as was described when they were designated by the board. They are not part of routine timber harvest operations, but there may be circumstances that would require the need for management (e.g., invasive species, cedar removal) and those will be detailed in site-specific plans presented to the board for review.

Availability of funding, staff, equipment, and contractors will also be factors considered in assigning a management level. The management levels are:

- 1: Active management and monitoring ongoing with activities planned in the next 5 years.

- 2: Management and monitoring ongoing with activities planned in 5 - 10 years; or management planning complete, but not yet implemented.
- 3: Proposed for management, but additional planning and resources needed to implement.
- 4: No active management anticipated and only periodic site-visits planned.
- NA: Not Assigned – management level not yet assigned.

5.2 Current Priority Resource Areas

Table 4 contains a summary of the current Priority Resource Areas designated on the forest with references to the 2019 management plan, which includes more details about each area.

Subsequent versions of this plan will include an appendix to summarize consistent information for each PRA (see template in Appendix 4) including:

- Desired condition(s)
- Site details
- Site history
- Natural features and/or species of conservation concern
- Conservation and management considerations
- Map(s)

Table 4. List of approved Priority Resource Areas on Pioneer Forest. Additional information about each area can be found in the 2019 management plan on the pages referenced below.

Name	Priority Resource Area Overview	2019 Management Plan Page No.
Blair Creek Hanging Fen Reserve	Targets: hanging fen community and rare plant populations Acres: 25 Management Level: 3	74
Bluff School Cultural Reserve ⁸	Target: historical schoolhouse Acres: 4.4 Management Level: 4	74
Capps Hollow Glades	Target: glade and marly seep fen restoration Acres: 297 Management Level: NA	30
Chalk Bluff Reserve	Target: dolomite bluff community Acres: 64.75 (26.4 under scenic easement, 38.35 on Pioneer Forest) Management Level: 4	24-25
Cunningham Sinkhole Reserve	Target: 3-acre sinkhole and buffer Acres: 27 Management Level: 4	75

⁸ The Bluff School Priority Resource Area used to a cave. The cave will now be included in the Cave Priority Resource Areas. As a result, the Bluff School Priority Resource Area is named here separately.

Name	Priority Resource Area Overview	2019 Management Plan Page No.
Fishtrap Hollow and Marshy Spring Hollow Fen Reserve	Target: fen communities Acres: 60 Management Level: 4	75
Himont Shortleaf Pine	Target: shortleaf pine-oak woodland Acres: 472 Management Level: 1	36
Jerktail Mountain	Target: Rhyolite and dolomite glade/woodland complex Acres: 1,159 Management Level: 1	84-85
Laxton Hollow Reserve	Target: old-age forest, cave, and spring Acres: 167 acres Management Level: 4	76
Leatherwood Creek Reserve	Target: geological features, natural communities, karst communities Acres: 1,003 Management Level: 4	76
Old Schoolhouse Hollow Fen Reserve	Target: fen community Acres: 140 Management Level: 4	77
Pineknott	Target: Shortleaf pine-oak woodland Acres: 330 Management Level: 1	27
Satterfield Hollow Reserve	Target: old-growth white oak and surrounding community Acres: 522 Management Level: 4	25
Sinkhole Ponds Reserve	Target: Bowles, Lily Pond, and Vinson Pond sinkhole ponds and surrounding community Acres: 34 Management Level: 4	77
Sutton School Hollow Fen Reserve	Target: fen community Acres: 60 Management Level: 2 (eastern red cedar removed)	78
Tall Larkspur (2 units)	Target: Tall larkspur (<i>Delphinium exaltatum</i>) populations and glade/woodland management Acres: 550 in Devil's Well and Welch Lodge management units Management Level: 1	32, 81-83

Name	Priority Resource Area Overview	2019 Management Plan Page No.
Thompson Hollow Glade and Fens ⁹	Target: glade and fen restoration; maintain old-growth cedar Acres: 90 Management Level: 1	31
Tufa Creek Reserve	Target: rare tufa deposits, fen community Acres: 116 Management Level: 4	78
Virgin Pine/Randolph Pine-Oak Woodland	Target: shortleaf pine and oak woodland habitat; maintain old-growth pine; glade restoration Acres: 1,095 Management Level: 1	79
Woods Hole Reserve	Target: historical importance for foundation, large diameter trees Acres: 58 Management Level: 4	26

Restoring and maintaining natural communities that are fire-dependent requires a long-term commitment to planning and implementing prescribed fire on a routine basis. The PRAs with a management level 1 are those that are expected to receive cyclic fire treatments in the future. This significant commitment of time and resources is one reason it is important to be strategic in selecting areas for expanded management with prescribed fire. Table 5 lists those areas and acreages currently under prescribed fire management, including important partnerships with NPS, Mark Twain National Forest (MTNF), and MDC.

⁹ The proposed expansion of the Jerktail Mountain Priority Resource Area will include the Thompson Hollow glade and fen.

Table 5. The areas of Pioneer Forest that are currently under prescribed fire management, including those in partnership with the NPS, MTNF, and MDC. Acres are listed by ownership for each unit.

Unit Name (partner landowner in parenthesis)	Pioneer Forest Prescribed Fire Acres	Partner Acres	Total Acres
Himont Shortleaf Pine Management	472	--	472
Jerktail Mountain (NPS)	1,150	687	1,837
Pineknot (MTNF)	64	2,717	2,781
Tall Larkspur – Devil’s Well (NPS)	428	607	1,035
Tall Larkspur – Welch Lodge (NPS)	122	721	843
Thompson Hollow	87	--	87
Virgin Pine/Randolph Pine-Oak Woodland (MDC)	623	14	637
<i>Total</i>	<i>2,932</i>	<i>4,746</i>	<i>7,678</i>

5.3 *Old-Growth Representations of Terrestrial Natural Communities*

There is no agreed upon definition of “old-growth,” as it is locally variable depending on the natural community type, dominant tree species, site conditions, disturbance regimes, and potential for the area to achieve an overstory cohort that is significantly older than the average lifespan for the dominant tree species. Pioneer Forest has examples of old-growth representing several natural communities, including glade, woodland, and forest types. While the historical percentage of woodlands and forests that could be classified as old-growth is not known, it is reasonable to assume they occupied a greater percentage of the landscape than present day. A study in the northern hardwoods of northeastern US, estimated that uneven-aged old-growth (>150 years) may have occupied 70-89% of the landscape (Lorimer and White, 2003). While the disturbance regimes and terrestrial natural communities in the northeast (e.g., longer mean fire interval, hurricanes) would be significantly different than in the central hardwoods region, it does indicate a shift of old-growth habitat availability from pre-European settlement to present day.

The forest’s timber management program continually creates new pockets of young, regenerating areas through the small gap openings left in the canopy following harvest. This is critically important habitat for a variety of flora and fauna including declining species of migratory birds. These gaps close over time, but new ones are created each year as harvest operations proceed. However, areas of the forest with old-growth characteristics are less common. Including old-growth objectives as part of a comprehensive management plan will ensure a range of habitats are available for the diverse array of species that occupy the forest. The goal is to designate Priority Resource Areas in representative community types that have the potential to develop old-growth characteristics.

5.3.1 Old-Growth in Existing Priority Resource Areas

There are a number of existing PRAs that have or have the potential to develop old-growth conditions namely:

- Satterfield Hollow – Current River Natural Area (522 acres)
- Virgin Pine/Randolph Shortleaf Pine-Oak Woodland (1,095 acres)
- Leatherwood Creek Reserve (1,003 acres)
- Laxton Hollow Reserve (167 acres)
- Tall Larkspur – Devil’s Well unit (428 acres)
- Cunningham Sink (27 acres)

These areas could support a variety of old-growth natural communities on 3,215 acres (~2%) of the forest. Dominant tree species in these communities vary and include white oak, shortleaf pine, mixed hardwoods, and eastern red cedar in cliff communities. Timber operations in the managed PRAs (e.g., Randolph Shortleaf Pine-Oak Woodland) can continue to foster and simulate old-growth conditions in these areas as restoration continues. The designated Tier 1 Cave PRAs around important bat hibernacula could also support old-growth character in the future on an estimated 1,150 acres, depending on the local site conditions.

5.3.2 Legacy Old-Growth Areas

There are a few remaining places on the forest that have old, legacy trees in higher numbers. When Leo Drey purchased Pioneer Forest he bought back the timber rights on a few select places to prevent the trees from being harvested. Generations of foresters have continued to leave most

of those trees on the land. Other places have been set aside to honor the legacy of the founder and his expressed preference to reserve some areas from harvest.

- Schoolhouse Hollow – Staff will evaluate Schoolhouse Hollow and develop a site-specific plan to manage the area to protect the existing old-age component and foster the next generation of trees that can continue the legacy. Estimated 300-400 acres.
- Tick-a-Chig Ridge – The area will be reserved from harvest to honor the legacy of Leo Drey. Staff will evaluate other restoration potential that is compatible with maintaining the old-growth desired condition. Estimated 450-500 acres.

5.3.3 Future Old-Growth Areas

Old-growth is a rare component of Ozark forests and woodlands, with much of the present condition being second-growth forests. The forest has scattered “legacy” trees that are reminiscent of a past with different disturbance regimes. While there are a few places with significant stands of old-growth trees (e.g., Current River Natural Area, Virgin Pine/Randolph, Schoolhouse Hollow), they are not common. The forest will identify places with the potential to grow and maintain old-growth conditions and designate additional areas to manage for old-growth in the future.

Several types of natural communities could be conducive to developing old-growth due to the characteristics of the dominant tree species. For example, shortleaf pine, white oak, post oak, and chinkapin oak are generally considered longer-lived tree species. There are numerous examples of these trees attaining ages of 150 years or more on the forest. Woodland and glade complexes would be expected to have old-growth post oak and chinkapin oak. Protected forest communities may have a mixture of white oak, northern red oak, sugar maple, black gum, and other mesic site species.

Staff will identify areas with good potential to develop old-growth characteristics across a variety of community types. One proposed area that resulted from initial Natural Features Inventory work is:

- Black River Reserve – ~35-50 acres reserved from harvest to protect scenic values of the river corridor and develop old-growth.

5.4 Missouri Natural Areas

Background

Leo Drey was an early leader in protecting natural areas in Missouri and his actions supported the groundwork that would eventually lead to the establishment of a statewide designation program. He formally acknowledged the value of natural areas through the designation of the Current River Natural Area under the Society of American Foresters (SAF) Natural Areas program in 1955. The original 10-acre designation was the first SAF Natural Area in Missouri and, according to a newspaper article written at the time, “Drey says these trees will not be harvested, but kept in their virgin state as a sort of monument to past greatness of Ozark forests and an object lesson as to what a fine forest can become if permitted to do so...” (Karel, 2008).

The L-A-D Foundation was formed in 1962 and it was through the foundation's work that Leo continued to support the identification, designation, and protection of natural areas in Missouri. MDC formed the statewide program in 1970 and two foundation-owned sites were among the

first designations in the Missouri Natural Areas system (Karel, 2008). While the definition, understanding, and management of natural communities has evolved over time, the core principle of designating exemplary, high-quality areas remains.¹⁰

Natural Areas on Pioneer Forest

The current goal of the Missouri Natural Areas program is to identify, designate, restore, and manage “the best remaining examples of natural communities and geological sites encompassing the full spectrum of Missouri’s natural heritage.” Missouri Natural Area designations are recommended by the Missouri Natural Areas Committee. The forest currently has five designated areas, three owned entirely and two owned in part, with other agencies holding the majority of the acres. In consultation with MDC, staff should consider additional areas on the forest for nomination to the Missouri Natural Areas Committee. Designated Missouri Natural Areas on the forest are automatically considered Priority Resource Areas because they have independently been recognized as having statewide significance.

The 2019 management plan included the following goals for existing Natural Areas on the forest:

- Review annual status reports with MDC staff each year.
- Periodically visit each site to assess conditions.

In addition to the goals for existing Natural Areas (see below), the 2019 management plan included a goal to “collaborate regarding a proposed Current River Caves natural area, to include Pioneer’s Conglomerate and Merritt Rock caves together with National Park Service’s Moss Prater Cave”. To date staff have had initial discussions with CRF about this concept. Additional work is needed to evaluate the interest of the NPS and the Missouri Natural Areas Committee.

Below are additional updates from the reports and goals identified in the 2019 management plan.¹¹

Table 6. Summary information about goals for the state-designated Natural Areas on Pioneer Forest.

Natural Area Name	Area Overview
Current River	Target: Old-growth white oak Acres: 265 acres Current Goals: None
Pioneer	Target: Acres: 20 acres Current Goals: 2019 management plan included goal to investigate for significance and possible addition of Pioneer Forest lands in the adjoining Big Creek valley. Status: Initial discussions with partners, but no actions taken.

¹⁰ See *Natural Areas Protection and Recreation Opportunities on Pioneer Forest and Other Properties of the L-A-D Foundation* (Karel, 2008) for a more complete discussion on the role of Leo Drey and the L-A-D Foundation in supporting the natural areas program in Missouri.

¹¹ The 2019 management plan has descriptions for Natural Areas in Appendix C.

Natural Area Name	Area Overview
Lily Pond	<p>Target: Sinkhole pond with pond shrub swamp Acres: 8 acres Current Goals:</p> <ol style="list-style-type: none"> 1. Monitor for signs of feral hog activity. 2. Evaluate plant community in sinkhole pond for rare plants and any management needs to maintain natural community type. 3. Consider designating a larger Priority Resource Area around Lily Pond.
Triple Sink/Sunklands	<p>Target: forested sinkholes Acres: 42 acres, part of larger 6,295-acre area Current Goals:</p> <ol style="list-style-type: none"> 1. Monitor for feral hog damage. 2. Consider designating a larger Priority Resource Area around Triple Sink for future old-growth.
Allen Branch	<p>Target: numerous high quality natural communities Acres: 88 acres, part of larger 1,900-acre area Current Goals: None yet identified for Pioneer Forest portion of the natural area.</p>

6. OTHER SPECIES AND NATURAL COMMUNITIES OF CONSERVATION CONCERN

6.1 Shortleaf Pine-Oak Woodlands

Shortleaf pine (*Pinus echinata*), Missouri's only native pine species, has decreased dramatically in extent across its range. Pine and mixed pine forest types used to cover more than 6 million acres in Missouri (Liming, 1946, Figure 8), but that has decreased by more than 85% (T. Goff, personal communication, September 29, 2021).

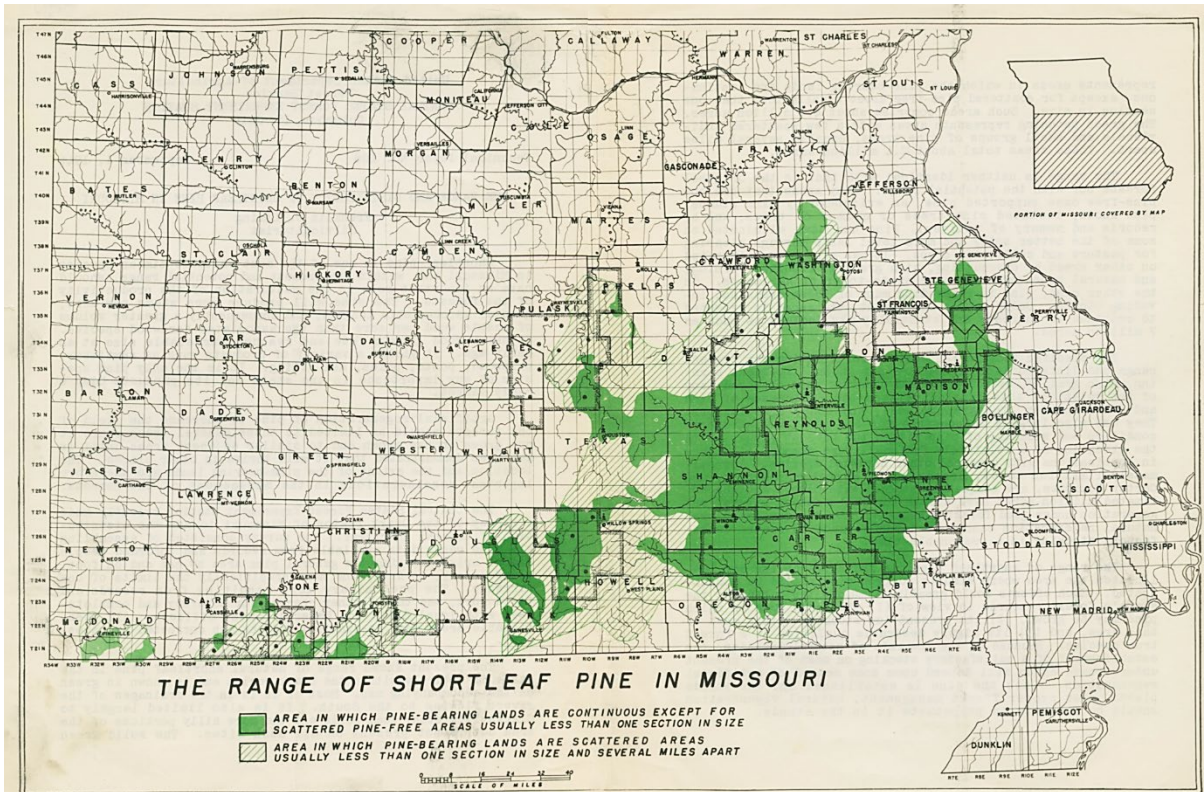


Figure 8. Approximate historical range of shortleaf pine in Missouri (Liming 1946).

According to 2013 U.S. Forest Service Forest Inventory and Analysis data, shortleaf-dominated forests have continued to decline by more than half (53%) since the 1980s (Figure 9), though Missouri had the smallest percentage decline as compared to other states (Oswalt, 2015). For conservation practitioners in Missouri, this means an opportunity to restore, maintain and demonstrate to others how to manage this important species and associated habitats.

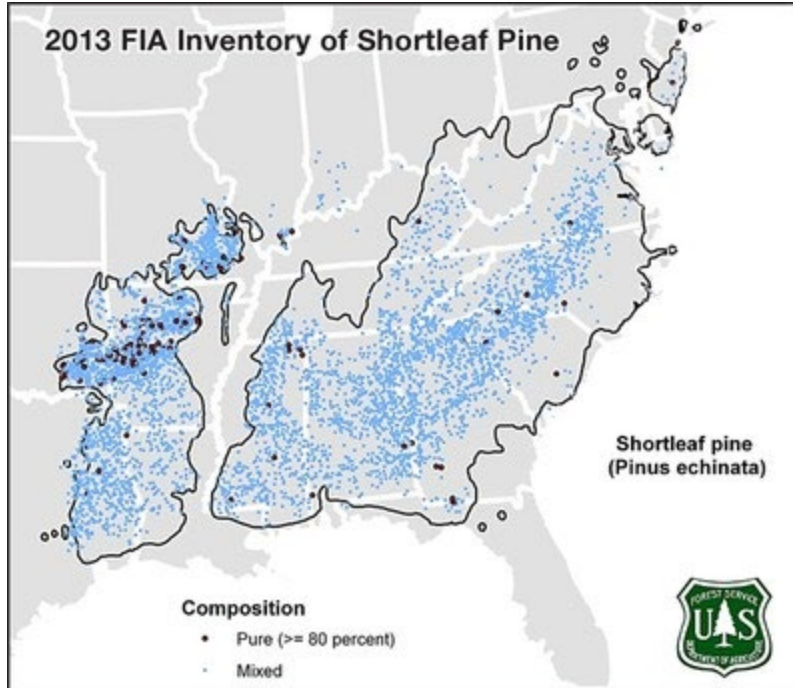


Figure 9. Geographical locations of sampled shortleaf pine (≥ 1 inch dbh) in mixed (shortleaf and mixed shortleaf-oak forest type) and pure stands ($>80\%$ stand is shortleaf) during the 2013 inventory. Black outline is the historic range. Range data: Little 1971. Credit: Chris Oswalt, U.S. Forest Service Southern Research Station, Forest Inventory and Analysis (FIA) Program.

Shortleaf pine is an important component of the forest. According to the General Land Office surveys conducted in the early 1800s, 34% of trees recorded on the forest were shortleaf pine, followed by white oak (27%) and black/scarlet oak (15%). Remnant fire-scarred pine stumps can commonly be found on the forest. Today, shortleaf pine makes up about 30% of the forest's standing volume (preliminary analysis of 2022 Continuous Forest Inventory (CFI) data).

Prescribed fire is an important tool for managing this species. For this reason, opportunities to expand shortleaf pine management must be in places where it is practical to implement prescribed fire. The forest will continue to consider opportunities for additional restoration management of shortleaf pine natural communities, and support partnerships such as the Interior Highlands Shortleaf Pine Initiative.

6.2 Fens and Glades

Fen and glade communities are unique terrestrial natural communities characterized by diverse herbaceous plants, some of which are tracked species of conservation concern or have limited range. While generally small in acreage, they have an outsized impact on the biodiversity of an area, providing habitat for plant and animal species not found in the surrounding forest matrix. Threats to these communities include physical soil damage from feral hogs, horses, off-road vehicles, or people; invasive species; and encroachment of vegetation not characteristic of the specific community type (e.g., woody encroachment into glades or prairie fens). The forest and other land-managing agencies have targeted the protection and restoration of these unique natural communities. Future designations of Priority Resource Areas should continue to prioritize these

community types, as restoration management that includes these smaller communities will support a greater diversity of flora and fauna.

6.3 Bird Species of Conservation Concern

Populations of breeding birds have had alarming declines over the last 50 years. The Missouri Bird Conservation Plan Technical Section ranks the species of greatest concern across a range of habitats (Table 7). Many of these species, including the three ranked of highest concern, can be found on the forest and are supported by management activities. Prairie Warblers, for example, are strongly associated with glades and have returned to restored habitats like Jerktail Mountain and the glades in the Tall Larkspur PRAs. Red-headed Woodpeckers are now common at the Randolph Shortleaf Pine-Oak Woodland. One of the species of greatest concern – Eastern Whip-poor-will – is found on the forest and researchers are interested in better determining the type of habitat and management that supports this species. While management activities on the forest are aimed at achieving an uneven-aged forest and ongoing restoration and stewardship of natural communities, there are several potential partnerships with academic researchers to better understand how management can support these declining bird species. See section 9.3 on Research Partnerships for additional discussion.

Table 7. Table of Missouri Concern Scores for bird populations from the Missouri Bird Conservation Plan Technical Section. The MO Concern Score reflects the sum of five scores: Population Trend (MO), Threats to Breeding (MO), Relative Density – Breeding (MO), Population Size (Global), and Breeding Distribution (Global). Each score's scale varies slightly, but in general 1=least concern/lowest threat level and 5=greatest concern/highest threat level.

Natural Community	Common Name	MO Concern Score ¹	Population Trend, MO	Threats to Breeding, MO	Relative Density - Breeding, MO	Population Size, Global	Breeding Distribution, Global
GRASSLAND BIRDS	Eastern Kingbird	15	5	3	4	2	1
	Grasshopper Sparrow	15	5	4	3	2	1
	Henslow's Sparrow	17	2	4	5	4	2
	Bobolink	11	1	4	2	2	2
	Eastern Meadowlark	17	5	4	5	2	1
	Dickcissel	16	4	3	5	2	2
SAVANNA, WOODLAND, AND YOUNG-FOREST BIRDS	Northern Bobwhite	16	5	4	4	2	1
	Yellow-billed Cuckoo	16	5	3	5	2	1
	Chuck-will's-widow	16	5	3	4	2	2
	Eastern Whip-poor-will	18	5	3	5	3	2
	Chimney Swift	16	5	4	4	2	1
	Red-headed Woodpecker	17	5	3	5	3	1
	Eastern Wood-Pewee	14	3	3	5	2	1
	Bewick's Wren	17	5	5	3	2	2
	Brown Thrasher	15	4	3	5	2	1
	Eastern Towhee	15	4	3	4	2	2
	Field Sparrow	17	5	3	5	2	2
	Yellow-breasted Chat	13	3	3	4	2	1
	Orchard Oriole	13	2	3	5	2	1
	Blue-winged Warbler	15	3	3	4	3	2
	Prairie Warbler	18	5	3	5	3	2
	FOREST BIRDS	Blue Jay	14	4	3	4	2
Wood Thrush		14	3	3	4	2	2
Worm-eating Warbler		15	2	3	5	3	2
Prothonotary Warbler		13	3	3	2	3	2
Kentucky Warbler		15	2	3	5	3	2
Cerulean Warbler		18	5	4	4	3	2
WETLAND BIRDS	Green Heron	15	5	3	3	3	1
GENERALIST BIRDS	Common Grackle	16	5	4	5	1	1

7. NATURAL FEATURES INVENTORY

The Natural Features Inventory will provide fine-scale information about natural communities, species of conservation concern, or geological features, and aid in identifying places needing restoration or management. The NFI will look for features for internal use to guide management decisions and Priority Resource Area designations. Where appropriate, data will be submitted to the Missouri Natural Heritage database managed by MDC.

While it is expected that identification of new natural features will not result in significant deviations from routine timber management for most areas of the forest, the NFI is anticipated to identify areas that may benefit from modified or adaptive management. For example, high quality glade and woodland communities could need decreased basal area, cedar cutting, and implementation of prescribed fire. Sinkholes, caves, or fens could require a buffer to ensure water quality and habitat structure is maintained. Staff will develop and prioritize management recommendations, as needed.

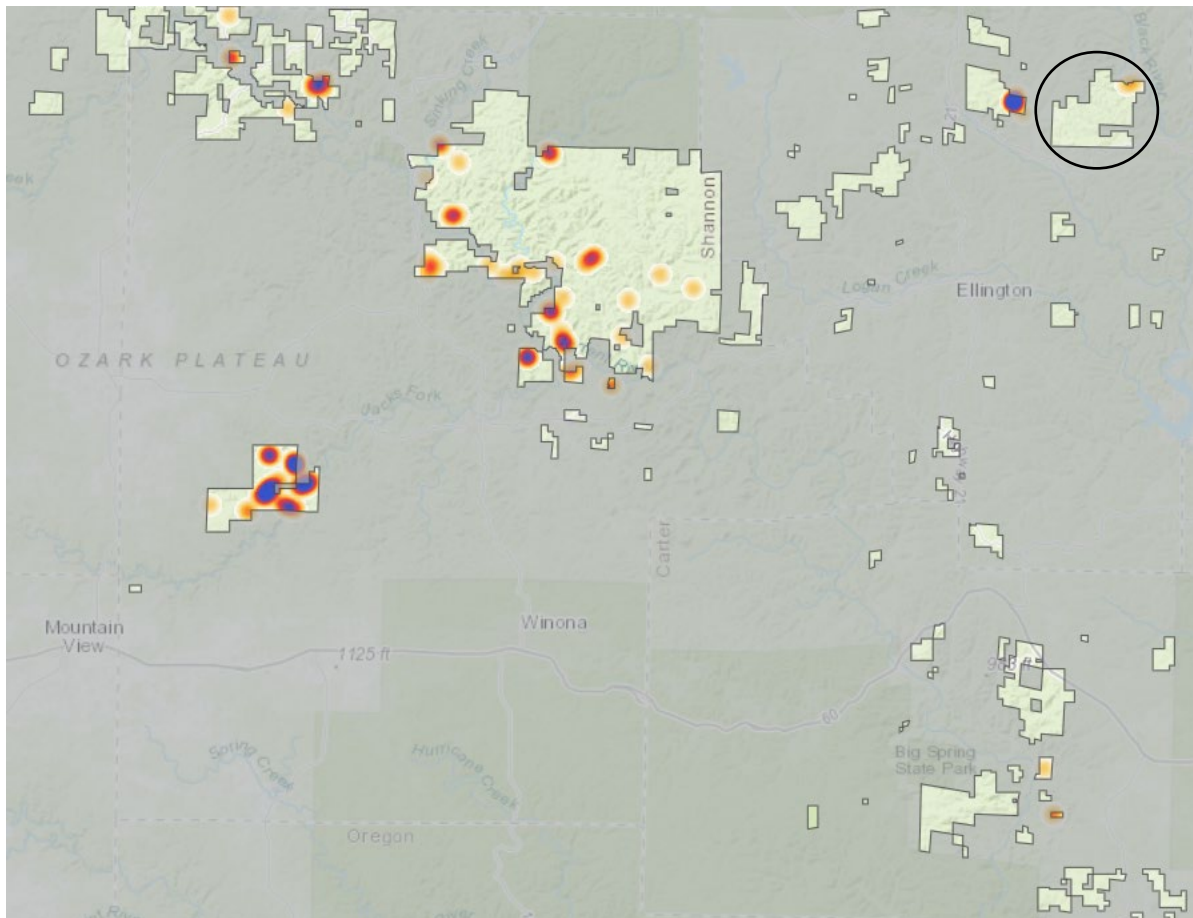


Figure 10. This is a heat map of available Natural Heritage records for Pioneer Forest (excluding cave-related records). The darker blue areas represent higher concentrations of records and the lighter orange areas have fewer records. There are large areas of Pioneer Forest that have few or no records, including the Egyptian tract circled above. The instance of records is attributed to the intensity of study on portions of the forest.

The Egyptian Tract (circled in Figure 10) was selected by staff as a place to pilot the NFI for several reasons. It is a large block of ownership with very few known Natural Heritage records. It is in the Black River Land Type Associations, which could offer features that differ from other parts of the forest. The tract also borders the Black River, a different watershed from other forest lands.

7.1 NFI Process Overview

The first step of the NFI is to select an area of the forest for evaluation. Areas may be selected to fill knowledge gaps, to expand or update existing natural feature data, or to provide site-specific management recommendations prior to scheduled timber harvests. In 2023, a pilot implementation of the NFI was initiated with the help of advisors with experience with the process. A detailed process document will be developed as part of the pilot project, but the following steps are an overview of the approach. Staff will set annual goals to identify areas and conduct Level 1 and Level 2 investigations. Level 3 studies will be dependent on available resources to conduct a more detailed inventory.

Level 1: Pre-Field Data Review

Available data are reviewed to identify locations for initial field scoping, which could include:

- Historical information – ownership history, land use/management history, historical aerial imagery, and General Land Office survey notes on historical trees and vegetation.
- Landform information – topographic maps, geology and soils information, LiDAR imagery to detect surface features (e.g., sinkholes, roads, structures, etc.), and other available GIS data.
- Ecological information – ecological site descriptions, Natural Heritage database records, presence of streams or wetlands, known vegetation communities, county records for plant species, monitoring data (e.g., CFI data, plant surveys, fish surveys), and other available GIS data.

These data are used to identify areas with the greatest potential for unique natural features (e.g., mesic sites, areas expected to have glades or other rare natural community types).

Level 2: Scoping Field Trips

The goal of the scoping trips is to conduct an initial investigation of the sites that have the greatest potential for exemplary natural features and would be worthwhile to further investigate during the growing season. Data from the Level 1 review process guides the field work during scoping trips. These initial scoping trips are best conducted during the leaf-off dormant season, which allows for easy visual observation over a larger area. For example, the team may visit riparian areas, potential sinkholes, wetlands, caves, north-facing cliffs, and unique xeric sites to make an initial assessment whether to conduct additional field work during the growing season to identify rare plant or animal populations.

Level 3: Detailed Field Study

The scoping process will narrow the list of areas to investigate during the growing season to those with the highest potential for identifying rare natural communities or plant populations. Species that have not yet been inventoried on the forest but have a high probability of occurring should be prioritized for further field investigation. Detailed location studies should be scheduled

when seasonally appropriate to ensure the greatest potential for correct plant species identification (e.g., fen surveys when sedge perigynia are present).

7.2 NFI Reporting Tool

Using spatial data tools developed by ESRI, field staff will be able to enter new observations of natural features in the field, to be automatically synced with a centralized database. Data collected by field staff will include the location, feature type, feature description and photographs. The image is an example of the survey Staff Report Form from the ESRI Survey123 smartphone application that will be deployed in the field to collect preliminary feature data. The list of attributes will be revised, as needed.

Features that may be appropriate for submission to the Missouri Natural Heritage database can be extracted from the data submitted by staff, verified in the field by qualified staff or partners, additional attributes collected, and then submitted to appropriate MDC personnel.

The forest is rich with archaeological and cultural history, and initial location information about these types of features can be collected using the NFI reporting tool. Identifying priorities and areas for additional investigation by qualified experts for cultural features would need to be a separate process specific to those resources.

7.3 Timeline

The three-year goal for the initial NFI of forest lands is to complete the Level 2 inventory on 18,000 acres and the Level 3 inventory on 6,000 – 10,000 acres. A complete inventory of all forest lands should be completed within eight years and staff will budget for resources to achieve this goal.

- Year 1 – Level 2 and 3 on 6,000 acres (Egyptian tract)
- Year 2 – Level 2 on 6,000 acres and Level 3 (with staff and contracting availability)
- Year 3 – Level 3 on 6,000 acres and Level 3 (with staff and contracting availability)

8. MONITORING

Monitoring is a critical component of adaptive management. There are three levels of monitoring, each requiring increasing levels of skill and effort and yielding increasingly more detailed results. Each level serves a different role and can guide different management decisions.

- Level 1 – remote or GIS-based assessment
- Level 2 – rapid field assessment
- Level 3 – intensive field data collection

Monitoring includes all three levels of assessment. Ongoing fire-effects monitoring for the ecological management program primarily includes Level 3 assessments with permanent vegetation plots located in managed areas. The current and future monitoring needs are described below.

8.1 Vegetation Monitoring in Priority Resource Areas

Vegetation monitoring plots are important for measuring pre-management baseline conditions and tracking changes in the herbaceous community during the restoration and maintenance phases of managing natural communities. There are several plot sample designs, which vary depending on the community type and monitoring partner. In addition to established monitoring plots, staff routinely conduct surveys of PRAs to gain additional knowledge about the biota in these areas and locate species of conservation concern.

Baseline monitoring and/or permanent plots are established in the following Priority Resources Areas:

- Virgin Pine/Randolph Shortleaf Pine-Oak Woodland
- Jerktail Mountain glade and woodland plots
- Tall Larkspur – Welch Lodge and Devil's Well PRAs
- Thompson Glade
- Himont Shortleaf Pine
- Fen plant community surveys (Rough Hollow, Thompson Creek, Marshy, Lewis Hollow, Sutton Schoolhouse, and Old Schoolhouse Hollow fens)

The NPS is an important managing and monitoring partner. Their staff have developed and lead ongoing fire-effects monitoring in the jointly managed prescribed fire units (e.g., Jerktail Mountain, Welch Lodge, and Devil's Well). Contractors are critical to obtaining high quality data in these and other forest management units (e.g., Virgin Pine/Randolph, Thompson Glade).

8.2 Other Monitoring Needs

8.2.1 Community Health Index

The Community Health Index is a Level 2 assessment for determining natural community integrity in a more rapid fashion than what is required by detailed floristic inventories. A CHI has already been developed for several key communities in the Ozarks, and work is ongoing to continue to develop indexes for other natural communities. The CHI does not provide the same level of detail as current vegetation monitoring on the forest but could be a tool to assess more areas recognizing limitations in staff and contracting resources for detailed vegetation

monitoring. It may be a useful tool for quickly determining site quality and evaluating restoration potential or community response to management activities.

8.2.2 Aquatic Communities

There is only minimal monitoring information available about the aquatic communities supported by streams and creeks on the forest. The data provided by MDC are helpful snapshots of the aquatic communities in certain streams on the forest, but there are no known robust or long-term monitoring data for water quality or aquatic communities on the forest. Freshwater faunal groups (e.g., freshwater mussels, snails, crayfish) are some of the most endangered taxa globally. Partnering with other agencies, researchers, or organizations on routine monitoring could help facilitate substantial learning opportunities about these resources. The three-year goal is to identify one or more stream systems (e.g., Big Creek in the backcountry) to target for monitoring, partner with appropriate resource specialists to collect data, and develop associated management recommendations.

8.2.3 Bats and Forest Habitat Use

There are several areas of research and monitoring that inform forest management to protect and enhance bat populations. The winter bat population monitoring indicates certain bat species are present on the forest, but there is little information about the use of the forest outside of cave habitats. The use of ultrasonic detection devices would enable identification of bat species that are using the forest during other times of the year. These data could help identify areas that are more highly used by bats and inform forest management. In addition, the data could help select locations to successfully trap and tag bats for the purpose of identifying roost trees (discussed below).

There were two maternity roost trees for northern long-eared bats identified on the forest during the planning for Echo Bluff State Park in 2014. Staff visited the two points and believe the individual trees have fallen or decayed beyond useful habitat. However, there are other standing dead trees in the area that could be used by bats. Prior to the next harvest operations, staff will identify a buffer or work with partners to collect acoustic data and determine if northern long-eared bats are still occupying the area during maternity season. Management activities will be adapted accordingly to protect the habitat.

Supporting research or partnering with qualified individuals to trap, tag, and track bats could provide locational data of roost trees, if they are present on the forest. This would allow the forestry team to better target management around sensitive areas and ensure important trees are not harvested or salvaged. Staff should seek opportunities to partner with agencies and researchers on projects that would foster greater understanding of bat populations on the forest and the Missouri Ozarks. Staff should continue to partner with agencies and organizations to monitor bat populations and revise management recommendations accordingly.

8.2.4 General Cave Data Collection

The foundation is the largest private landowner of caves in Missouri, with 157 known caves on the forest and the number continues to increase as new caves are located. There is a need to collect additional data from within caves on the forest to better understand the karst resources. Of the known caves, approximately 60 (38%) have minimal or no biological records. According to

data summarized by Scott House with CRF, there are far fewer faunal records from foundation-owned caves than other cave-owning agencies (Table 8), which he noted was likely due to a lack of monitoring rather than an absence of cave fauna. Most of the biological data from caves owned by the foundation are those that have been inventoried as part of the Ozark National Scenic Riverways cave monitoring. Staff will develop a list of caves to target for initial biological inventory and routine monitoring, working with CRF, Missouri Speleological Survey, and qualified volunteers to collect data.

Table 8. Cave faunal records for public agencies and Pioneer Forest. One faunal record represents one species identified on one monitoring trip. The total number of faunal records is the sum of faunal records over time and increases with repeated monitoring trips (e.g., 500 *Myotis sodalis* counted during 3 separate monitoring trips to Cave X is 3 faunal records).

Manager	Total # of caves	Total # of faunal records	Average # of faunal records/cave
Mark Twain National Forest	901	9293	10.3
National Park Service	431	7757	11
MO Department of Natural Resources/State Parks	264	2917	12
MO Department of Conservation	467	5592	12
Pioneer Forest, including caves on NPS easements	188	1264	6.7
Pioneer Forest, excluding NPS	157	529	3.4

9. PARTNERSHIPS: RESEARCH, DEMONSTRATION AND REGIONAL CONSERVATION GOALS

This section discusses the role of the foundation and forest in advancing conservation outcomes beyond its ownership boundaries. It summarizes ongoing initiatives (e.g., Scenic Rivers Invasive Species Partnership) and describes opportunities for future collaboration.

9.1 L-A-D Foundation Scenic River Lands and Legacy Lands

The foundation owns significant lands that are within the Ozark National Scenic Riverways and Legacy Lands that are managed through long-term partnerships with state agencies. These are briefly described below, but given the different management structures and locations, are beyond the scope of this plan.

The foundation owns approximately 845 acres along nearly 20 miles¹² of the Ozark National Scenic Riverways corridor, making it an important partner and giving the foundation a unique position to support the continued protection of this important national resource. These lands were retained by Leo Drey with easements to protect the scenic quality of the newly formed Ozark National Scenic Riverways and then donated to the foundation in the 1970s. These easement tracts, in various places along one or both sides of the Jacks Fork and Current Rivers, protect the scenic values for a 300-foot-wide corridor. The easements are located in Shannon and Carter counties and primarily adjoin forest property. In addition, there are several parcels outside the scenic easement corridor, but within the legislative boundary of the Ozark National Scenic Riverways that have timber management agreements (TMAs). The TMAs are intended to allow selective harvest under a site-specific plan reviewed and approved by NPS. There are 5 parcels comprised of approximately 650-acres (+/-) with TMAs, which are described in greater detail in Appendix F of the 2019 management plan.

The foundation owns nearly 4,000 acres of property outside Pioneer Forest boundaries that protect cultural, geological, or natural features in Missouri. These lands were purchased by Leo Drey for the protection of those unique resources and, in most cases, are under long-term lease agreements with the Missouri Department of Natural Resources (portions of Dillard Mill State Park and Grand Gulf State Park) or MDC (portions of Blue Spring Branch, Clifty Creek, and Rocky Hollow Conservation Areas; Hickory Canyons Natural Area, and three Piney River sites). One area, Lower Rock Creek, is not under a management partnership, but adjoins MTNF land in Madison County. The unique qualities and management partnerships on these special resource properties necessitate site-specific plans, which have been developed by the partnering agencies in consultation with the L-A-D Foundation. These lands are discussed in more detail in a companion document, L-A-D Foundation Lands Handbook, which will be updated in the future.

9.2 Regional Conservation Partnerships

Partnerships are critically important for achieving conservation outcomes across the region. Several important efforts have emerged over the years and staff routinely connect with partners on a variety of projects, a few of which are highlighted below.

¹² The acreage is based on county tax records in the foundation's consolidated land list for 2022. GIS acreage calculations for these easement parcels is approximately 1,000 acres. The mileage reported is for linear river miles where there is an easement on one or both sides of the river.

9.2.1 Conservation Opportunity Area

MDC's Comprehensive Conservation Strategy identifies forest, woodland, glade, cave, and aquatic Conservation Opportunity Areas (COAs) in the Current River region. The Current River Hills COA partnership is one of the remaining active COA groups in the state and continues to be an important mechanism for information-sharing, networking, and shared-learning among partners. Meetings are held several times a year and are routinely attended by 30 or more staff from U.S. Forest Service (USFS), NPS, MDC, MO State Parks, The Nature Conservancy, University of Missouri-Extension, L-A-D Foundation, Quail Forever/Pheasants Forever, Doe Run, and others. Foundation staff are involved in chairing and organizing meetings for the COA and will continue to seek partnership opportunities through the COA network.

9.2.2 Scenic Rivers Invasive Species Partnerships

The mission of the Scenic Rivers Invasive Species Partnership is establishing a strong, cross-boundary public-private partnership that inventories, monitors, controls, and prevents the spread of invasive species for a nine-county area in the southern Ozarks. The SRISP is a partnership among federal and state agencies, non-governmental organizations, and local landowners to tackle the threat of invasive species in a cooperative, resource-sharing manner, working across boundaries to map, treat, and track invasive species. This is the first example of a cooperative invasive species partnership in Missouri and serves as a demonstration for other regions of the state. The foundation was involved in the formation of the SRISP, is a signatory on the memorandum of understanding, has staff representation on the SRISP board, and will continue to support the work of the partnership.

9.2.3 Landscape Restoration Partnerships

The foundation has supported several landscape-scale restoration efforts, a few of which are briefly summarized below. Staff will continue to seek strategic opportunities to engage with partners to advance the foundation's mission to serve as a demonstration forest.

Shortleaf Pine Restoration

The USFS initiated a significant shortleaf-pine oak woodland restoration project through the Collaborative Forest Landscape Restoration Program, and the 330-acre Pineknott Priority Resource Area of Pioneer Forest is part of a prescribed fire unit with the USFS. Following more than a decade of restoration work in the region, the brown-headed nuthatch was reintroduced to the project area through the work and support of MDC, USFS, University of Missouri, Arkansas Game and Fish Commission, and others. The birds may be using the Pineknott tract and could possibly extend to other portions of the forest where suitable habitat exists.

The Interior Highland Shortleaf Pine Initiative is a regional partnership that was formed by the Central Hardwoods Joint Venture in 2011 with the goal of improving knowledge sharing about shortleaf pine restoration and management. Participants include agencies and organizations managing shortleaf pine in the Ozark, Boston, and Ouachita Mountains of Missouri and Arkansas.

Ozark Chinquapin Restoration

The mission of the Ozark Chinquapin Foundation is to restore the Ozark chinquapin (*Castanea ozarkensis*) species to woodlands and forests in its native range across the south-central United

States. The L-A-D Foundation is a long-term partner of their efforts and has donated the use of several places on Pioneer Forest for the cultivation and research of blight-resistant trees. The foundation will continue to support this partnership and the goal of restoring this native species.

9.3 Research and Demonstration Partnerships

Research and other field studies are important for developing a better understanding of the impacts of management activities. The foundation has a long history of supporting academic research on the forest and will continue to foster partnerships that advance the mission. In the next three years, staff will develop relationships with researchers and academic institutions to cultivate opportunities for research on Pioneer Forest that will improve understanding of the forest's resources and inform management.

Eastern Whip-poor-will

Recent research related to the Eastern Whip-poor-will has created numerous opportunities for partnership and collaboration. This migratory songbird has seen steep declines and is of high conservation concern. Preliminary field surveys indicate the management of the forest has resulted in habitat that supports a population of Eastern Whip-poor-wills during breeding season that is more abundant than many other sampling locations (Table 9). A future research project aims to advance the understanding of habitat preferences and associated management for this species.

Table 9. Preliminary data from one field season of Eastern Whip-poor-will point counts. Source: Dr. Michael Ward, University of Illinois.

Average of Mean Whip-poor-will Abundance Per Point	Location Description
4.82	Northwest Wisconsin (Douglas County Forest)
4.73	Southeast Missouri (L-A-D Foundation)
4.17	Southeast Missouri (MTNF)
4.01	Northeast Wisconsin (Marinette County Forest)
3.85	Central Missouri (Jackson County Forest)
3.73	North lower peninsula of Michigan (Traverse City State Forest)
3.72	Northeast Wisconsin (Nicolet National Forest)
3.37	Southeast Missouri (MTNF)
3.15	Northeast lower peninsula of Michigan (Huron National Forest)
2.85	Northern Missouri (Union Ridge Conservation Area)

Partnering with academic researchers, the forest can support a greater understanding of the management needs for this species and serve as a demonstration for other landowners. These partnerships may also present an opportunity for the forest to collaborate on a full life-cycle conservation effort, as the bird overwinters in a relatively concentrated region of southern Mexico and Central America. As an iconic nocturnal bird species, the Eastern Whip-poor-will may be a helpful communication tool for reaching private landowners about the benefits of restoration and management. Supporting and partnering with others on initiatives like the International Dark Sky Places program could also support the conservation of the species.

The three-year goal is to continue supporting research efforts, develop a conservation strategy with partners, and articulate the foundation's role in supporting a broader conservation effort for the species. The conservation strategy will be informed by the foundation's communication planning effort. Staff will continue to collect bird point count data as part of the Center for Conservation Biology Nightjar Survey Network (www.nightjars.org) to support the range-wide effort to improve population data.

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APPENDIX 1: MANAGEMENT FOR BAT SPECIES OF CONSERVATION CONCERN

Management for Bat Habitat

The forest’s uneven-aged, single-tree selection harvest regime and other management activities support a healthy, diverse forest. As informed by the 2017 Continuous Forest Inventory (CFI), the current goal is to manage 5,000 – 7,000 acres of the approximately 144,000-acre forest annually using commercial timber harvest to achieve a 20-year cutting cycle. Research suggests that managed forests with a matrix of mature trees, historical thinnings, and small patch gaps are preferred by certain bat species (Divoll et al., 2022). While some species may be more preferential to early successional habitats (e.g., tricolored bat), others rely more on mature stands (e.g., northern long-eared) (Loeb et al., 2006). The forest’s long-standing approach to management supports bat populations by continually creating foraging areas (e.g., small gap openings), managing a mosaic of forest types with a diversity of tree species, providing a range of size and age classes, maintaining native forest and woodland cover types, and supporting snag creation and retention.

The 2019 management plan includes the following guidelines in its Forest Policy and Performance Standards (Appendix A, p. 63-67), which should support high quality habitat for bats:

- Retain an average of 50 square feet of basal area post-harvest.
- Timber removal is avoided within 50 feet of streams, allowing retention of large trees in important foraging areas.
- Selected “legacy trees” are retained to provide seed source, diversity in stand structure, and wildlife benefits.
- Snags are retained (unless they pose a safety hazard to workers).
- Wildlife trees are retained and allowed to die naturally to provide snags and large woody debris.

While the harvest regime was not selected to meet the specific needs of bat species, data indicate the habitats created through the staff’s approach to forest management do provide high quality resources for bats. The 2017 CFI indicates the forest, on average, has sufficient large diameter live trees to align with the guidelines set forth by other agencies (see Table 10). This is further evidence that the forest’s existing management approach supports bat habitat.

Table 10. Recommendations from the MDC Habitat Conservation Plan for bat species of conservation concern and data from the forest’s 2017 CFI.

Guideline	MDC Habitat Conservation Plan Recommendation	Pioneer Forest Practice/Data
<i>Minimum basal area</i>	30ft ²	Target 50 – 60ft ²
<i>Trees per acre (tpa) 19” dbh and greater</i>	3.0*	3.3
<i>Live trees per acre (tpa)</i>	16 tpa >9” dbh	66.6 tpa 9” dbh and greater

tpa = trees per acre

dbh = diameter breast height

*MDC’s guideline is for 3.0 trees per acre of trees 20” and greater. The CFI data is summarized in 2-inch diameter classes (e.g., 19 -20.9”, 21 – 22.9”), which is why the data are reported as 19” or greater.

Retaining Suitable Roost Trees

The characteristics of suitable roost trees vary among the tree-roosting bat species, but several species are known to roost under loose bark, or in cracks, crevices or cavities in larger diameter live or dead trees. Weather, disease, insects, and incidental damage of residual trees during harvest or prescribed fire can create cavities or snags. Retaining these damaged live trees and snags provides habitat for tree-roosting bat species on the forest. Available data from the 2017 CFI indicates good availability of roosting habitat for bats on the forest. According to those data, there are 14.5 dead or cull (50% or greater of unusable wood) trees per acre, and of those, 9.5 trees are standing dead with a diameter of 7-inches or greater. Assessing the number of dead and cull trees on the forest is not a perfect metric for characterizing bat roosting habitat, but it is a good indicator. Other trees that are not identified as cull trees during the CFI may also provide roosting habitat, as there could be available roosts higher in the canopy that are not degrading the timber quality (e.g., cracks, holes or breaks in upper limbs) and therefore not documented in the cull tree data. As such, the measurements from the CFI are likely an underestimate of the potential roosting habitat available on the forest.

Staff occasionally salvage dead or dying trees from various areas of the forest, on an as-needed basis. Salvage harvesting varies and is dependent on the density and distribution of salvageable trees. In some cases, the trees are down (e.g., windthrown) and so the harvest activity is not expected to result in the taking of bats. Any harm to bat populations in these instances would have come from the natural disturbance event rather than harvest activity. In the cases where standing dead or dying timber is being considered for salvage, staff will consider the following guidelines to evaluate the availability of suitable roost trees in the area and the benefit of retaining some trees for wildlife habitat. Where available:

- Retain 3 to 7 live roost trees (trees with cavities or broken limbs that provide roosting habitat) per acre in forested areas.
- Retain 25 live roost trees per acre in riparian areas (if available); prioritize dens located more than 20 feet above ground.

Management around Known Maternity Roost Trees

Two maternity roost trees for northern long-eared bats (*Myotis septentrionalis*) were identified on the forest during the planning for Echo Bluff State Park in 2014. Staff visited the two points and believe the individual trees have fallen or decayed beyond useful habitat. However, there are other standing dead trees in the area that could be used by bats. Prior to the next harvest operations, staff will identify a buffer or work with partners to collect acoustic data and determine if northern long-eared bats are still occupying the area during maternity season. Management activities will be adapted accordingly to protect the habitat (see guidelines below).

Other than those two records described above, there are no known maternity roost trees on the forest, as tracking and identifying roost trees requires specialized equipment and skills. Given the large number of bats that hibernate in the Ozarks it is likely that there is summer bat use on the forest. CFI data indicates the forest provides suitable habitat and current management continues to maintain conditions that are beneficial for tree-roosting bat species.

It is an ongoing management goal to pursue additional monitoring and research to identify areas that may have maternity bat use, which would support more effective management around those

areas. If maternity roost areas are identified, they will be managed to prevent take of the species (see guidelines below). Staff will consult with expert advisors to evaluate management needs in the area around roost trees and propose designating these areas as PRAs on the forest. Those areas will be managed to enhance bat roosting habitat, targeting retention of large diameter trees and snags, and providing a continual supply of suitable roost trees.

In areas where maternity roost trees are identified, the following guidelines will apply:

- Do not harvest known roost trees, which should be left to naturally fall to the ground.
- Minimize disturbance within 150 feet of roosts.
- Harvest only in winter.
- Prohibit removal of suitable roost trees during swarming/stage period (Sept 15 – Oct 31, March 15 – April 30)
- Implement prescribed fire only during winter hibernation when roost trees are not occupied.

Prescribed Fire

Prescribed fire is an important habitat management tool for the forest and has indirect positive effects on bat populations by enhancing insect populations, increasing foraging habitat by creating more open understory conditions, and creating roost trees. Fire could also have negative impacts on cave and tree roosting habitats as there is potential for direct adverse effects due to smoke in caves or near roosts. During spring emergence and fall swarming, bats may make use of short periods of torpor to conserve energy on cooler days. If fire occurs during this time, then individuals may not be able to respond quickly enough on cold days to avoid adverse smoke impacts (Loeb and O'Keefe, 2014). Indirect effects include changing the forest structure near cave entrances, consuming roost trees, and snag removal. To continue to provide positive habitat management and avoid negative impacts, prescribed fire operations should adhere to the following guidelines:

- No prescribed fire within a 20-acre buffer around Tier 1 cave entrances or summer roosts when bats are occupying those habitats.
- Prescribed burn plans in the area should take into consideration smoke management techniques to ensure smoke is directed away from cave entrances to minimize potential adverse impacts. Cave and air temperature differential should be evaluated to ensure smoke does not flow into caves on colder days.
- Prescribed fire should avoid the spring emergence and fall swarming seasons (March 15 – April 30, September 15 - October 31). If prescribed fires take place between March 15 - April 30 or September 15 - October 31, then burning on warmer days or during warmer times of the day should help ensure bats are active and able to escape any negative impacts of smoke.
- No mechanically constructed firelines within 100 feet of any cave entrance.

Currently, most prescribed fire activity on the forest occurs far from known cave hibernacula and during the inactive season before spring emergence. The prescribed fire season on the forest is generally concluded by April 1 of each year, thus no direct impacts are anticipated on maternity colonies. The guidelines above should minimize or fully eliminate any adverse impacts on bats from prescribed fire activities.

Training and Coordination

The ecology staff will develop training and tools to facilitate implementation of management guidelines. Training could include use of ESRI mapping to ensure adherence to management guidelines in designated PRAs. Staff will routinely coordinate about harvest operations to ensure sinkhole and cave entrance locations are noted and accommodated during timber marking operations.

Cave Access Restrictions

All caves on the forest are closed to the public. Cave gates exist at select locations and are routinely monitored by cave researchers and qualified volunteers.

Cave monitoring should only be undertaken by qualified research professionals and trained staff or volunteers during appropriate seasonal periods. The forest has a long history of partnership with MDC and CRF. Members of the Missouri Speleological Survey also volunteer their time and expertise to map new cave passages on the forest. Mapping trips are often coupled with biological survey reports, which advances the knowledge of karst resources on the forest. Foundation/Forest staff maintain close coordination with these agencies on cave-related activities. All other parties interested in research should submit an "Application to Conduct Research on L-A-D Foundation Property."

Researchers, staff, and approved visitors to caves on the forest should follow all recommended safety procedures and the most recent recommended decontamination procedures (White-nose Syndrome Disease Management Working Group. 2020. National White-Nose Syndrome Decontamination Protocol – October 2020. www.WhiteNoseSyndrome.org).

Confidentiality

Caves are sensitive habitats and bats are particularly adversely impacted by disturbance. The location and condition of *any* cave on the forest should not be distributed beyond staff, board, and close partners involved in cave monitoring or research. Publications (including social media posts) related to caves on foundation or forest lands should only identify the county, if at all. Names and detailed location information should be excluded from descriptions. Staff should communicate these limitations with partners and volunteers.

The public version of this plan should have cave identifying information removed before distribution.

APPENDIX 2: BAT SPECIES OF CONSERVATION CONCERN

Missouri is home to fourteen species of bats, with five being species of concern due to their federal listing (or anticipated listing) as threatened or endangered species:

- Gray bat (*Myotis grisescens*) - federally listed as an endangered species in 1976
- Indiana bat (*Myotis sodalis*) - federally listed as an endangered species in 1967
- Little brown bat (*Myotis lucifugus*) - under review by the U.S. Fish and Wildlife Service for listing as a threatened or endangered species
- Northern long-eared bat (*Myotis septentrionalis*) - federally listed as endangered in 2022
- Tricolored bat (*Perimyotis subflavus*) - under review by the U.S. Fish and Wildlife Service for listing as a threatened or endangered species

All five of the bat species of conservation concern have been found in caves owned by Pioneer Forest, several of which are routinely monitored by the U.S. Fish and Wildlife Service, MDC and the CRF for bat populations.

There are several important seasons in the life cycle of bats:

- Hibernation – bats enter a state of torpor during the winter; the species of concern addressed in this plan are cave-hibernating bats.
- Staging/emergence – spring activity where bats begin to emerge from hibernacula and use habitat in relatively close proximity to their hibernacula before moving to summer roosts.
- Summer – males and females generally separate into separate roosting habitat; pups are born in maternity colonies and are flightless until July.
- Fall swarming – fall activity where bats begin to return to their hibernacula; mating usually occurs during this time and they use habitat in relatively close proximity to their cave before entering hibernation.
- Migration – migration comprises the movement between winter and summer habitats and bats occupy habitats in a transient manner.

There is variation among species, across geography, and annually due to localized weather conditions in the time when bat activities transition between seasons. April 1 – October 31 is considered the Active Season and November 1 – March 30 is generally the Inactive Season. Table 11 summarizes the estimated transition among seasons for each species. The “shoulder” seasons when bats stage and begin to emerge from their hibernacula and swarm around hibernacula in the fall are considered particularly sensitive because there could be high concentrations of bats in close proximity to the cave entrances. Avoiding direct harm to bats during this time is important. As noted above, the exact timing of staging and swarming will vary from year to year and by species. Generally, March 15 - April 30 and September 15 - October 31 are considered to be highly active times around cave hibernacula and management activities should be avoided in these areas to minimize potential for harm.

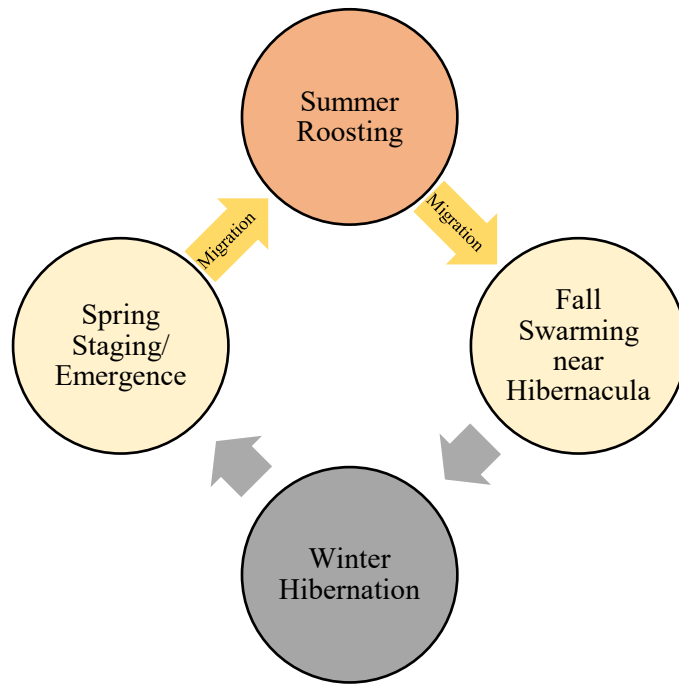


Table 11. Summary of important season in the annual life cycle for bat species of conservation concern.

Month	Gray bat <i>Myotis grisescens</i>	Indiana bat <i>M. sodalis</i>	Little brown bat <i>M. lucifugus</i>	N. long-eared bat <i>M. septentrionalis</i>	Tricolored bat <i>Perimyotis subflavus</i>
Jan	Hibernation	Hibernation	Hibernation	Hibernation	Hibernation
Feb					
Mar	Staging	Staging, migration	Staging, migration	Staging, migration, maternity colony establishment	Staging, migration
April	Transient caves	Migration, maternity colony establishment	Migration, maternity colony establishment		Migration, maternity colony establishment
May	Maternity & Bachelor caves				
June		Pups flightless	Pups flightless	Pups flightless	Pups flightless
July	Transient caves	Maternity colony breakup	Maternity colony breakup	Maternity colony breakup	Maternity colony breakup
Aug					
Sept	Migration to hibernacula	Migration, swarming, breeding	Migration, swarming, breeding	Migration, swarming, breeding	Migration, swarming, breeding
Oct					
Nov	Hibernation	Hibernation	Hibernation	Hibernation	Hibernation
Dec					

The following are important habitat components for the bat species of concern on the forest:

- Cave hibernacula and cave maternity sites
- Swarming and staging habitat between hibernacula and summer roosts

- Maternity roost trees and male roost sites
- Foraging habitat
- Water resources

The specific habitat characteristics needed for each species varies and not all components are provided on the forest. For example, gray and Indiana bats that over-winter in caves on the forest may migrate over 100 miles to their summer roost sites. Below is a brief overview of the major habitat components for each of the five species of conservation concern. This summary relies heavily on the Missouri Bat Habitat Conservation Plan. Please refer to that document and its Appendixes (ICF, 2021) for more detailed information, including threats and population trends.

Gray Bats (*Myotis grisescens*) - Endangered

Gray bats are “cave bats” in the sense that they rely on cave habitat year-round. They are philopatric to both winter and summer caves. Male and female bats share winter hibernacula and will use transient caves in April, but by mid-May are generally found at the maternity or bachelor roost caves. In July and August, both sexes are found at maternity and transient caves. Winter hibernacula are occupied and mating occurs in early fall followed by hibernation in early/mid-November. The distance between winter and summer habitat may be more than 100 miles (Elder and Gunier, 1978).

It is important to consider management actions that could impact hibernacula, especially during the winter, spring, and fall seasons when high concentrations of bats may be present at a single cave. Activities like prescribed fire and harvest can be timed to reduce the likelihood of impacting bats.

Indiana Bats (*Myotis sodalis*) - Endangered

Indiana bats are considered a cave/tree-dependent species, as their habitat varies during the year. They rely on caves during winter hibernation, concentrated tree roosts for summer maternity colonies, and then more dispersed use of woodlands after pups begin flying in July. Mating occurs in the fall during the “swarming” season when bats start to congregate around cave habitats. Hibernation begins in November, when large clusters (250 or more) of Indiana bats form in their cave hibernacula. Emergence from hibernation begins in spring, which can typically occur around mid-March to mid-May. During this time, bats use the habitat near the cave for a few days before migrating to their summer habitat. Females form summer maternity colonies and have strong site fidelity to their selected summer region, making it especially important to ensure a continual supply of usable roost trees are available. Roost trees are typically 9 inches dbh or greater and have loose or exfoliating bark. Trees larger than 20 inches are preferred. Solar exposure is an important factor in roost tree selection. Male bats typically roost in trees during the summer, though some may use caves year-round in a transient manner.

The largest populations of Indiana bats occur in Missouri (USFWS, 2017), which underscores the importance of protecting these sites from disturbance and during the spring and fall swarming seasons when large concentrations of bats are active near the winter hibernacula. Activities like prescribed fire and harvest can be timed to reduce the likelihood of impacting bats. The USFWS prioritized Indiana bat hibernacula based on their current or historical winter population counts.

The forest has three higher priority hibernacula and four other caves that have had detections of Indiana bats in lower numbers.

Little Brown Bats (*Myotis lucifugus*)

Little brown bats are similar to Indiana bats in their use of cave hibernacula in the winter and summer maternity roosts. However, little brown bats are more likely to use anthropogenic structures for summer roosts, in addition to larger trees with exfoliating bark. There is not extensive data on little brown bat migratory patterns in Missouri, but available research suggests that when they disperse from their winter cave hibernaculum, they may migrate relatively short distances to summer roosts. Distances range from 20 to 240 miles away, with the average distance of about 100 miles, but the highest density of summer roosts are believed to be around hibernacula. Males are generally more widely distributed during the summer. Both males and female maternity colonies are often found in anthropogenic structures. Important summer foraging habitat is characterized by more open forested areas in proximity to their summer roost and water sources.

Northern Long-eared Bats (*Myotis septentrionalis*)

Similar to Indiana bats, northern long-eared bats rely on wintertime cave habitat and summer roost trees but can also be found in anthropogenic cave-like structures. They are often found sharing cave hibernacula with other species, but unlike Indiana bats, northern long-eared bats tend to hibernate as individuals in cracks and crevices in caves rather than in dense groups. Northern long-eared bats follow similar patterns of hibernation, spring/fall swarming, and summer maternity roosts with the exception of a period of male swarming in late summer. Similar to Indiana bats, male northern long-eared bats have been found at hibernacula during the summer, but they typically use tree roosts. Female maternity colonies rely on roost trees with similar characteristics as required for other tree-roosting bat species, and they also take advantage of smaller diameter trees and anthropogenic structures. Northern long-eared bats do not have high fidelity to roost trees and will change sites every few days, which has important implications on management to ensure an adequate supply of habitat trees. Overall, northern long-eared bats have a smaller home range than other species.

Tricolored Bat (*Perimyotis subflavus*)

Tricolored bats have similar life cycle stages as the other cave/tree-dependent species. However, one thing that makes tricolored bats distinct from the other species is that they will commonly roost in clusters of dead leaves or other plant material, live tree foliage, on buildings, and use more open habitats. Females will change roosts every few days to another suitable site that is relatively close (within 0.1-mile). Males will roost in similar foliage but are more likely to stay longer at a roost and be closer to the ground (~16 feet) than females. Some males may also use cave habitat year-round. Hibernating tricolored bats are normally found as individuals or occasionally as small groups. Like the northern-long eared bats, they will also use anthropogenic structures for hibernacula. Research indicates that this species likely hibernates in most Missouri caves. They also have the earliest cave entry date (mid-October) and the latest date for moving to summer habitat (mid-April). Tricolored bats travel shorter distances between their winter and summer habitats than other tree-roosting species, with the maximum recorded distance of 85 miles, resulting in smaller home ranges for this species.

Impact of White Nose Syndrome

The decimation of certain species by white nose syndrome cannot be overcome simply through good forest management. However, recognizing the precarious status of these bat species, the importance of healthy bat populations to a fully functioning ecosystem, and the inherent value in supporting healthy, diverse populations of native organisms, it is important to consider how management can be further enhanced to support these significant species.

The endangered Indiana bats and gray bats appear to have been less severely impacted by white nose syndrome. Focusing efforts to enhance habitat for these species may have a greater likelihood of having a positive impact on the recovery of the species than for those that have suffered severe population declines due to white nose syndrome (e.g., >90% declines in populations of northern long-eared bats). While gray bats and Indiana bats have been less impacted than other species, in some areas there have been population declines. Continuing to provide excellent foraging habitat forest-wide through ongoing timber harvest program and making enhancements (as needed) in areas around caves could have a positive impact on these species by ensuring the bats have sufficient resources to survive the winter.

APPENDIX 3: MAPS OF CAVE PRIORITY RESOURCE AREAS

Tier 1 Cave boundaries are approximate until site-specific plans can be developed. The circular buffers around Tier 2 and 3 Caves are expected to be modified to allow on-site adaptive management to topographical features.

Maps of Cave PRAs excluded from this version to protect cave location information.

APPENDIX 4: DESIGNATED PRIORITY RESOURCE AREAS TEMPLATE

SAMPLE TEMPLATE

Area Name: Bluff School Reserve

Desired Condition(s)

Protect and maintain Bluff School, a one-room schoolhouse with wooden frame construction that is representative of many Ozark rural schools.

Site Details

Location (TRS): T31N R6W Section 10

Lat/Long: 37.395959, -91.582938

Acres: 4.4 acres

Description: Bluff School is located past the end of County Road 385A, approximately 50 feet from the Current River. The building is a 32' x 21' wood frame structure on a pier foundation, with four windows on each side wall, a double entry and a central chimney. The building has never had electricity. The exterior is white painted clapboard with a tin roof covering the original shingles. Outhouse foundations are located nearby.

Site History

Designation Date: 1995

Brief History: Around 1940, Missouri ranked third in the nation for its number of one-room schools, and there were more than 75 in Shannon County alone. The date 1920 was written into the entrance step at the entrance to the building. According to a listing of teachers at Bluff School, teaching began here as early as 1928 and continued until 1952.

Natural Features and/or Species of Conservation Concern

The school has several prominent trees near the front steps. No species of conservation concern are noted from this site, as the cultural resource is the primary target.

Conservation and Management

Threats

- | | | |
|---|--|---|
| <input type="checkbox"/> Overstocked | <input type="checkbox"/> Lack of appropriate fire | <input type="checkbox"/> Cedar encroachment |
| <input type="checkbox"/> Non-native invasive species (NNIS) | <input type="checkbox"/> Feral hogs | <input type="checkbox"/> Feral horses |
| <input checked="" type="checkbox"/> Insect infestation | <input type="checkbox"/> Vehicle trespass/damage | <input checked="" type="checkbox"/> Dumping |
| <input type="checkbox"/> Erosion/soil degradation | <input checked="" type="checkbox"/> Other: <u>vandalism, weather and age-related degradation</u> | |

Management Level

- 1 Active management and monitoring ongoing with activities planned in the next 5 years
- 2 Management and monitoring ongoing with activities planned in 5-10 years
- 3 Proposed for management, but additional planning and resources needed to implement
- 4 Monitoring only; no active management anticipated
- NA Not Assigned – a resource level not yet assigned

Management Activities:

- | | | |
|---|--|---|
| <input type="checkbox"/> Timber harvest | <input type="checkbox"/> Prescribed fire | <input type="checkbox"/> NNIS treatment |
| <input checked="" type="checkbox"/> Other (see description below) | | |

Description: Pioneer Forest began working on repair of the school building with assistance from retired Pioneer Forester Russ Noah, later with neighbors the Howells, Back Country Horsemen of Missouri, and three contractors to stabilize the structure and repair vandalism over the years. Ongoing maintenance and repair to the schoolhouse will be needed.

Monitoring

Periodic site visits

Associated Plan Documents

None

Planning Needs

None

Management Partners

National Park Service

Back Country Horsemen of Missouri

Other interested individuals

Recreation

Hiking

Horseback riding

None designated

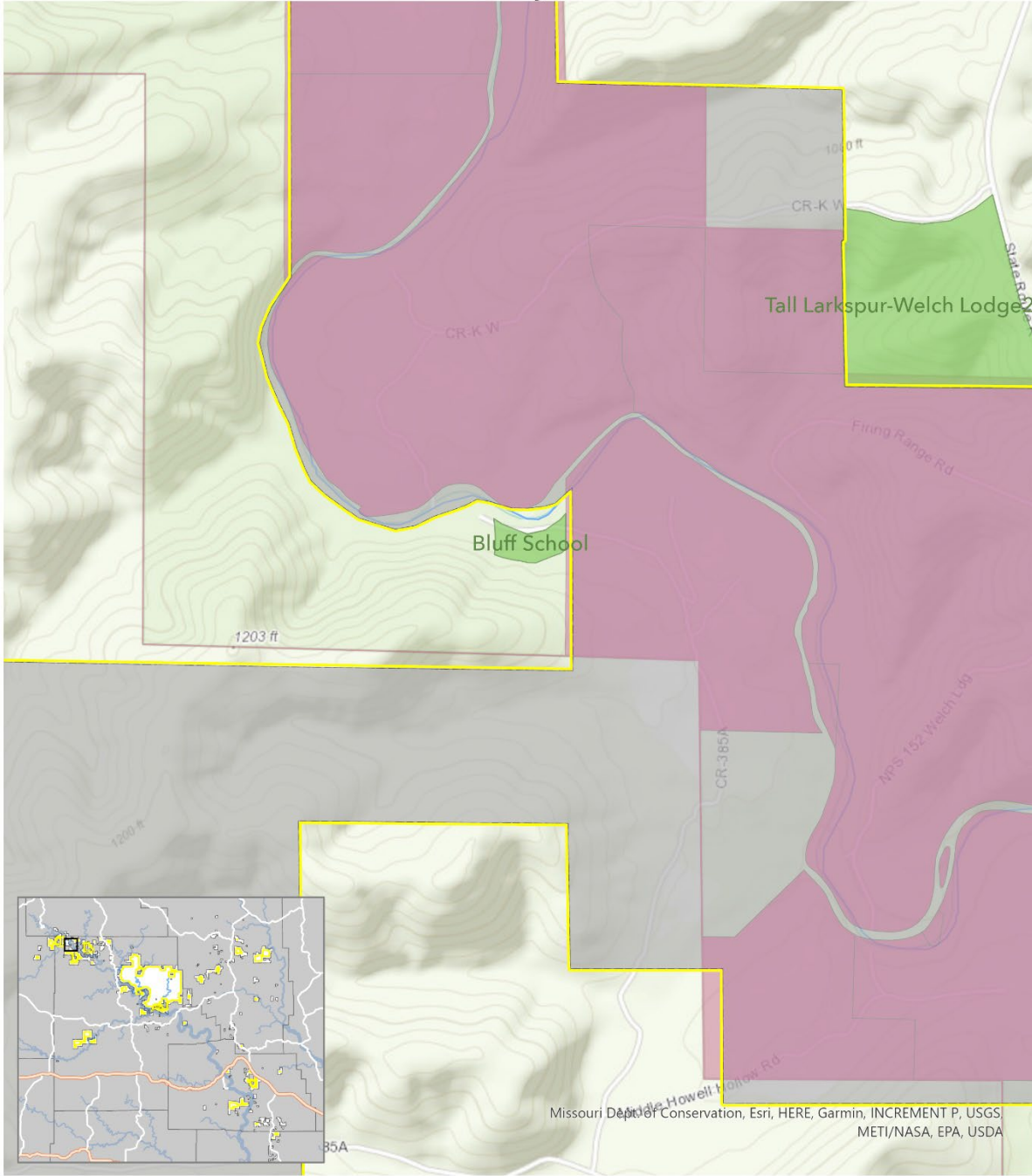
Other: accessible by road, no managed recreation opportunities




Restrictions: _____



Map

Bluff School Priority Resource Area



-  Priority Resource Areas
-  LAD/Pioneer Forest Boundary
-  National Park Service Boundary
-  National Park Service Ownership

L-A-D Foundation
R. Landewe, May 2023