Greater Bonne Femme Watershed Initiative

Wildlife Habitat Restoration Plan

Final | September 2025

Acknowledgments

The Watershed Management Plan's technical advisory teams, comprised of local, state, and federal government and agency partners, as well as local landowners and non-governmental organizations, were instrumental in determining the path forward for drafting and implementation of the habitat plan. The Implementation Committee consists of private-lands professionals and partners who have and will continue to provide support in planning.

Boone County, Missouri, occupies the ancestral, traditional, and contemporary lands of indigenous people. Specifically, it occupies land ceded by treaty in 1808 by the Osage and in 1824 by the Ioways, Sacs, and Foxes. We acknowledge these Indigenous peoples as the original stewards of the watershed and affirm their history and traditions, honor their experiences, and recognize their continued relationship with the land and water.

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1 INTRODUCTION

1.1 Project Context & Purpose

Anyone who explores the diverse habitats of the Greater Bonne Femme Watershed can sense the natural rhythms of the landscape and ecology – they are linked in a dynamic equilibrium. It's more than red-shouldered hawks keeping a keen eye on prairie and pasture, streams slipping underground in pocked karst systems, or bluegill lingering in quiet pools. It's the surge of frogs in spring, warblers gorging on summer insects, and foxes raising kits in predictable rhythms synchronized to the availability of food and habitat. The ecology of the Greater Bonne Femme Watershed reflects its landscape position and the physical processes that shaped it. Together, these elements create a thriving ecosystem that can protect our water quality, sustain agriculture, and drive our economy.

The purpose of a watershed-wide Wildlife Restoration Plan is to support the Greater Bonne Femme Watershed Initiative (GBFWI or the Initiative) by providing a framework to guide landowners in the watershed to improve wildlife habitat on their property. Therefore, this plan is intended to be a resource for landowners as well as decision-makers and practitioners. This document supports that effort by summarizing key concepts, spatial priorities, and technical resources in habitat restoration for Initiative partners, including the Missouri Department of Conservation and wildlife groups. Wildlife habitat restoration is projected to have similar water quality benefits to the installation of agricultural best management practices.

1.2 Intro to Habitat Connectivity & Restoration

The Greater Bonne Femme Watershed's prairie and meadow, rolling hill transitional, bottomland woodlands, and agriculture ecosystems are vulnerable to a multitude of stressors and threats that can compromise their overall health and function, affecting both individual components and overarching processes. Stressors such as invasive species and nutrient overloading can intensify over time and evolve from affecting an ecosystem on the patch scale to a landscape-level threat. Currently, land use change is one of the largest threats to wildlife habitat in the Greater Bonne Femme Watershed. Development, along with its supporting infrastructure, accumulates over time to result in a loss of core habitat areas.

Development also brings specific challenges for streams and waterways. When impervious surfaces (such as roads, parking lots, and buildings) increase and natural vegetation decreases, significant environmental changes to hydrology, water quality, and habitat occur. Increased surface runoff creates rapid rises and falls in water levels and increases erosion and flood risk. Pollution such as oils, heavy metals and fertilizers are conveyed directly into streams instead of filtered through extended contact with soil. Habitat effects include warmer water and eroded channels that are deeper and simpler, and unable to support a full complement of biodiversity.

Responding to threats, the GBFW Wildlife Habitat Restoration Plan aims to conserve and restore a healthy and diverse mosaic of habitat types to protect the biodiversity of the watershed in the context of a changing environment. These are prioritized by their connectivity to adjacent habitat patches.

Habitat management and restoration require the understanding that ecosystems are not closed systems and that flows of energy, materials, and people are constantly being exchanged on the landscape between areas of differing land cover and land use. Generally, the larger the area of contiguous habitat (Figure 1), the more species that habitat can support. Establishing habitat areas that are as large as possible best meets the needs of the broadest possible range of species.

Figure 1. Development leads to habitat fragmentation, which limits the interior core habitats (dark green) available to wildlife.

In an increasingly urbanized and agricultural landscape, where development and infrastructure fragment the habitat, managing and restoring native plant and animal communities requires thoughtful interventions on multiple scales as well as a framework that accounts for the spatial dynamics between habitat areas and other landscape uses. In light of these considerations, this plan relies on three primary principles and goals: minimizing fragmentation, habitat enhancement, and removing barriers to reconnect functional habitat areas.

1.2.1 Habitat Restoration Principles & Goals

Minimize habitat fragmentation

- Create continuity of habitat in privately-owned landscapes to benefit small mammals, reptiles, birds, and insects.
- Prioritize buffer areas adjacent to protected areas and connecting corridors for restoration projects.

Enhance Habitat

- Restore forest, prairie, and wetland habitats that have been degraded or lost due to land use changes.
- Implement management practices that mimic natural disturbances, such as prescribed burns that promote native species and maintain ecosystem health.
- Removal or control of non-native and invasive species which threaten the integrity and function of natural systems and wildlife populations.

Remove barriers & reconnect functional habitat areas

- Enhance living infrastructure connectivity through areas developed for compatible species such as pollinators
    - Increase diversity of flowering native shrubs and forbs that support pollinators and maintain undisturbed nesting sites, such as brush and leaf piles.
    - Protect pollinator habitat from insecticide and most herbicide applications. Consider policy changes to eliminate or restrict the use of non-specific herbicides such as glyphosate in open spaces except as used for restoration.
    - Use native plantings in stormwater management areas to create a connected network of living infrastructure.
- Address aquatic connectivity through culvert retrofits, dam or tile drain removal, or bridge repair for wildlife passage.
- Suggest or mandate green infrastructure practices in new developments that can benefit wildlife, such as maintaining wildlife corridors through developments, wildlife-friendly stormwater management, and site plans that prioritize contiguity and tree preservation.

1.3 Relevant plans and studies

The GBFW figures prominently in several regional planning efforts because of its importance to Boone County residents as an exceptional local landscape. Landscape-level habitat management plans from other communities also provide useful insight into effective habitat management.

1.3.1 Local and Regional Planning

Greater Bonne Femme Watershed-Based Plan 2023

The recent watershed-based plan provides recommendations for best management practices (BMPs) to reduce *E. Coli* in the GBFW, including spatial prioritization and estimated costs. These BMPs are multifunctional, and also reduce nitrogen, phosphorus, and sediment. Some of the BMPs, such as buffers and filter strips, provide habitat restoration benefits, but the recommendations differ in that they are focused on *E. Coli* management without an explicit priority of wildlife habitat connectivity and value.

Our Boone County: Master Plan 2025

Salient recommendations on wildlife habitat from the Our Boone County: Master Plan (adopted June 12, 2025) appear in the Natural Resources (NR) section and include:

- NR. 03 Utilize analysis of habitat cores and hub analysis to prioritize voluntary conservation easement locations.
- NR. 04 Review of zoning, subdivision regulations, and site development regulations, with consideration of an enhanced Sensitive Area zoning overlay in 'Conservation Buffer' land use areas to supplement existing stream buffer, land disturbance, wetland, and sinkhole protections.
- NR. 06 Encourage residential property owners, especially on parcels greater than one acre, to restore or preserve natural habitats instead of having lawns or monocultures.

MO Comprehensive Conservation Strategy

This regularly updated resource from the Missouri Department of Conservation (MDC) identifies priority geographies for conservation at a state-wide level. Designated areas in the GBFW (Figure 2) include the Missouri River corridor and the karst landscapes of Rock Bridge Memorial State Park.

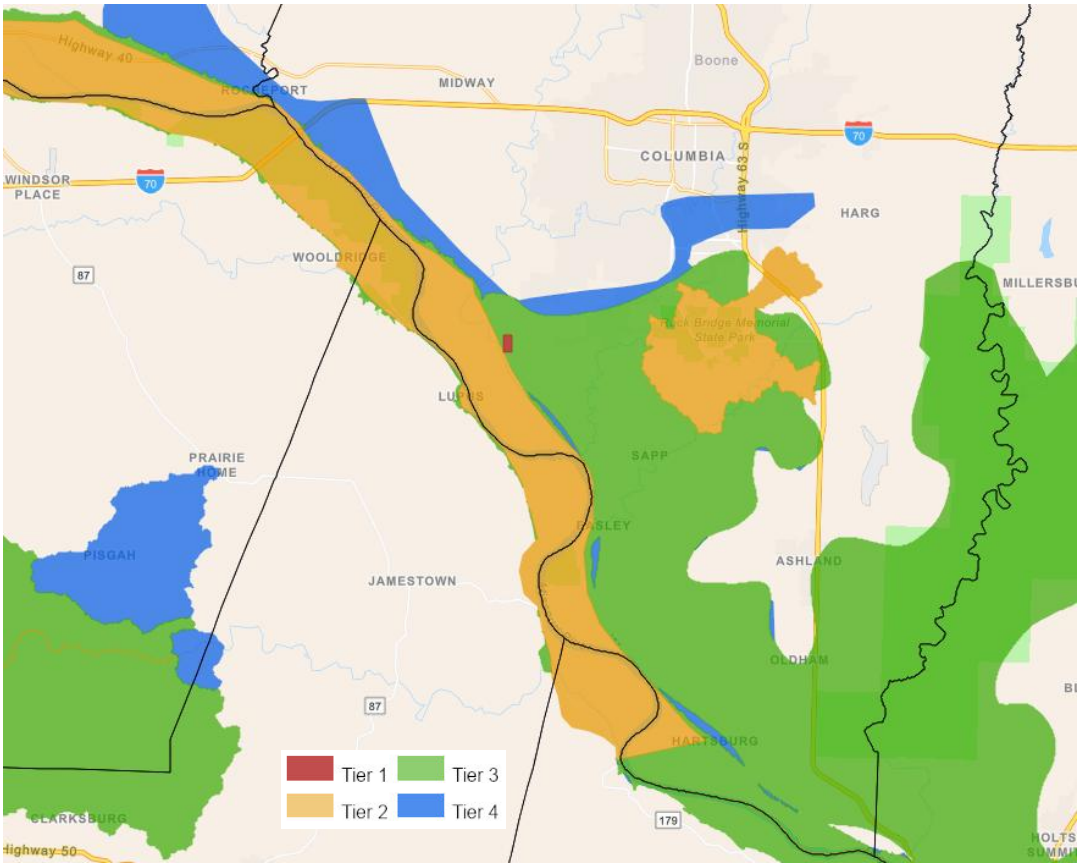

Figure 2. Missouri Department of Conservation Priorities.

1.3.2 Select technical precedents

Lower Meramec River Floodplain Tool & Meramec Watershed Mapping

https://maps.freshwaternetwork.org/meramec-floodplain/
https://www.ewgateway.org/wp-content/uploads/2019/06/MeramecRiverFloodplain-SilverCreekWatershed-1.pdf

The Nature Conservancy's mapping tool provides spatial criteria for prioritizing floodplain protection and restoration based on a combination of water quality, wildlife habitat, and human exposure to flood risk. Some of the pertinent analysis approaches are drawn from EastWest Gateway Council of Governments' planning data for their Ecological Approach to Infrastructure Development initiative, including a spatial layer that considered floodplain patch size, diversity, and landscape context to assign ranks for wetland mitigation and restoration importance.

Delaware River Watershed Business Plan

https://www.nfwf.org/sites/default/files/2023-01/delaware-river-watershed-business-plan-20230123.pdf

National Fish and Wildlife Business Plans provide a concise, multi-year blueprint for achieving conservation outcomes. The Delaware River Program is dedicated to restoring the fish and wildlife habitats and water quality of the Delaware River and its tributaries. It explicitly links habitat restoration to water quality outcomes, for example, by spatially prioritizing high standards for stormwater BMPs according to the presence of wildlife populations of concern.

Ecoregional Conservation in the Osage Plains/Flint Hills Prairie

https://www.conservationgateway.org/ConservationPlanning/SettingPriorities/EcoregionalReports/Documents/final_plan.pdf

Although not primarily focused on water quality, this plan demonstrates a precedent for functional landscapes, collaboration with working lands, and the integration of restoration into agriculture. It also has a good conceptual model (pg 20) of the review of area habitat needs for species in comparison to natural processes, juxtaposing the spatial scales for various conservation targets.

1.4 Plan Timeline and Partners

Boone County worked with its consultant to research and facilitate collaboration for habitat restoration and improvement planning. The joint project kickoff on August 8, 2024, was attended by the broader implementation committee. The Wildlife Habitat Restoration Subcommittee met in mid-September 2024 with representatives of MDC, United States Fish and Wildlife Service, United States Geologic Survey, Quail Forever, and Ducks Unlimited to review data sources and cost-share opportunities. They provided feedback on a preliminary approach to a desktop habitat suitability analysis for habitat restoration techniques with a focus on water quality outcomes and landscape-scale habitat connectivity. Their final meeting in June 2024 reviewed this draft document.

The project team toured the watershed in November 2024 to characterize the typologies of restoration activities among the three habitat typologies of the watershed: prairie and meadow, rolling hill transitional, and bottomland woodlands.

This plan relates to the water quality monitoring program for GBFW, which can help quantify the impact of habitat restoration projects on the instream water quality.

2 NATIVE WILDLIFE HABITAT

2.1 Terrestrial Habitats

Wildlife coevolves with other elements within ecological systems, so understanding the native systems that underlie the watershed today is important to setting restoration goals or targets. Although there are many smaller units, the watershed is divisible into three basic typologies (Figure 3): headwater prairie and meadow, rolling hills and karst transitional, and bottomland woodlands and floodplain ecosystems. The plant and wildlife species described in this section are typical of the natural, intact system, and some are not found in the watershed today. Current and historic plant and wildlife species are useful for setting restoration goals. Indicator species can serve as proxies for system-level functions, such that managing for them means managing for a broader ecological community.

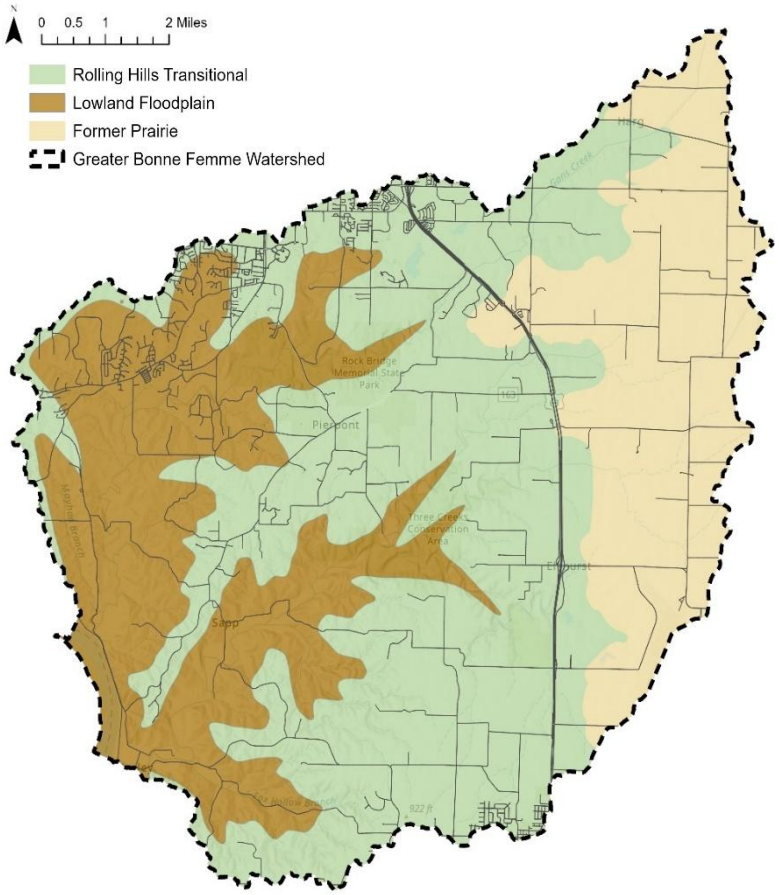

Figure 3. Major Habitats in Greater Bonne Femme Watershed.

2.1.1 Headwater Prairie and Meadow

Historically, most of the agricultural land on the eastern side of the watershed (roughly to the east of Highway 63) was tallgrass prairie, an ecological system that has been converted over 96% of its former extent. Because of the clayey soil, native grasses and forbs were intermixed with wet-tolerant sedges. The historic hydrology was characterized by very shallow drainages and a seasonal high-water table perched on the clayey subsoil. Some depressional areas pond for short periods of time, mostly in the spring. These shallow depressional areas were more common prior to the conversion of nearly all areas of this ecological type from prairie to cropland. Natural drainage systems were modified, or man-made drainage systems were constructed to move water away from production areas. Moving the water quickly off the landscape has changed the stream hydrology, flood risk, and water quality in downstream drainages.

2.1.2 Rolling hills and karst transitional

Historically, this region was oak savanna and woodlands in the uplands, with denser oak and mixed-hardwood forests on valley slopes and bottoms. Some poorly drained, ephemeral wetlands and prairie may have occupied the flatter uplands. Karst areas have soluble limestone or dolomite geology and include caves, sinkholes, underground streams, springs, and losing or sinking streams, which are surface streams that lose all or part of their surface flow to groundwater systems. The central karst area in the GBFW is unique because it was never covered by glaciers. Instead, soils are mostly the material remaining from weathered limestone bedrock. Thin loess covers some ridge tops and uplands. The topography consists of rolling hills with steep slopes, rock outcrops, sinkholes, and more deeply dissected stream valleys. Overall, karst recharge areas can support unique plant assemblages and also tend to be vulnerable to groundwater contamination because surface water rapidly enters the cave system with little or no opportunity for reducing contaminants by surface soils.

2.1.3 Bottomland woodlands and floodplain

Riverfront bottomland forests or riparian forests can be found in floodplains along major river systems and streams. In the GBFW, the flat riverside terrain tends to be punctuated by steeply sloping hills with few rock outcrops. The vegetation communities can have a poorly structured canopy with variable heights and age classes depending on their relationship to recently deposited sediments and organic

materials. The understory is usually sparse and open due to flooding and inundation, and high-velocity overflow creates a scouring effect that can lead to unevenly developed patches of ground flora.

Soil is characterized by wind-blown (loess) deposits from the Missouri River floodplain. This loess is mainly silt.

2.2 Aquatic Habitats

The primary causes of stream channel degradation are changes to the volume and velocity of water entering our waterways. Water that falls on impervious surfaces or is channeled by ditches hits receiving streams, moving quickly and in concerted pulses that scour the streams down and disconnect the stream channel from its natural floodplain. Undersized culverts or bridges can also create backups where the water concentrates into forceful, erosive flows.

Instream or aquatic restoration to address chronic conditions tends to be a more costly and time-consuming process than private landowners are able to undertake. Nevertheless, restoring aquatic conditions and habitat should be an important consideration for road maintenance, bridge repair/replacement, post-flood repair, and capital projects, as well as in negotiating development agreements and approvals with larger landholders. The primary restoration strategies for GBFWI fall into the categories of stream restoration, removing aquatic barriers, and managing existing streams.

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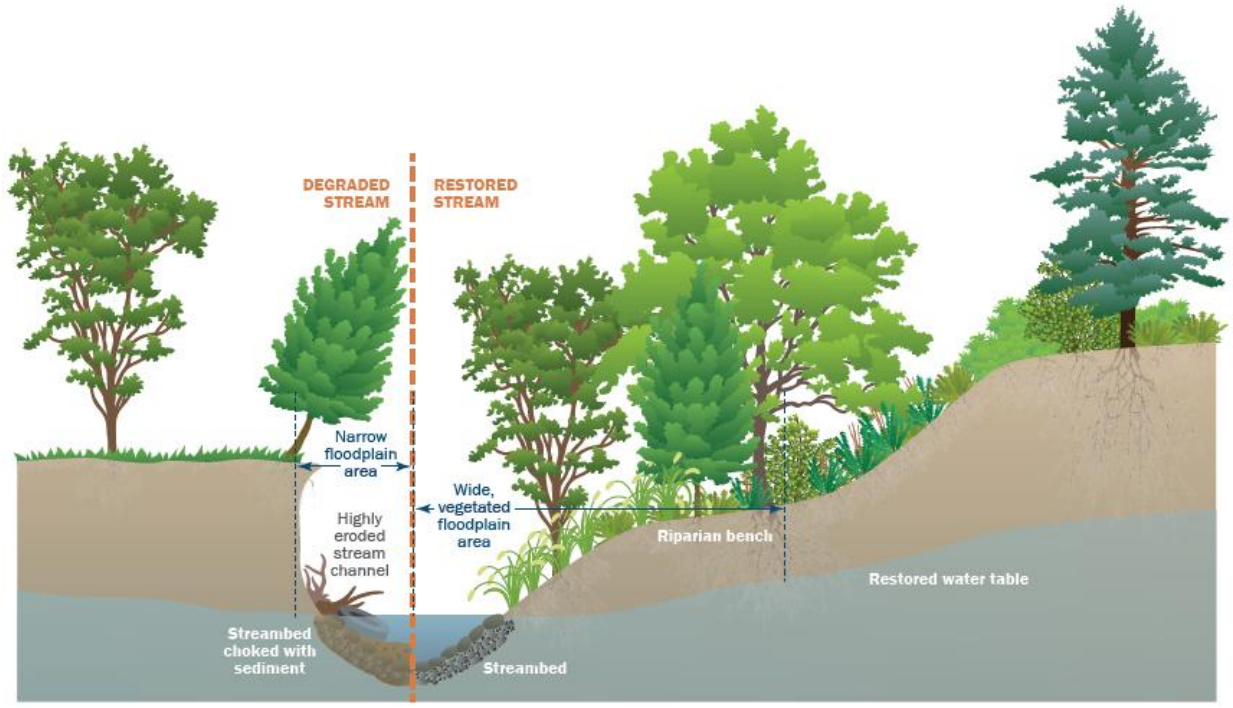

Figure 4. Degraded Streams often have Steep and Eroding Banks because of the Storm Flows.

2.2.1 Stream Restoration and Bank Stability

Stream restoration is an umbrella term for a variety of practices to stabilize eroding banks and reconnect stream channels to their floodplains. Techniques might include anchoring rocks or large woody debris in the channel to slow and diversify flows or recontouring entire banks. The best bank stabilization measures are engineered vegetative, structural, or combination practices designed to reduce further erosion and provide a stable area to establish vegetation. Such measures protect from further erosion losses and water quality impacts of added sediment, particularly agricultural soils, if they have been modified by chemicals.

These approaches must be undertaken with upstream conditions in mind: if large quantities of fast-moving water create problems and those conditions persist, restoration projects may not be successful in the long term.

2.2.2 Removal of aquatic barriers

Most inline dams (e.g., damming a stream to make a farm pond) and low-water crossings prevent the regular movement of aquatic organisms and thereby reduce

habitat quality. Aquatic barriers can also include culverts, bridges and low water crossings that do not span the entire floodway and/or become clogged with debris. Addressing these habitat impairments requires consultation with an engineer or extensionist with expertise in the system.

2.2.3 Debris Management

Clearing all the debris from channels can reduce habitat value and increase velocity. If trees and other natural debris in the stream do not pose an imminent threat to infrastructure in the corridor, it is generally best to leave them alone.

3 HABITAT RESTORATION STRATEGIES

Understanding native habitat typologies and wildlife species inhabiting those systems informs the potential strategies that could be implemented to restore those habitats. Habitat restoration can range in size and scale from small efforts to support native pollinators to large-scale restoration that restores previous hydrologic dynamics. This section provides a menu of habitat restoration strategies for stream buffers, floodplains, and terrestrial systems. A mapping approach (see 3.3.1) was then used to prioritize these strategies within the GBFW and identify areas that could be targeted for implementation.

3.1 Stream buffers and floodplains

Like many rivers in agricultural and developing landscapes, the tributaries of the Bonne Femme Watershed serve as habitat corridors for wildlife where fragmentation frequently dissects available habitat into ever-smaller pieces. Even narrow bands of contiguous forests along waterways are and will be important to wildlife and water quality as development pressures increase. Therefore, establishing and protecting a forested buffer along most of the stream corridor may be the highest priority for restoration and conservation efforts.

3.1.1 Riparian buffers

Riparian buffers of native vegetation are perhaps the most important habitat restoration strategy that is tied to water quality, and a focus of the WBP Implementation effort. Improving buffers where they are limited or absent can render stacked benefits, including wildlife habitat, water quality protection, aesthetic

values, and water volume control. A primary objective of the Initiative is to enhance the riparian corridors of the GBFW and extend narrow tree lines near stream banks.

3.1.2 Floodplain restoration and wetland creation

Flooding is an inherent part of riparian systems but added peaks of stormwater flow from suburban and urban development and intensifying storm events have resulted in an unusual frequency and intensity of flood events in recent years. One result of increased peak flows is that tributary channels are too deep relative to the top of their banks to overtop and reach the floodplain in many areas, so less water is absorbed and stored along the river, resulting in larger events downstream. There are several opportunities in the study area to lay back the bank and create a riparian bench or restore larger floodplain wetland systems. Such restoration projects that re-establish floodplain connection can add water storage capacity and reduce downstream flood risk or at least direct floodwaters to more desirable places that are intended to flood during smaller flood events.

In addition to flood risk reduction, creating or expanding streamside wetlands supports floodplain habitat. Though ephemeral pools were once common in the floodplain, channelization, and incision have greatly reduced the available habitat. Where floodplain-activating flows cannot reach the floodplain, a lower floodplain can be established to offset the vertical difference between floodplain and flow levels, which can then support streamside wetlands.

3.1.3 Enhancing existing wetlands

The key to habitat value in almost any system is complexity. There are a variety of ways to increase complexity in aquatic systems. Increasing water depth in some areas, adding wetland shelves and native riparian vegetation and wetland plants like sedges, rushes, forbs, shrubs, etc. enhance wildlife habitat. Existing stormwater ponds or detention areas can be enhanced for wildlife value. Natural wetlands are often hydrologically altered, so offering more hydrologic support can often improve them. Improving their creek and floodplain connections can increase groundwater elevation and assist in rewetting former riparian wetlands.

3.2 Terrestrial

3.2.1 Headwaters Strategies – Prairie & Pasture

Converting former turfgrass or fescue pasture to diverse native warm-season grassland communities is the most important restoration strategy in the eastern headwaters of the GBFW. Prescribed burning, mechanical tree and brush removal, mowing, haying, and limited herbicide treatment continue to be tools to keep woody vegetation and invasive species at bay. Prairie strips on low-yield agricultural land and along riparian corridors are a special subset of this strategy.

3.2.2 Transition Zone Strategies – Living Infrastructure

The transitional zone has exceptional habitats that are largely protected as state and federal public lands, and the most quickly evolving habitat threat in this area of the watershed is development and land use change. Because of the rapidly expanding footprint of large residential developments, e.g., 3 to 10-acre properties with new single-family homes, homeowner education campaigns (see the Outreach and Communication Plan) and small-scale habitat improvements within developments are the highest priority. Measures such as maintaining or planting riparian buffers, using native landscaping, and incorporating living infrastructure for stormwater management are appropriate for smaller-scale efforts and could be incentivized. These can reduce the severity of habitat fragmentation. Where there are larger properties, particularly those directly adjacent to the existing protected areas, landowners should consider forest management plans or some of the conservation tools, such as conservation easements, that can protect land into the future.

3.2.3 Bottomland Woodland Strategies – Restoring Forest

In the lower flatlands at the bottom of the watershed near the Missouri River, bottomland timber plantings can minimize scour, sheet, rill, and other soil erosion, provide wildlife habitat, promote carbon sequestration, and enhance wetland functions and values. Areas that are prone to flooding, do not produce high-yield crops, or have been taken out of crop production could be targeted for restoration activities on a case-by-case basis.

3.3 Spatial Analysis of Restoration Priority

Geographic Information Systems (GIS) and spatial analysis are essential tools in restoration planning, allowing practitioners to make data-driven decisions by integrating soil types, current land cover, hydrologic conditions, and other factors. By mapping, visualization, and analysis of spatial patterns and processes relevant to ecosystem restoration, - areas where restoration would yield the highest ecological and societal returns can be identified.

3.3.1 Input Layer Methodology

The spatial analysis sought opportunity areas for three major restoration project types: Prairie restoration, Wetland/floodplain restoration, and Stream buffer restoration (of shrubs or trees), and then synthesized the highest priorities in each into a summary map.

Overall Connectivity

Overall connectivity of natural habitats across the watershed were examined ss a basic input to the maps. Nationwide data developed by the Nature Conservancy (TNC) were used to prioritize connectivity across the entire watershed. Areas that had a score of at least 75/100 for their capacity to allow the movement of species of plants and animals across the landscape were mapped. Using a layer of land with high connectivity or within 300 feet of such land, habitat patches that were within half a mile of an intact habitat core, defined as minimally disturbed natural areas at least 100 acres in size, were mapped (Table 1 shows data inputs). The red areas in Figure 5 represent where ecological restoration will most improve connectivity.

Table 1. Defining Connectivity Priority

Habitat Reconnectivity		
Spatial Layers	**Measurements/Criteria/Thresholds**	**Data Sources**
Easily reconnectable Habitat Fragments	Habitat patches separated from habitat cores by <.5 mi with the low-cost surface (<50th percentile) between them. Low-cost surfaces are a spatial analysis tool that shows the difficulty of moving across a landscape.	TNC habitat fragments, Midwest Landscape Initiative, Habitat Cost Surface (ESRI)
Climate Flow Buffer	Areas within 300ft of flow values >75th percentile for climate flow	TNC Climate Flow Data indicates where species are likely to travel

Prairie Restoration

Areas most suitable for prairie restoration are presented in Figure 6. The analysis prioritizes areas without current forest cover that were historically prairie systems on suitable soils, with higher scores for patches that are closer to the existing prairie. Table 2 lists data inputs and sources.

Table 2. Spatial Analysis Criteria for Prairie Restoration

Priority Prairie Restoration Areas		
Spatial Layers	**Measurements/Criteria/Thresholds**	**Data Sources**
Historical Prairie Maps	Areas historically identified as prairie ecosystems, if available	MO Natural Heritage Data
Current Land Cover	Areas currently classified as grassland, pasture, or low-intensity agriculture.	NLCD, USDA NASS CDL
No Trees	Absent of woody vegetation (<25% cell)	USFS forest cover data
Soil Types Suitable for Prairie	Mollisols* (highest suitability), also "Carlow" as dominant soil order	SSURGO Mollisols and MUs with "Carlow" as a dominant component. E.g., 66068: Carlow" silty clay, 0 to 2 percent slopes, occasionally flooded (2533700)
Proximity to Existing Prairies	Within 0.5 mi of existing prairie remnants	MO Natural Heritage Data, Natureserve Priority Conservation Areas (prairie)

** Mollisols are a deep, fertile soil type that develops under grasslands.*

Floodplain and Wetland Restoration

Figure 7 is a map prioritizing floodplain restoration along tributaries in the GBFW in low-lying and unvegetated areas near historic or current wetlands that have hydric soils and lack substantial forest development (data layers and sources are in Table 3). Hydric soils form when there is enough water saturation during the growing season that there is very little available oxygen in the upper layers of soil. This combination of factors may not apply to all the priority sites, but an area of land with more of these features would score as more suitable for floodplain restoration than one with fewer.

Table 3 Spatial Analysis Criteria for Floodplain and Wetland Restoration

Spatial Layers	Measurements/Criteria/Thresholds	Data Sources
Floodplain/wetland		
Hydric Soils	Soils classified as "hydric" or "partially hydric" (Class A or B)	SSURGO
Degraded Wetlands	NWI wetlands within ag lands, urban/developed, grasslands, or barren lands	NWI wetlands within NLCD attributes
Lack of Vegetation	NDVI <0.5. Clip out surface water (surface water will have an NDVI of 0, or close to it)	NAIP NDVI, NHD surface water (or otherwise)
Topographic Depressions (from DEM)	TWI > 10	TWI calc from DEM
Proximity to Existing Wetlands	Within 300 ft of existing NWI wetlands	NWI buffer

Forest Buffer Restoration

Although thoughtful forest restoration anywhere in the historically forested sections of the watershed would be beneficial to wildlife, the highest priorities are the riparian corridors that protect the tributaries and streams of the watershed. Figure 8 prioritizes the buffer areas that do not have current canopy cover according to the state habitat priority scores from the Midwest Conservation Blueprint.

Table 4. Spatial Analysis Criteria for Riparian Buffer Forest Restoration

Spatial Layers	Measurements/Criteria/Thresholds	Data Sources
Forest buffer protection		
Stream Buffers	**50' on class 3, 150 on larger streams**	
No Existing Forest Cover		NLCD
Midwest Conservation Blueprint	Higher scores	

3.3.2 Spatial Prioritization

Figures 5 through 9 depict the prioritization process, beginning with an assessment of overall habitat connectivity, followed by specific priorities for prairie, wetland, and riparian buffer reforestation, and culminating in a synthesized analysis that integrates these four elements.

The overarching analysis of restoration opportunities (Figure 9) is a compilation that weights each of the input layers and adds the overall connectivity enhancement to tell us where, from a species' point of view, ecological restoration would offer the greatest habitat benefits. Connectivity among sites is strongly prioritized for habitat value (as described in Section 1.2).

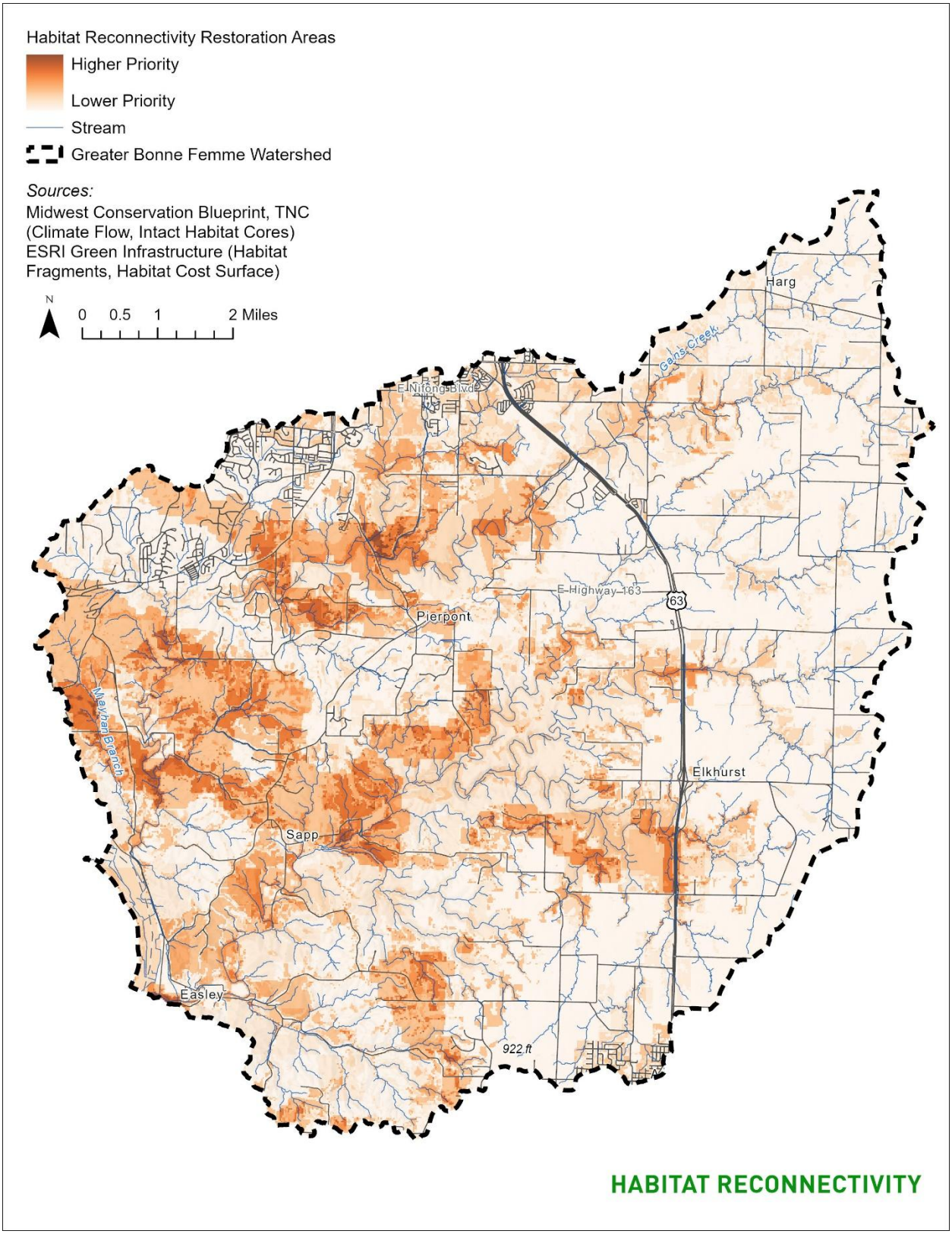

Figure 5. Habitat connectivity is important to each of the restoration strategies.

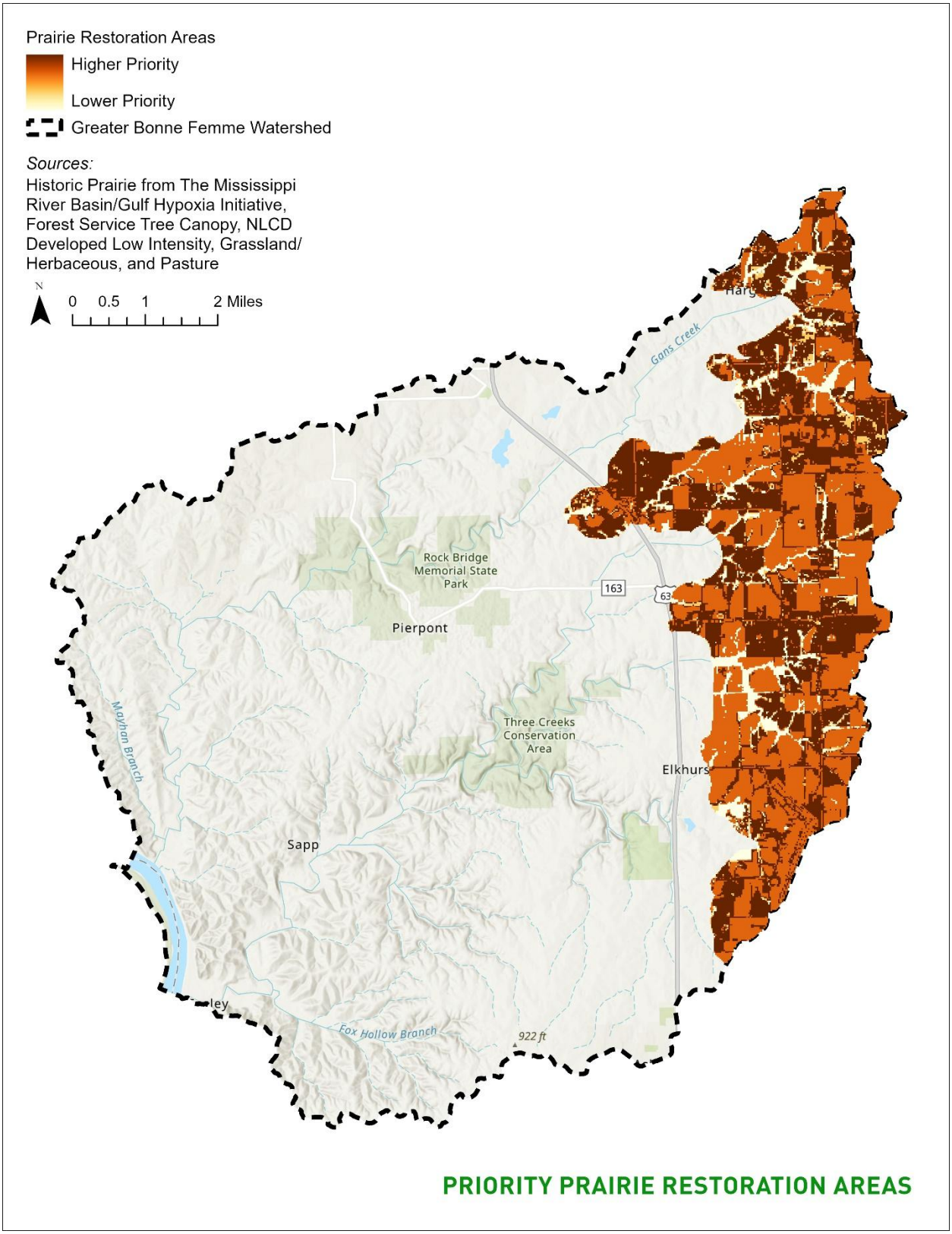

Figure 6. Prairie Restoration Opportunities

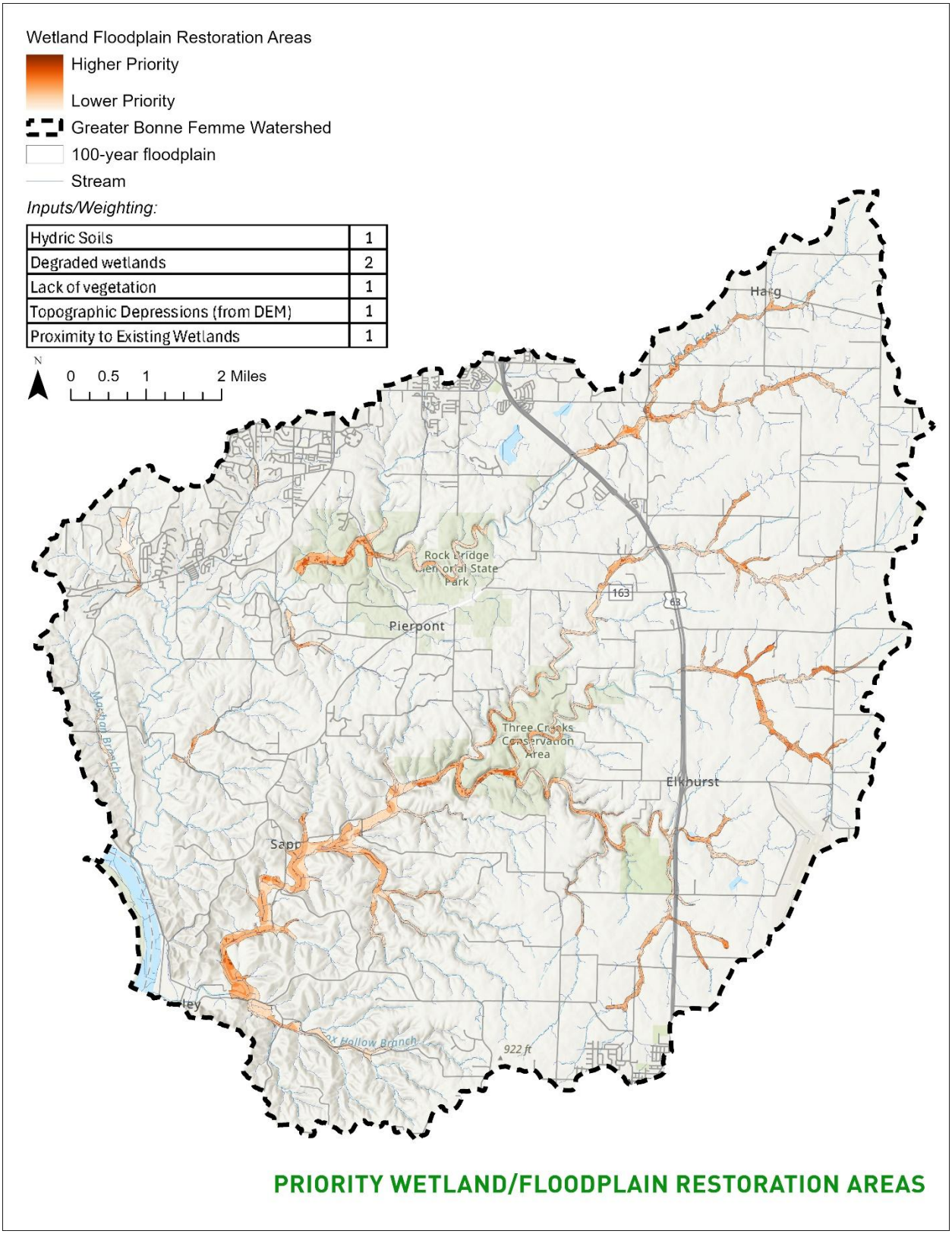

Figure 7. Wetland and Floodplain Restoration Priorities

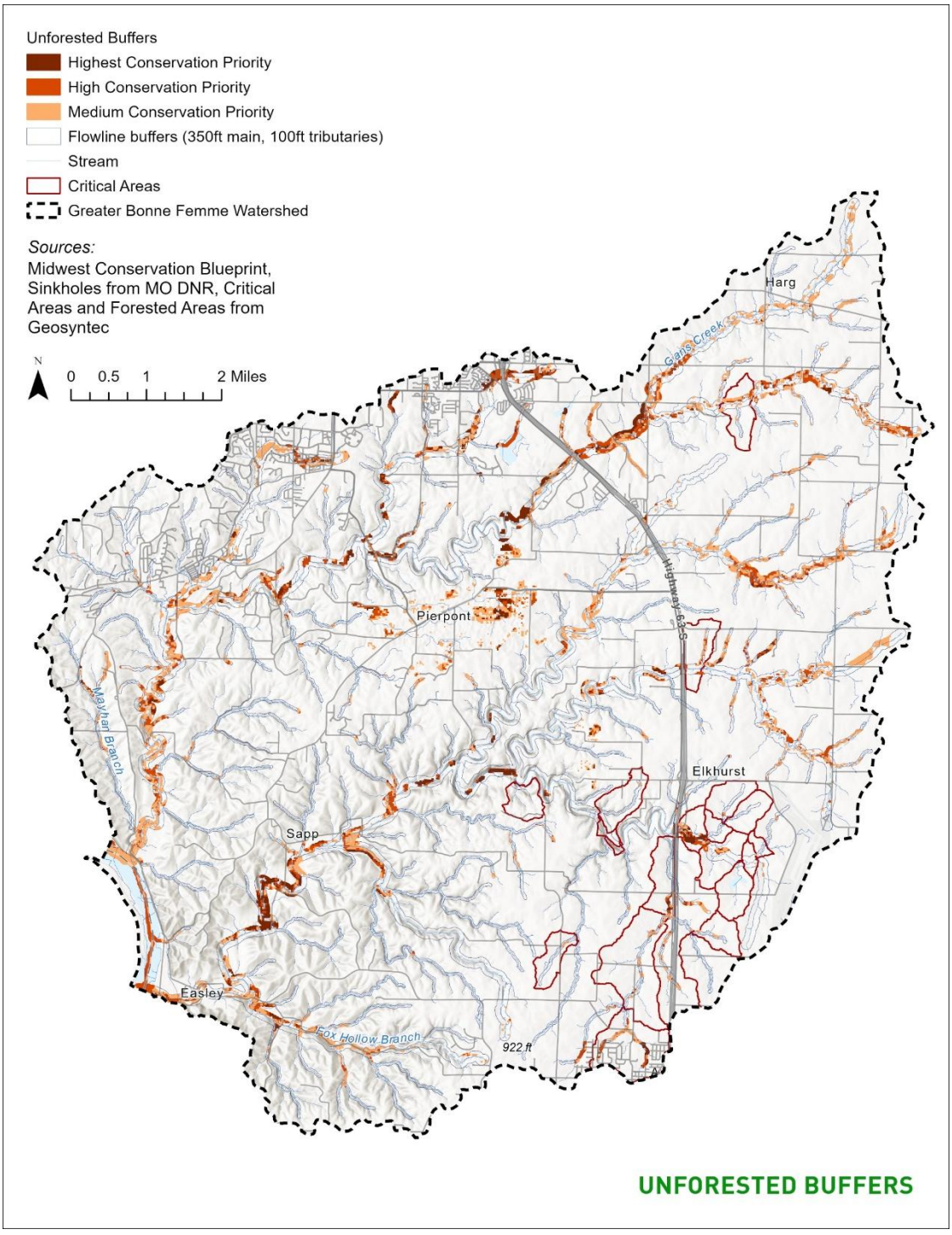

Figure 8. Unforested Buffers Opportunities

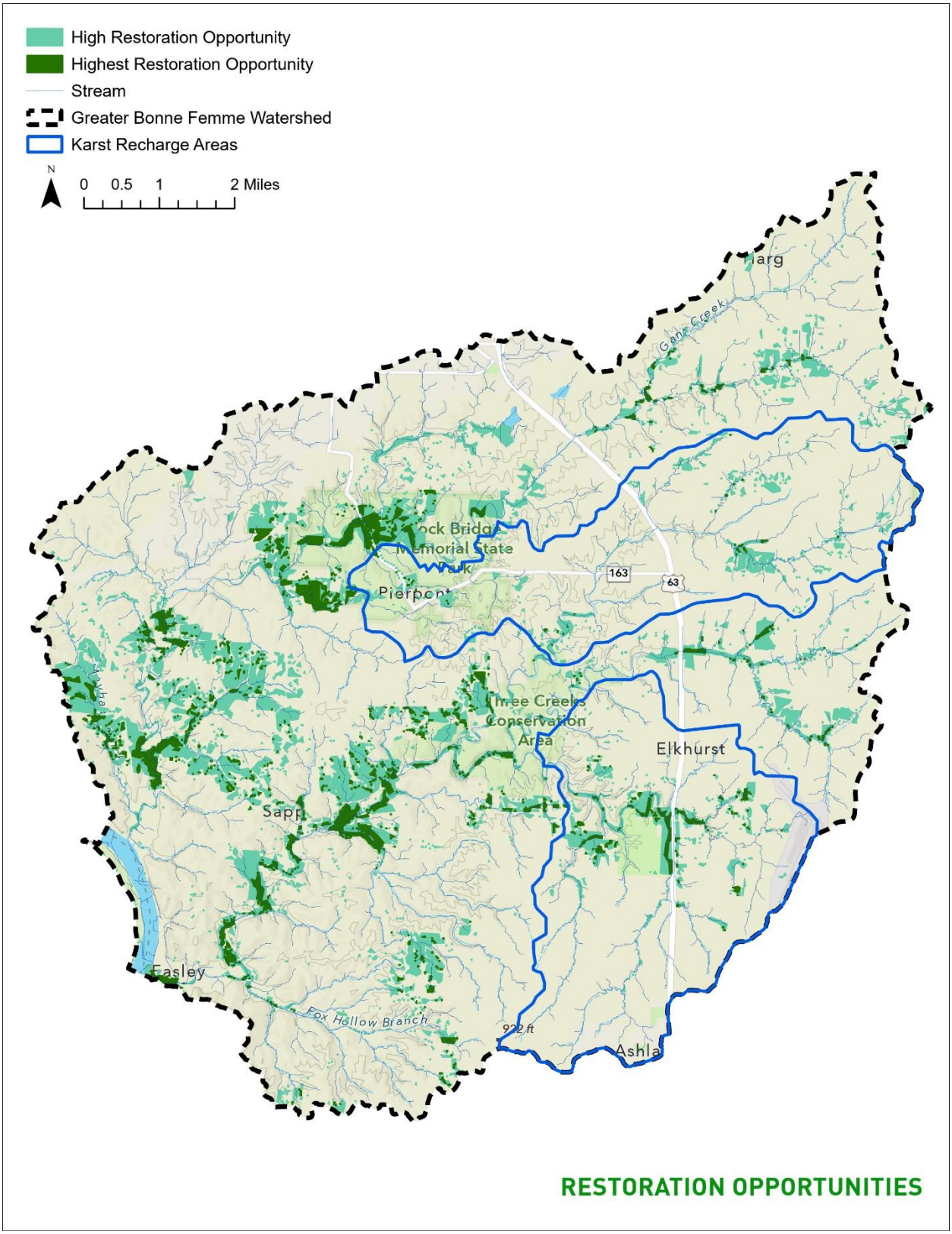

Figure 9. Synthesis of Habitat Restoration Priorities

4 IMPLEMENTATION

4.1 Data and Monitoring

Citizen science and improved wildlife mapping should be used to understand the presence and distribution of wildlife, particularly with regard to indicator species. In addition, a water quality monitoring program should be undertaken to quantify the impact of habitat restoration projects on the instream water quality.

4.2 Internal Planning

Boone County, the City of Columbia, and the City of Ashland should have and maintain a map of ecologically sensitive areas, whether or not they are regulated in any special way, for its own prioritization. Both waterway systems, such as riparian buffers, wetlands, and floodplains, as well as habitat connectivity considerations, should be used to target outreach or programming and perhaps eventually to inform land use, land management, and project planning decisions.

4.3 Conservation Practice and Policy

As code revisions are being considered, the GBFW Initiative partners may find valuable resources at https://sustainablecitycode.org/about and select precedent descriptions. The following list provides a high-level overview of tools and solutions for habitat improvement and restoration.

Design Standards for Wildlife

Special regulations near parks, open spaces, or places with special ecological functions, such as floodplains, are becoming more common. Although this is a habitat restoration plan, thinking about wildlife regulations as part of a larger whole is important, particularly if regulation or code eventually evolves to offer developers "menus" of options for meeting standards for zoning categories or overlay districts. Examples include:

- Wildlife crossings where movement paths intersect roads and culvert designs to facilitate wildlife movement along stream corridors
- Bird-friendly window designs
- Dark sky lighting for facilities and streets

Ordinance-enabled Conservation Tools

Many private land conservation tools, such as some easements and the nationwide Conservation Reserve Program, are private decisions by landowners, but others, such as Conservation Subdivisions or the Transfer of Development Rights, require government action to create the appropriate regulatory environment. These tools are explained to the public in the Boone County Master Plan.

Land Dedications

Ensuring that parks and open spaces remain natural habitats requires specific land dedications that prevent transference of uses or loss of valued resources, protecting the areas in perpetuity. The criteria for designations and types of protections vary by municipality and range from requirements for recreation set asides in developments to watershed protection lands.

Sensitive Wildlife Areas and Enhancements

Extending protection for environmentally sensitive areas to include land adjacent to already protected areas or outstanding state resource waters should be considered. Development standards for habitat protection establish more specific regulatory restrictions near sensitive habitats such as karst. Such "sensitive area" designations are already used in Boone County and elsewhere. Tree protections can be required to protect trees with existing nest sites to prevent the destruction of habitat during off seasons for wildlife.

Buffer Regulations for Wildlife Habitat

Although stream buffer zones are required under existing regulations, establishing riparian buffer zones and standard buffer zones for different habitat types and natural features should be considered. For example, heron rookeries and eagles' nests are protected from disturbance in some municipalities. Enforceable conservation buffers and setbacks between development and sensitive habitats are common tools (more details can be found here https://sustainablecitycode.org/chapter/chapter-1/1-3/)

Vegetation Protection Areas along Stream Corridors

Review opportunities for each GBFWI partner to incentivize improvements to riparian buffers or mandate protection for new developments through ordinance or regulation.

Stormwater Green Infrastructure

Review opportunities for each GBFWI partner to use stormwater management regulations to encourage green infrastructure.

Additional Development Standards – e.g., Native Landscaping

Other programs to consider include homeowner's association policies and standards for supporting native landscapes and preventing requirements for non-functional turf. For more on native plant landscaping enhancements, see examples in Model Landscape Plant Landscape Ordinances https://perma.cc/56VB-VS8C.

4.4 Partnerships and Private Landowner Incentives

Jurisdictions, from the county to the state level, can provide incentives such as offering technical assistance for grant applications, establishing programs that encourage conservation on private lands, providing awareness of existing programs for landowners, and establishing incentive programs such as cost-shares or conservation banking.

Cost-share Opportunities

Cost-share opportunities are a way to incentivize landowners to incorporate restoration strategies into their land management. Landowners can benefit from government programs to pay for or lessen the cost of implementing certain approved practices. In addition, they help landowners overcome financial hurdles during the initial years of investment.

Large land managers can also benefit from cost-share opportunities designed to increase sustainable land use including opening land to public recreation, habitat and vegetation enhancements, and preventing soil and water quality degradation caused by intensive agricultural use.

The following cost-share programs may benefit private landowners, nonprofits, tribes, and certain governmental agencies who wish to fund conservation, restoration, and habitat enhancement projects on their land.

Ducks Unlimited

Conservation Easement Program

- **Benefits:** The Conservation Easement Program offers estate, income, and property tax benefits for landowners who wish to dedicate their land to protecting habitats while continuing to use the area for economic gain or recreation.
- **Eligibility:** Property owners with land that has a valid conservation purpose as defined by Internal Revenue Code Section 170(h)(4)(A), where the land is reserved for preservation for outdoor recreation or education for the public, contributes to protecting habitats, or preserves open space.
- **Additional Information:** https://www.ducks.org/conservation/land-protection/ducks-unlimiteds-conservation-easement-program

Missouri Department of Conservation (MDC)

Landowner and Community Assistance Program (LCAP)

- **Benefits:** The LCAP program offers a 75% cost-share for grass/forb establishment and flat rate payments for site preparations needed to establish pollinator habitats on a variety of ecological sites if they are in MDC Tier 2 geographies. Cost share in Tier 3 areas is approximately 50% (see Figure 2). Assistance to agricultural producers who want to increase biodiversity on farmland is also offered in the form of flat rate payments on alternative watering systems, fencing, and deferment payments when incorporating native warm season grass/forb mixtures into their conservation plan. Flat rate payments to manage existing habitats through burning, disking, or herbicide treatments and to establish pollinator-friendly trees and shrubs are also available.
- **Eligibility:** Available on request. First come, first served to any Missouri landowner with exceptions, including city and county units of government, other political subdivisions, and NGOs. Applies to any MDC cost-share practice implemented by itself or combined with any other practice(s) to meet identified conservation priorities as determined by the conservation planner.
- **Additional Information:** https://moformonarchs.org/wp-content/uploads/2020/10/Brochure_Missouri-Dept-of-Conservation_v2-Web.pdf

Missouri Community Conservation Cost-share

- **Benefits:** Cost-share program designed to promote sustainable development practices and the establishment of natural resource conservation practices in municipal and developing areas.
- **Eligibility:** Proposed projects may be reviewed as needed by the Regional Community Conservation team based on regional priorities. Eligible property includes public lands in public ownership or open to the public, as well as private property that extends or connects to projects on public land providing stormwater conveyance, habitat connectivity, or other public benefits.
- **Additional Information:** https://mdc.mo.gov/community-conservation/community-conservation-funding-opportunities

Missouri Outdoor Recreational Access Program

- **Benefits:** $15-$25 an acre per year in the form of annual payments. Land offers are evaluated and ranked based on access type, amount of quality habitat on the land, proximity to major metropolitan areas or other priority geographies, planned habitat improvements or conservation practices, size of parcel offered, and availability of other public lands in the local area. The standard commitment period is three years. Participants are also eligible for enhanced cost-share incentives of up to 90 percent to complete planned habitat practices.
- **Eligibility:** Any Missouri landowner, regardless of legal residence, is eligible to participate if the property is under the ownership and control of the applicant or legal representative and the land has a public road frontage to allow for legal access to the property by the public for taking game species. Land offers must be at least 40 acres contiguous in size, and at least 20 percent of the tract must provide quality habitat. Offers for wildlife viewing access must be at least five contiguous acres and contain unique habitat features. Offers are considered on a case-by-case basis.
- **Additional Information:** https://mdc.mo.gov/your-property/missouri-outdoor-recreational-access-program-mrap

Natural Resource Conservation Service (NRCS)

Wetland Reserve Easement – MO

- **Benefits:** Permanent Easements – Permanent easements are conservation easements in perpetuity. NRCS pays 100% of the appraised easement value for the purchase of the easement. Additionally, NRCS pays between 75 to 100 percent of the restoration costs.
  30-year Easements – 30-year easements expire after 30 years. Under 30-year easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.
  Term Easements - Term easements are easements that are for the maximum duration allowed under applicable State laws. NRCS pays 50 to 75 percent of the easement value for the purchase of the term easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.
  30-year Contracts – 30-year contracts are only available to enroll acreage owned by Indian tribes, and program payment rates are commensurate with 30-year easements.
  Appraisals are required for proposed easements. Compensation will be 95% of the appraised Fair Market Value, not to exceed $5,000 per acre.
- **Eligibility:** Owners of privately held land, including land held by American Indian tribes. All landowners who meet the adjusted gross income (AGI) limitations, including all members of landowner-legal entities and those compliant with the Highly Erodible Land and Wetland Conservation provisions of the Food Security Act of 1985.
  Land eligible for wetland reserve easements includes privately held farmed or converted wetlands that were previously degraded due to agricultural uses and can be successfully and cost-effectively restored. NRCS will prioritize applications based on the easement's potential for protecting and enhancing habitat for migratory birds and other wildlife.
- **Additional Information:** https://www.nrcs.usda.gov/programs-initiatives/wre-wetland-reserve-easements/missouri/wetland-reserve-easement-mo

Conservation Stewardship Program - MO

- **Benefits:** (1) Annual contract payments, which are based on two components: Payments to maintain the existing level of conservation based on the land uses included in the contract. Payments to implement additional conservation practices and activities. (2) Supplemental payments for producers willing to implement a resource-conserving crop rotation, improve an existing resource-conserving crop rotation, or implement advanced grazing management. (3) Minimum contract payments for most contracts.
- **Eligibility:** Eligible lands include private agricultural lands, agricultural Indian lands, nonindustrial private forest land, farmsteads, associated agricultural lands, and public land that is under the control of the applicant and part of their operation. There is no minimum acreage requirement. CSP enrolls your entire operation into the program, not just one specific field or tract. All land must be in compliance with USDA highly erodible land and wetland conservation provisions to be eligible for CSP.
- **Additional Information:** https://www.nrcs.usda.gov/programs-initiatives/csp-conservation-stewardship-program/missouri/conservation-stewardship-program

Environmental Quality Incentives Program (EQIP)

- **Benefits:** (1) Annual rental payments, based on soil productivity and the average cash rental rates in the county. Cost-share assistance is also available for up to 50% of the cost of establishing approved conservation practices.
- **Eligibility:** Agricultural producers and landowners with environmentally sensitive land that meets specific criteria related to cropping history and environmental characteristics are eligible. Applicants must demonstrate the potential for significant environmental benefits through the implementation of conservation practices.
- **Additional Information:** https://www.fsa.usda.gov/resources/programs/conservation-reserve-program

US Department of Agriculture Farm Service Agency (FSA)

Conservation Reserve Program

- **Benefits:** (1) Financial assistance for practices may be available through EQIP. Some producers may also qualify for advance payment. (2) Technical assistance to plan, design and implement conservation practices or develop conservation activity plans.
- **Eligibility:** Qualified landowners as determined by site visit with conservation planner.
- **Additional Information:** https://cra.missouri.edu/environmental-quality-inventive-program-eqip-usda-nrcs/ and https://www.nrcs.usda.gov/programs-initiatives/environmental-quality-incentives-program

US Fish and Wildlife Service

National Fish Passage Program

- **Benefits:** The program provides technical expertise, financial assistance, and coordination support to complete aquatic ecosystem restoration projects. Projects may include physical barriers such as dams, culverts, inefficient fishways or hydrologic barriers like inadequate flows or water quality issues. The service aims to prioritize a 1:1 match requirement but does not require a match.
- **Eligibility:** Open to all entities, including, but not limited to, federal and state agencies, NGOs, tribes, and private landowners. Service regions implement the program according to both national guidance criteria and regional priorities.
- **Additional Information:** https://www.fws.gov/page/national-fish-passage-programs-bipartisan-infrastructure-law-2024-funding-opportunity-guidance

Partners for Fish and Wildlife Program

- **Benefits:** This program provides free technical and financial assistance to landowners, managers, tribes, corporations, schools and nonprofits interested in improving wildlife habitat on their land. Custom habitat restoration projects are focused on areas of conservation concern, such as upland forests,

wetlands, native prairies, marshes, rivers, and streams. Projects are voluntary and customized to meet landowners' needs. Participating landowners continue to own and manage their land while they improve conditions for wildlife.

- **Eligibility:** All private landowners interested in restoring wildlife habitat on their land are eligible to participate. Priority goes to projects judged likely to provide habitat for rare, threatened and endangered species. Projects have a minimum duration of 10 years. Participating landowners do not forfeit any property rights and are not required to allow public access.
- **Additional Information:** https://www.fws.gov/program/partners-fish-and-wildlife

The Bee & Butterfly Habitat Fund

Seed-A-Legacy Program

- **Benefits:** The program provides free seed and technical guidance to ensure project success in establishing high-quality pollinator habitats.
- **Eligibility:** Landowners and land managers that have at least 2 acres.
- **Additional Information:** https://www.beeandbutterflyfund.org/seed-a-legacy-program.html

Missouri Department of Natural Resources (MoDNR)

Nutrient Pest Management

- **Benefits:** Incentive to encourage the adoption of a nutrient management or pest management plan designed to protect water quality by encouraging the adoption of new management techniques for applying fertilizers and pesticides or herbicides on agricultural land. Funds are requested based on the number of acres that need a management plan applied. Cost-share assistance may supplement federal cost-share funding for a practice only if combined federal and state funding does not exceed 75% of the estimated cost of the practice.
- **Eligibility:** This applies to lands where plant nutrients (commercial fertilizers and/or manure) have been improperly applied, and the cooperator is utilizing a new approach in the application of nutrients. The land must be eroding at or below the tolerable soil loss level.

- **Additional Information:** https://dnr.mo.gov/land-geology/businesses-landowners-permittees/soil-water-conservation-cost-share-practices/nutrient-pest-management

Sheet, Rill, and Gully Erosion

- **Benefits:** Approved practices for protecting the soil from runoff to stop potential land degradation and assist with water quality protection. Cost-share assistance may supplement federal cost-share funding for a practice only if combined federal and state funding does not exceed 75% of the estimated cost of the practice. Funds are requested based on either the total number of acres treated in the field or the total number of gullies treated.
- **Eligibility:** Practice is eligible for cost-share based on sheet and rill erosion or ephemeral gully erosion. Erosion must be in excess of tolerable soil loss. Post-installation erosion rates must be less than pre-installation erosion rates.
- **Additional Information:** https://dnr.mo.gov/land-geology/businesses-landowners-permittees/soil-water-conservation-cost-share-practices/sheet-rill-gully-erosion

Woodland Erosion

- **Benefits:** Funds are requested to treat the number of woodland acres that need protection from sheet and rill, or gully erosion. Cost-share assistance may supplement federal cost-share funding for a practice only if combined federal and state funding does not exceed 75% of the estimated cost of the practice.
- **Eligibility:** Practice is eligible for cost-share based on sheet and rill erosion or ephemeral gully erosion. Erosion must be in excess of tolerable soil loss. Post-installation erosion rates must be less than pre-installation erosion rates.
- **Additional Information:** https://dnr.mo.gov/land-geology/businesses-landowners-permittees/soil-water-conservation-cost-share-practices/nutrient-pest-management

4.5 Potential Focal Areas

4.5.1 Headwaters: Upper Gans Creek

Upper Gans Creek, east of Highway 63, was a high priority for riparian buffer and restoration work, according to the spatial analysis. This is the site of upcoming test and demonstration restoration projects in collaboration with the University of Missouri. This and subsequent projects could be an important site to visit for prospective landowner partners.

4.5.2 Headwaters: Near Airport

Between Columbia Regional Airport and Hwy 63, several subwatersheds were identified as having the highest importance in the 2023 Watershed-Based Plan, and they also ranked highly for having unforested buffers. Nearby, the wetlands along Bass Creek ranked highly in the wetland restoration analysis.

4.5.3 Transitional: Nature School and Middlebush Farm

The restoration that has been initiated at the Nature School property could be extended with attention to wildlife corridors and protecting streams as a demonstration. This area might also provide an opportunity to pilot better utility corridor management with native species.

4.5.4 Transitional: Smith Hatchery Road

Rapid development on converted farmlands presents an opportunity to reach out to landowners to investigate the feasibility of conversion to native habitats.

4.5.5 Bottomlands: Easley

The rich, flood-prone bottomlands near the confluence with the Missouri River tend to have unforested riparian buffers, so incentivizing riparian corridors should be a consistent management strategy.

5 ADDITIONAL RESOURCES

Spatial Data Acronyms and Definitions

DEM (Digital Elevation Model) – A representation of the Earth's surface topography, typically in raster format, showing elevation data.

ESRI (Environmental Systems Research Institute) – A leading provider of Geographic Information System (GIS) software, tools, and spatial analysis solutions.

Habitat Cost Surface – An ESRI product spatial model that quantifies the difficulty or "cost" for wildlife to move through a landscape based on habitat conditions and barriers.

Midwest Landscape Initiative – A collaborative effort focused on landscape-scale conservation planning and ecosystem management in the Midwest region.

MONHP (Missouri Natural Heritage Program) – A program that collects and maintains data on Missouri's biological diversity to support conservation planning and decision-making.

NAIP (National Agriculture Imagery Program) – A program managed by the U.S. Department of Agriculture's Farm Service Agency that acquires aerial imagery during the agricultural growing seasons in the continental United States.

Natureserve Priority Conservation Areas – Areas identified by NatureServe as critical for biodiversity conservation based on ecological assessments and species data.

NDVI (Normalized Difference Vegetation Index) – A remote sensing metric that measures vegetation health and biomass using satellite imagery.

NHD (National Hydrography Dataset) – A dataset that provides detailed information on surface water features such as rivers, lakes, and watersheds in the U.S.

NLCD (National Land Cover Database) – A comprehensive land cover classification dataset that maps land use and land cover changes across the U.S.

NWI Wetlands (National Wetlands Inventory) – A database of wetland locations and characteristics in the U.S., managed by the U.S. Fish and Wildlife Service.

SSURGO (Soil Survey Geographic Database) – A detailed soil database managed by the USDA NRCS, providing high-resolution soil mapping for conservation and agricultural planning.

TNC (The Nature Conservancy) – A global environmental nonprofit organization focused on land and water conservation.

TWI (Topographic Wetness Index) – A hydrological index used to predict areas of soil saturation and potential wetland locations based on terrain data.

USDA NASS CDL (United States Department of Agriculture National Agricultural Statistics Service Cropland Data Layer) – A geospatial dataset mapping annual crop types across the U.S. based on satellite imagery and survey data.

USFS forest cover data (United States Forest Service Forest Cover Data) – A dataset providing information on forest extent, type, and density across U.S. landscapes.