

Garrison Spring Community Forest Management Plan

A Partnership Between:

**City of Ozark, Missouri
James River Basin Partnership
Watershed Conservation Corps**

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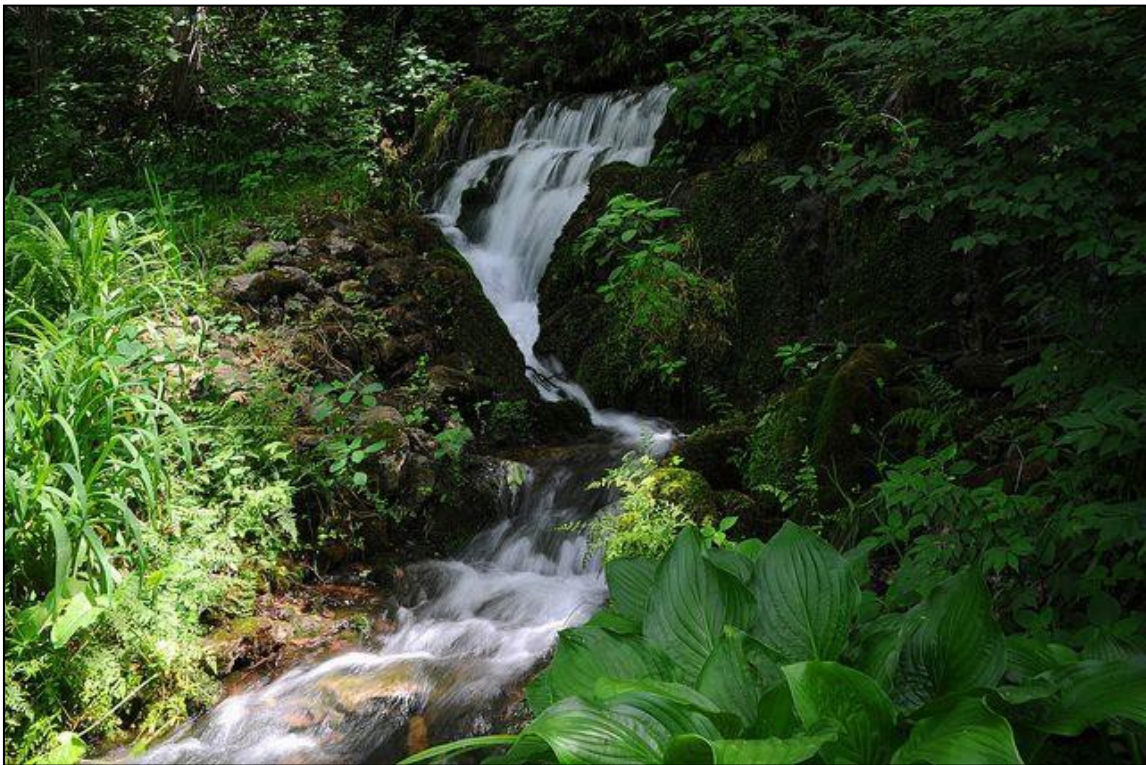
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Project Introduction

Garrison Spring and Gardens was recently purchased by the city of Ozark, with aid from the Missouri Department of Conservation and U.S. Forest Service, with the goal of developing and managing a park that offers visitors an up-close experience with the native ecosystems and geologic features of the Ozarks. The park also provides guests with cultural and historical aspects of the landscape and region. The city of Ozark has solicited the James River Basin Partnership (JRBP), a 501(c)3 non-profit organization, whose mission is to “improve and protect the water quality of the springs, streams, rivers, and lakes in the James River watershed,” to develop a management plan for the site. Garrison Spring Branch, which flows directly through the park, discharges into the Finley River only a mile downstream, which then is discharged into the James River only 10 miles southwest of Ozark near Jamesville, Missouri.

The James River Basin Partnership has subcontracted the Watershed Conservation Corps (WCC), an entity of Watershed Committee of the Ozarks, another local 501(c)3 organization, to provide site evaluations and ecological recommendations for this management plan. The goal of the WCC/JRBP management plan is to provide the city of Ozark a comprehensive ecological profile of the site, a list of opportunities for community involvement, and conservation recommendations intended to guide the current and future stewardship of the Garrison Spring property.



Garrison Spring in 2021

Cultural Significance

Garrison Spring in Ozark, Missouri, discharges from a wooded hillside and flows west before emptying into the Finley River. The spring branch's base flow is supported by the discharge from Garrison Spring. Intense rainfall and precipitation events around the Ozarks lead to rapid increases in stream flow, which causes seeps and springs to constantly alter in flow magnitude. Factors such as topography, soil type, and geological components affect water runoff and infiltration rates, which ultimately affects groundwater and spring discharge.

Garrison Spring Branch flows through the park and previously supplied drinking water for the railroad and some Ozark residents. It was slightly impounded by hand-built dams during the early 20th century, but those structures have long weathered and provide little to no resistance to the current today. Downstream of the park, the branch discharges into the Finley River south of Finley River Park. The stream is less than two miles in total length from the cave to the river. While the watershed of Garrison Spring Branch is relatively small in area, its landscape and aesthetic beauty have been a focal point of outdoor recreation in Ozark for over five decades.

Garrison Spring is a beautiful, natural landmark with a history intertwined with that of the city of Ozark as a whole. The area near Ozark was first described by Henry Schoolcraft in the journal he kept during his 1818 geological expedition. Surveys of the land began in 1835, the first inhabitants arrived in 1840, and Ozark was established in 1843. Christian County was incorporated from parts of Greene and Taney counties in 1859, named after Christian County, Kentucky.

Garrison Spring once served as an important source of water to the citizens of Ozark. Drinking water for the school was collected from the nearby springs. A small but rich lead mine was erected in 1869, and most of the material mined was washed in the Garrison Spring. A railroad connecting Springfield to Ozark was finished in 1881. In 1899, a new hydraulic pump was added to the spring to direct water where needed, including to the Frisco Railroad depot to give their engines steam. John Robertson, an Ozark businessman, had owned the springs temporarily around 1920 when he installed retaining walls to create the Robertson Bass Lakes. The dams, although they are in poor condition, still exist on the property today.

The Garrison family arrived in the 1840s and owned many acres of land in Ozark and the surrounding areas. A house was built near the spring, and the area there became a popular gathering place for the people of Ozark. One of the largest meetings at the site took place in 1880, when over 2,000 people attended a political rally. The Garrisons lived on the property for decades, until Mike Garrison sold the land in the early 1990s to Ernest and Mary Lou Braswell. The Garrison house on the property burned down soon after the sale, but the Braswells rebuilt it close to the original design. Though the property was privately owned, the Braswells allowed the public to visit their property and enjoy the spring. Thanks to their hospitality and continued care for the grounds, Garrison Spring remained a local attraction. The City of Ozark purchased Garrison Spring from the Braswells in 2020 with the intent to preserve the community and ecological values of this unique property.



John Robertson holding a stringer of bass from the ponds at Garrison Spring



Garrison Spring has been a local place of gathering for over a century.

Sources: White River Valley Historical Quarterly, Ozark, and Vicinity in the 19th Century by William Neville Collier <https://thelibrary.org/lohist/periodicals/wrv/v2/n10/w66f.html>
Unlock the Ozarks, Schoolcraft's Ozark Journey <http://www.unlocktheoazarks.org/early-explorers-and-settlers/schoolcraft/near-ozark/>
Ozarks Independent, City of Ozark Acquires Garrison Spring Garden and Park by Samantha Payne <https://ozarksindependent.com/2021/03/23/city-of-ozark-acquires-garrison-spring-garden-and-park/>

Forest Management Objectives

The goal of this document is to create a scientifically informed and sustainable forest management plan that enhances the overall resilience of the forest, in such a way that protects wildlife habitat and water quality, while promoting recreational activities within the park. Garrison Spring should be a landscape that marries the ideas of access for public recreation and natural resource conservation. The following objectives are desired for the park:

1. Create opportunities for forest-based experiential learning and forest stewardship education for students and the community.
2. Develop a stewardship plan for the forested areas of the park to ensure a sustainable forest with adequate levels of reforestation and regeneration of dominant hardwood species.
3. Improve bank stabilization of the park with additional plantings, buffer zone establishment, and monitoring.
4. Promote the retention of woody material (slash, coarse woody debris, snags, etc.) to provide soil protection and to improve future infiltration and water storage properties of the soil.
5. Identify areas that should be left to grow wild, allowing natural processes to take their course, while ensuring the safety of park visitors.
6. Within the defined riparian zone, allow mature trees to grow without disruption from future onsite developments.
7. Protect and enhance stream/terrestrial habitat for potential Missouri Department of Conservation Species of Conservation Concern.
8. Minimize and control the spread of invasive plants to new areas of the site, while mitigating any plant diseases observed.
9. Monitor and maintain all culverts, bridges, and fords over streams, or consider removing these due to safety concerns.
10. Provide recreational opportunities for residents and visitors of Ozark.

Community Involvement

In February of 2018, The city of Ozark released the [“Ozark Parks and Recreation Next Step Master Plan”](#). The goal of the plan is to strategically select projects based on community support. During this planning process, the city organized stakeholder interviews, focus groups, a public meeting, and a citizen survey to help rank community preferences.

The survey’s results for the highest rated recreation facilities in priority order was:

- Trails
- Nature center
- Playgrounds
- Park shelters and picnic areas
- Passive natural areas

The survey’s results for the highest rated recreation programs in priority order was:

- Special events
- Adult fitness and wellness programs
- Nature programs/environmental education
- Outdoor adventure programs

By purchasing Garrison Spring, the city has the opportunity to fulfill the desires of the community and create unique educational and recreational opportunities for citizens and visitors. Garrison Spring Community Forest will offer visitors a variety of recreational uses, including soft surface and hard surface trails, passive natural areas, environmental education stations, and the opportunity for a variety of adventure and wellness programs.

Garrison Springs Community Forest Committee was formed during this process. The group has met numerous times over the past six months. We sent an email asking them to be a part of the committee prior to choosing a consultant for the plan. We meet every three weeks to discuss the project. They gave input for the Community Forest Plan. They also helped in the review process of picking an organization to write the Forestry Plan. They have reviewed the proposed plan and have approved.

Trail Development & Fitness Opportunities

Ozark has growing network of trails that provide opportunities for recreation, wellness, and alternative forms transportation. Garrison Spring offers a unique opportunity to create the first soft surface trail system within the city of Ozark, and a beautiful ADA compliant hard surface trail that provides views of the spring, gardens, and learning stations. Though the property is relatively small and features challenging conditions for sustainable trail construction, there is an opportunity to develop over 1 mile of trails that allow visitors to connect with the many natural resources found within the park. Due to the size of the park and intended uses, it is recommended that soft surface trails be designated for foot travel only, and off limits to cycling, off-road vehicles, and equestrian use. Flooding, water crossings, steep slopes, soil types, environmentally sensitive areas, and natural hazards must be factored into the trail design. It is highly recommended that the city of Ozark consulted with specialists experienced in developing soft

and hard surface trails within the Ozarks landscape. There are a number of local groups and resources available that could provide guidance in the development of the Garrison Spring trail system.

Ozark Greenways, Trail Spring, and the Watershed Conservation Corp have years of experience developing and maintaining trail systems throughout the region.

The development of a trail system provides opportunities for residents of Ozark to get involved with the construction and maintenance of the park. Enlisting volunteers to assist in trail development will increase community buy-in and develop a sense of ownership, which could decrease the likelihood of illicit trail building and other destructive activities.

In addition to hiking and trail running opportunities, Garrison Spring offers the city of Ozark Parks Department a venue for group fitness classes, including guided hikes and outdoor yoga. Permits could be offered to local adventure groups and fitness instructors wishing to host private events.

Outdoor Education

Garrison Springs is well suited for passive and guided outdoor education. The park showcases many unique natural features, including limestone outcroppings, upland hardwood forests, springs, seeps, and the opportunity to showcase the interconnectedness of surface and groundwater. In addition to these natural features, the park contains several gardens that feature ornamental plants and pay homage to the previous owners. This diverse landscape will be attractive for many types of recreational uses, therefore offering opportunities to tie in recreation with the protection of our natural resources.

Trail users can enjoy well-placed educational signs and primitive rest areas that provide a scenic view. The city could place a limited number of geocaches on the property that take visitors to learning stations. Ozark Parks could coordinate with local groups like the Greater Ozarks Audubon, Springfield Master Naturalists, and Christian County Master Gardeners to develop birding lists, scavenger hunts, plant guides, and other interactive resources.

Garrison Spring and Garrison Branch provide excellent opportunities for water quality education. The city could work with the James River Basin Partnership and Watershed Conservation Corps to develop streamside and forest learning stations that could be utilized for field trips, guided hikes, and passive use. These learning stations could be similar to those found at the Watershed Center at Springfield's Valley Water Mill Park. The home and outbuildings could be modified for use as an education center for watershed festivals, field trips and other group outings. To promote community involvement in the protection of the area's water resources, the city could develop an Adopt-A-Stream program and enlist volunteers to aid in the protection of the spring and Garrison Branch.

Ozark's proximity to local universities could allow for opportunities to partner on research, grants, and other educational projects that improve and protect the area's natural resources.

Restoration & Protection of Native Ecosystems

Garrison Spring offers visitors an excellent opportunity to visit an upland hardwood forest, karst features and an Ozark stream without traveling far from home. These natural features provide opportunities for community involvement in the restoration and protection of our native landscape. Through careful guidance from experts such as the Missouri Dept. of Conservation, U.S. Forest Service, Christian County Extension, James River Basin Partnership, and the Watershed Conservation Corps, the city could enlist volunteers to assist with invasive species control, native plant and garden maintenance, tree planting, litter cleanups, and trail maintenance. Community involvement in these efforts creates a sense of ownership that will assist in the development and protection of the park and its natural resources.

It will be important to allow for community involvement in water quality protection projects such as tree planting along the stream and spring. In the past, these areas have been mowed and accessible, which has caused degradation to the stream and riparian corridor. It is highly recommended that the streambanks be revegetated and that a proper vegetated buffer is maintained around the spring. Volunteer tree planting events, media coverage, and signage will help educate the public about riparian corridors and aid in the success of the project.

Stewardship Issues

Missouri contains a tremendous variety of ecosystems and management challenges. This section of the plan will provide background information about the landscape of Ozark forests and potential issues that might affect the property now and in the future. A full stand description including habitat management recommendations is included later in the document. The management plan will be directed at ensuring forest health and recreational safety.

Biodiversity

Biological diversity is, in part, a measure of the variety of plants and animals, the communities they form, and the ecological processes (such as water and nutrient cycling) that sustain them. With the recognition that each species has value, individually and as part of its natural community, maintaining biodiversity has become an important resource management goal.

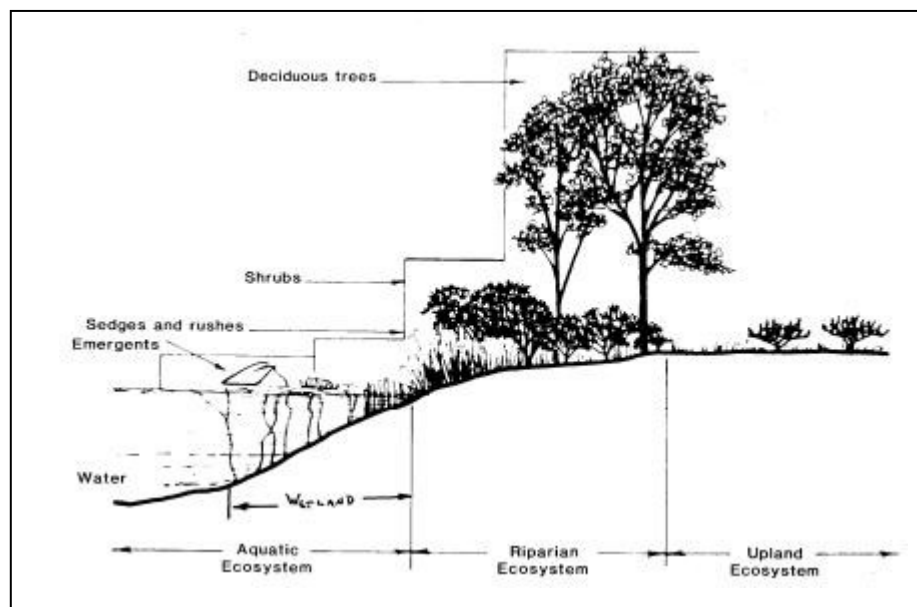
The largest threat to biodiversity in the Ozarks is the loss of habitat to development. Urban sprawl and the outward growth of the Springfield Metropolitan Area has severely limited habitat suitability for numerous wildlife species. The introduction and spread of invasive, non-native plants are also a direct threat to habitat diversity. Non-native invasives like wintercreeper, callery pear, and bush honeysuckle spread quickly, crowding out native species and dramatically altering ecosystem structure and function. Once established, invasives are difficult to control and even harder to eradicate, while limiting native plant growth.

Another factor influencing biodiversity in southern Missouri is the distribution of forest growth stages. Wildlife biologists have recommended that, for optimal wildlife habitat on a landscape

scale, 5-15% of the forest should be in the seedling stage (less than 1" in diameter). Yet, the Ozarks currently average no more than 2-3% of the forest in early successional stage seedling forest across the region. There is also a shortage of forest with large diameter trees (greater than 20"). These larger trees serve as "crop" trees and produce the seed for the next age class in the forest, thus the two classes are closely related. Invasive species decrease the regeneration success of the seedlings and crop tree efficiency substantially.

Riparian & Wetland Areas

Riparian and wetland areas are transition zones between wet areas (aquatic) and dry landscapes (terrestrial). More specifically, a wetland is an area with saturated soils and a unique community of plants that are adapted to live in these wet soils. Thousands of endangered plants around the world are found only in wetlands and saturated soils. Wetlands are generally near streams or ponds or found isolated in an otherwise drier landscape. A riparian zone may contain wetlands, but can also include areas of well-drained, sandy soils due to flood deposition. In essence, riparian areas are where the water and land meet.



Riparian zone diagram

Water is the lifeblood of wetlands and riparian zones. It functions as an agent of change and as a stabilizing factor for the ecosystem adjacent to the waterway. Below are some functions of the ecosystem that are important for habitat conservation.

Filtration: Riparian zones serve as a filter to remove pollutants, sediment, and debris before they reach large water bodies and potential drinking water supplies. This greatly reduces the amount of filtration required from local municipalities, reduces downstream habitat degradation, and protects groundwater.

Flood control: Riparian zones help alleviate flood damage by storing excess water in hydric soils. The zone simply acts as a sponge, which takes in water and reduces downstream flow, thus lowering flood water levels and potential habitat damage.

Critical wildlife habitat: Many birds and mammals need riparian and wetland areas for all or part of their life cycle. These areas provide food, water, cover, and travel corridors. They are often the most important habitat feature in forests.

Recreational opportunities: Lakes, rivers, and streams are a focal point for outdoor recreation. Protecting riparian habitat is important both ecologically and economically.

To protect wetlands and riparian areas and to prevent soil erosion during timber harvesting activities, Missouri promotes the use of “Best Management Practices” or BMPs. Maintaining or reestablishing the protective vegetative layer and protecting critical areas are the two rules that underlie these commonsense measures.

Soil and Water Quality

Forests are exceptional at forming a buffer that promotes soil longevity and water quality. Trees and other woody plants perform interception, by catching rain as it falls and reducing its impact on the forest floor. This reduces the amount of sediment loss to erosion and keeps the organic matter of the soil in place for biological processes, such as decomposition and plant nutrient uptake.

To maintain a supply of clean water, forests must be kept as healthy as possible. Forests with a diverse mixture of vigorous trees of different ages and species can better cope with periodic and unpredictable stress such as insect attacks or windthrow. This is typically noted as being an “uneven” age forest structure, with many different age classes of trees.

Timber harvesting in the Ozarks must be carried out cautiously to prevent soil disturbance and erosion. Sediment in waterways causes turbidity, which degrades the quality of the water, posing a risk to fish and other wildlife. If Best Management Practices are implemented correctly, it is possible to undertake active forest management without harming water quality. It is important to develop and carry out BMPs for the site to ensure the suitability and sustainability of the riparian and forested zones.

Forest Health

Like individual organisms, forests can be valued on overall health. The health of a forest is affected by many factors including climate, soil type, pests, and human activity. Forest health evaluators do not focus generally on individual trees when assessing forest health. Instead, a broad look at the forest through sampling and individual stand measurements are used to assess a forest landscape and make management recommendations in respect to forest health.

Like human health, it is easier to prevent forest health problems than to cure them. This preventative approach usually involves two steps. First, it is desirable to increase biodiversity within the forest landscape. This diversity makes a forest less susceptible to a single devastating

health threat, such as an insect pest or fungal disease. Second, by thinning out weaker and less desirable trees, well-spaced healthy individual trees are assured the proper nutrients for adequate growth and potential regeneration. These two steps will result in improved forest health and longevity.

Fire

Most forests in the Ozarks are adapted to fire. In fact, many species depend on frequent disturbance for establishment and growth. Historically, Native Americans commonly burned certain forests to improve hunting grounds and for increased visibility across the landscape. In modern times, most fires are caused by human action and negligence. Adherence to the Missouri slash law minimizes the risk. Under the law, slash (cut timber on the ground) is to be removed from buffer areas near roads, boundaries, and critical areas and lopped close to the ground to speed up decay. Ensuring fast decay of the slash lowers the fire risk, while improving soil health with increased nutrients and biological activity. Overall, slash buildup is the greatest risk when it comes to fire in the Ozarks.

Fire can also be considered as a management tool to favor certain species of plants and animals, depending on the objective of the landowner. The use of prescribed burning is common practice in the Ozarks, and generally occurs in the late winter before many plants germinate. State agencies, such as the Missouri Department of Conservation, and federal agencies, such as the United States Forest Service, conduct numerous controlled burns around the Ozarks from late January through early March. Thousands of acres of forest are burned to improved habitat diversity and overall forest health. Please consult with these agencies for future management if a prescribed fire is desired.

Wildlife Management

Enhancing the wildlife potential of a forested property is a common and important goal for forest owners. Sometimes actions can be taken to benefit a particular species of interest. In most cases, recommended management practices can benefit many species, and fall into one of three broad strategies. These are **managing for diversity, protecting existing habitat, and enhancing existing habitat**.

Managing for Diversity: Many species of wildlife need a variety of plant communities to meet their lifecycle requirements. In general, a property that contains a diverse collection of habitats will support a more varied wildlife population. A mature stand of oaks provides acorns for foraging deer and turkey, while an open field provides the right food and cover for cottontail rabbits, fox, and many birds of prey. It is often possible to create these different habitats on the property through active management. The appropriate mix of habitat type will primarily depend on the composition of the surrounding landscape and landowner objectives.

Protecting Existing Habitat: This tactic is commonly associated with managing for rare species or those species that require unique habitat features. Missouri is home to many species that are only found in the Ozarks ecoregion due to having specialized habitats. These specialized habitat features include vernal pools, springs and seeps, forested

wetlands, rock outcrops, snags, den trees, and large blocks of unbroken forest. Some of these features are rare, and they provide the right mix of food, water, and shelter for a particular species or specialized community of wildlife. At Garrison Spring, there are no “Species of Conservation Concern” per the Missouri Department of Conservation, which reduces the need for critical habitat to be identified and protected.

Enhancing Existing Habitat: This strategy falls somewhere between the previous two. One way the wildlife value of a forest can be enhanced is by modifying its structure (number of canopy layers, average tree size, density). Thinning out undesirable trees from around large, crowned mast (nut and fruit) trees will allow these trees to grow faster and produce more food. The faster growth will also accelerate the development of a more mature forest structure, which is important for some species. Creating small gaps or forest openings generate groups of seedlings and saplings that provide an additional layer of cover and food.

Each of these three strategies can be applied on a single property and to individual forest stands. The overview, stand description and management practice sections of this plan will expand the context of the surrounding landscape and the potential to diversify, protect, or enhance wildlife habitat.

Wood Products

If managed wisely, forests can produce a periodic flow of wood products on a sustained basis. Stewardship encompasses finding ways to meet current needs while protecting the forest’s ecological integrity for long-term use. In this way, harvested timber can generate income without compromising the opportunities of future generations.

Ozarks forests grow many highly valued species (black walnut, white oak, and shortleaf pine) whose lumber is sold throughout the world. These products and their associated value-added industries contribute millions of dollars annually to the Missouri economy.

Harvesting from sustainably managed woodlands – rather than from unmanaged or poorly managed forests – benefits the public in a multitude of ways. The sale of timber, pulpwood, and firewood also provides periodic income that can be reinvested in the property, increasing its value, and helping meet long-term goals. Producing wood products helps defray the costs of owning woodland, and helps landowners keep their forestland undeveloped.

Cultural Resources

Cultural resources are the places containing evidence of people who once lived in the area. Whether a Native American village from 1,700 years ago, or the remains of a farmstead from the 1800s, these features all tell important and interesting stories about the landscape and should be protected from damage or loss.

Missouri has a long and diverse history of human habitation and use. Native American tribes first took advantage of the natural resources of the Ozarks over 10,000 years ago. Many of these settled villages were located along the streams and large rivers of the region, due to drinking

water proximity. The interior woodlands of the Ozarks were used for hunting, traveling, and temporary camps. Signs of these activities are difficult to find in today's forests due to the passage of time and ecological weathering. They were obscured by the dramatic landscape impacts brought by European settlers as they swept over the area in the 18th and 19th centuries.

By the early 1900s, more than 50% of the forests of Missouri had been cleared for crops and pastureland. Houses, barns, wells, fences, mills, and roads were all constructed as woodlands were converted for agricultural production. Many of the abandoned buildings were disassembled and moved, but the supporting stonework and other changes to the landscape can be easily seen today.

One particularly ubiquitous legacy of this period is stone walls. Most were constructed between 1870 and 1910 as stone fences (wooden fence rails had become scarce) to enclose livestock, or to exclude them from croplands and hayfields. Clues to their purpose are found in their construction. Walls that surrounded pasture areas were comprised mostly of large stones, while walls abutting former cropland accumulated many small stones as farmers cleared rocks turned up by their plows. Other cultural features to look for include cellar holes, wells, old roads, and even old trash dumps. Rock was also used in accordance with wood to create dams along streams and rivers for water supply and aquatic hatchery purposes.

Invasive Species Management

Invasive species pose immediate and long-term threats to the woodlands of Missouri. Defined as a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health, invasives are well adapted to a variety of environmental conditions, out-compete more desirable native species, and often create monocultures devoid of biological diversity. A website entailing the description of many invasive plants found in Missouri can be located at <https://mdc.mo.gov/trees-plants/invasive-plants>. Some of the common invasive plants found in the Ozarks are listed below:

- Bradford/Callery Pear
- Bush Honeysuckle
- Wintercreeper

Pesticide Use

Pesticides such as herbicides, insecticides, fungicides, and rodenticides are used to control “pests”. A pest is any mammal, bird, invertebrate, plant, fungi, bacteria, or virus deemed injurious to humans and/or other mammals, birds, plants, etc. The most common forest management use of a pesticide by woodland owners is the application of herbicide to combat invasive species. Missouri Department of Natural Resources suggests using a management system that promotes the development and adoption of environmentally friendly, non-chemical methods of pest management that strive to avoid the use of chemical pesticides. If chemicals are used, proper equipment and training should be utilized to minimize health and environmental risks. In Missouri, the application of pesticides is regulated by the Missouri Department of Agriculture. For more information, contact MO Department of Agricultural Resources (MDA), Pesticide Bureau at (573) 751-4211

Climate Change Adaptation & Forest Carbon

Forests are always changing and responding to new conditions. At the same time, the climate is changing in ways that humans have never experienced before, resulting in rising temperatures and shifts in seasonal precipitation patterns. Past and future climate changes in the Ozarks include:

- Temperatures have risen more than 2°F since the late 1800s, with the greatest warming occurring in winter (more than 3°F increase average). By the end of this century, average annual temperatures are projected to increase another 5-10°F, increasing both the length of the growing season and the frequency of elevated temperatures.
- A longer growing season, warmer temperatures, and more variable summer rain are likely to increase summer moisture stress leading to potentially harmful droughts.
- As the climate continues to change, conditions are expected to become less favorable for the traditional northern trees in Missouri. Common trees like maple and birch are likely to experience greater stress, particularly on warmer and drier sites. Trees that are more common farther south may benefit from warmer conditions, such as oaks and hickories.

Climate change will not affect all forest species, communities, and parts of the landscape in the same way. Additional stress will amplify some threats that forests already face, such as invasive species, insect pests, forest diseases, and deer browse. Species and forest types that are more tolerant of disturbances may have less risk from climate change, and forests with greater diversity (species, genetic, and structural diversity) may also have less risk.

Ensuring that forests can adapt to climate change will also help ensure that forests continue to remove greenhouse gases from our atmosphere. Forests play a vital role in the earth's carbon cycle, as they remove carbon dioxide from the atmosphere and store it in biomass (trunks, branches, foliage, and roots). Sustainable forest practices can increase the ability of forests to absorb and store atmospheric carbon while enhancing other ecosystem services, such as soil and water quality. Harvesting and regenerating forests can also result in net carbon sequestration in wood products and new forest growth.

Forest Inventory & Management

Plan/Stand Map

A forest stand is a community of trees and plants growing together. The trees in a stand are generally similar in size, age, and species. They can be distinguished from other stands by these characteristics. The map shown below identifies these stands on your property. The acreage shown in the image is approximate. There are five stands on the Garrison Spring property.



<u>Stand No.</u>	<u>Acres</u>
1	.97
2	2.09
3	2.21
4	1.77
5	2.66

Stand: 1

Acres: .97

Stand Management Objectives:

- **Gain control of invasive species through an integrated pest management strategy**
- **Improve habitat density through natural community restoration**
- **Maintain barrier between forest and bottomland garden**

Description of Stand Condition:

<i>Stand Data</i>				
BA/ac	TPA	Average DBH	Site Index	% Stocking
78	415	8.5	56	82

Stand 1 is in the northwest corner of the property. It is bordered by the property boundary on the north and west side of the stand, and by a small drainage ditch on the east side. The south border of the stand is the transition zone from the bottomland, manicured landscape, to the interior forest in the north end of the property.

The forest is mainly composed of eastern red cedar, hackberry, shagbark hickory, and white oak. Most of the red cedar is <10 in DBH and occupies a small glade-type environment near the north end of the stand. The white oaks, shagbark hickories, and hackberries are interspersed throughout the stand and are the dominant canopy species. Large white oaks and a few black walnuts dominate the upper reaches of the canopy. Mid-level canopy includes smaller hackberries, eastern red cedar, sugar maple, and slippery elm. While these species are noted, most are <8 in DBH and are shaded out by the dominant species listed previously. Many black walnuts can be found in the southern area of the stand, closer to the bottomland area of the property. Ground cover was prevalent, with buckbrush and native sedges being the most common. Many small stands of Virginia wild rye were noted along the southern edge of the plot.

Numerous invasive species were observed in the stand, including bush honeysuckle, Chinese privet, multiflora rose, wintercreeper, and callery pear. The stand is fully stocked at 82% stocking and many of the small, understory species have regenerated due to a lack of grazing or fire. Regeneration of desirable species, such as white oak and black walnut, was non-existent. Invasive species populations and clusters of non-desirable tree species are occupying a large area of the understory.

Desired Future Condition

Conduct a sizeable amount of invasive species removal to improve open space in the understory. This will allow native woody species to regenerate more effectively. Many of the trees in the stand are not considered acceptable growing stock, so smaller trees, such as red cedar, should be removed to improve growing stock percentages. Leave some small understory hackberries and hickories to provide future shade trees. The large overstory trees should be left alone to serve as crop trees for the next generation of upland hardwoods. White oaks, black walnuts, and large shagbark hickories will need to be left alone to ensure proper regeneration occurs, while keeping invasives at bay. Smaller trees that are too close to crop trees need to be removed. A burn may be

needed after invasive species removal to influence regeneration of secondary species. Make sure to leave a buffer on the south end of the stand to not disrupt the adjacent garden. **As much as 20 ft²/acre of removal is necessary to improve stand conditions.** Continual invasive species treatment will be needed for the foreseeable future.

This strategy will create a unique habitat that mimics an upland hardwood forest. A variety of wildlife species are attracted to this habitat, including songbirds, small game mammals, and large game species, such as deer and turkey.

Management Schedule

This schedule should be implemented to follow management recommendations:

Description	Materials Needed	Date
Removal of invasive plant species	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Fall 2021-Spring 2022
TSI to remove approximately 20ft ² /acre of basal area	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Winter 2021-Spring 2022
Chip and dispose of slash	Woodchipper, PPE, chainsaw, chainsaw chaps	Spring 2022
Spray selective herbicide to invasive/non-desirable plants	Herbicide, herbicide sprayer, PPE	Spring-Summer 2022
Spot-spray missed invasive species/non-desirable species	Herbicide, herbicide sprayer, PPE	Fall 2022
Inventory and plan prescribed burn once slash is disposed	Biltmore stick, BAF prism	Winter 2022
Prescribed burn	Torch, shovels, rakes, blowers, water, fire hose, PPE	Early Spring 2023
Inventory stand post-burn	Biltmore stick, BAF prism	Spring 2023
Spot-spray invasive species	Herbicide, herbicide sprayer, PPE	Spring-Fall 2023

Stand 2 Acres: 2.09

Stand Management Objectives:

- Gain control of invasive species through an integrated pest management strategy
- Improve habitat density through natural community restoration
- Maintain barrier between forest and bottomland garden

Description of Stand Condition:

<i>Stand Data</i>				
BA/ac	TPA	Average DBH	Site Index	% Stocking
94	445	8.8	54	87

Stand 2 is in the northeast corner of the property. It is bordered by the property boundary on the north and east side of the stand, and it is bordered by a small drainage ditch on the west side. The south border of the stand is the transition zone from the bottomland, manicured landscape, to the interior forest in the north end of the property.

The stand is mainly composed of eastern red cedar, hackberry, slippery elm, and black walnut. Most of the red cedar is <10 in DBH and in very poor condition, occurring along a small trail that goes through the stand. The black walnuts, shagbark hickories, and hackberries are interspersed throughout the stand and are the dominant canopy species. Large black walnuts and a few slippery elms dominate the upper canopy of the stand. Mid-level canopy includes hackberries, eastern red cedar, ash, and smaller slippery elm. While these species are noted, most are <8 in DBH and are shaded out by the dominant species listed previously. Many black walnuts can be found in the southern area of the stand, closer to the bottomland area of the property. Ground cover was prevalent, with buckbrush and native sedges being the most common.

Numerous invasive species were observed in the stand, including bush honeysuckle, Chinese privet, multiflora rose, wintercreeper, and callery pear. The stand is fully stocked at 87% stocking and many of the small, understory species have regenerated due to a lack of grazing or fire. Regeneration of desirable species, such as white oak and black walnut, was non-existent. Invasive species populations and clusters of non-desirable tree species are occupying a large area of the understory.

Desired Future Condition:

Conduct a sizeable amount of invasive species removal to improve open space in the understory. This will allow native woody species to regenerate more effectively. Also, many of the trees in the stand are not considered acceptable growing stock, so smaller trees, such as red cedar, should be removed to improve growing stock percentages. Leave some small understory hackberries and hickories to provide future shade trees. The large overstory trees should be left alone to serve as crop trees for the next generation of upland hardwoods. Black walnuts and large shagbark hickories will need to be left alone to ensure proper regeneration occurs, while keeping invasives at bay. Smaller trees that are too close to crop trees need to be removed. A burn may be needed after invasive species removal to influence regeneration of secondary species. Make sure to leave

a buffer on south end to not disrupt the adjacent garden. **As much as 25 ft²/acre of basal area removal is necessary to improve stand conditions.**

This strategy will create a unique habitat that mimics an upland hardwood forest. A variety of wildlife species are attracted to this habitat, including songbirds, small game mammals, and large game species, such as deer and turkey.

Management Schedule

This schedule should be implemented to follow management recommendations:

Description	Materials Needed	Date
Removal of invasive plant species	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Fall 2021-Spring 2022
TSI to remove approximately 25ft ² /acre of basal area	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Winter 2021-Spring 2022
Chip and dispose of slash	Woodchipper, PPE, chainsaw, chainsaw chaps	Spring 2022
Spray selective herbicide to invasive/non-desirable plants	Herbicide, herbicide sprayer, PPE	Spring-Summer 2022
Spot-spray missed invasive species and non-desirable species	Herbicide, herbicide sprayer, PPE	Fall 2022
Inventory and plan prescribed burn once slash is disposed	Biltmore stick, BAF prism	Winter 2022
Prescribed burn	Torch, shovels, rakes, blowers, water, fire hose, PPE	Early Spring 2023
Inventory stand post-burn	Biltmore stick, BAF prism	Spring 2023
Spot-spray invasive species	Herbicide, herbicide sprayer, PPE	Spring-Fall 2023

Stand 3 Acres: 2.21

Stand Management Objectives:

- Gain control of invasive species through an integrated pest management strategy
- Maintain barrier between forest and bottomland garden
- Install native herbaceous and woody plants along streambank and riparian zone

Description of Stand Condition:

<i>Stand Data</i>				
BA/ac	TPA	Average DBH	Site Index	% Stocking
54	109	15	56	<50%

Stand 3 is in the valley of the property to the north of the spring branch. The area had previously been managed as a stroll garden and many flower beds of non-native plants with irrigation lines can be found throughout the stand. The main road of the property runs along the south side of the stand. The stand also includes building structures such as a barn, wellhouse, and the main house for the property. While this landscape varies from the other stands on the property as far as stocking level and species composition, it will be important to manage this stand effectively due to its proximity to the road and visitors.

The stand is mainly composed of mature black walnut, red bud, sugar maple, and hackberry. The black walnuts and hackberries are interspersed throughout the stand and are the dominant canopy species. Large black walnuts dominate the upper canopy of the stand, with some having DBH values of over 24 inches. Mid-level canopy includes hackberries, red buds, and smaller slippery elm trees. While these species are noted, most are <8 in DBH and are shaded out by the dominant species listed previously. Many black walnuts can be found near one another and have been thinned previously to encourage diameter growth. Ground cover was prevalent, mainly composed of ornamental grass, tall fescue, and small garden beds.

Numerous invasive species were observed in the stand, including bush honeysuckle, Chinese privet, wintercreeper, and callery pear. The stand is technically understocked at <50%, however this landscape is not interior forest, and will not be managed for forest techniques in the future. Regeneration of desirable species, such as white oak and black walnut, was non-existent due to mowing. Invasive species populations are clustered and near the road.

Stand 3 includes the riparian zone on the spring branch. For years, the bank has been mowed for landscaping purposes, which has caused increased siltation of the stream and a lack of native vegetation. The stream bank needs to be protected through the addition of native trees and shrubs, and the riparian corridor, specifically the north side of the stream, needs to be stabilized to mitigate potential erosion effects.

Desired Future Condition:

Continue to monitor the stand and utilize this management plan to guide future use. The invasive

species observed in the stand will need to be removed to prevent reseeding and potential spread to other stands. The plans for the park entail the planting of native woody and herbaceous plants, as well as a walking trail that may pass through the stand. Overall, this stand does not have much forest suitability, and should be managed in other fashions.

It is recommended to reduce the gardens to small areas just west of the barn. Two or three garden areas should be developed in proximity to the house. One area could be a “formal” garden, with seating and trails, to honor the legacy of the Braswell’s gardens. Add one or two additional gardens near the house to reduce mowing. These gardens should contain elements of native plantings to attract butterflies, hummingbirds, bees, and other pollinator species. The gardens should also contain open areas, or “garden learning stations,” where school groups could gather for native plant talks, or as relaxing places for the public to use. This learning station would provide opportunities to educate kids and the public about yard landscaping, yard ethics, and attracting desirable birds and wildlife to urban settings.

A planting of native plants, including both woody and herbaceous species, is desired to improve riparian habitat and stabilize the streambank. Common woody plants that are found in riparian zones are buttonbush, elderberry, ninebark, sycamore, swamp white oak, black willow, and bald cypress. Common herbaceous plants in riparian zones are jewelweed, swamp milkweed, dogbane, sedges, and Virginia wild rye. Many of these plant species can be bought from local native plant nurseries and hand-placed along the stream to insure proper alignment and erosion management.

Management Schedule

This schedule should be implemented to follow management recommendations:

Description	Materials Needed	Date
Removal of invasive plant species	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Fall 2021-Spring 2022
Chip and dispose of slash	Woodchipper, PPE, chainsaw, chainsaw chaps	Spring 2022
Purchase native grasses and forbs for planting	Not applicable	Spring 2022
Plant native herbaceous species around garden and riparian area	Shovel, trowel, mattock, PPE	Spring-Summer 2022
Plant trees and woody species along streambank for stabilization	Dibble bar, shovel, mattock, PPE	Spring-Summer 2022
Spray selective herbicide to invasive/non-desirable plants	Herbicide, herbicide sprayer, PPE	Spring-Summer 2022
Spot-spray missed invasive species and non-desirable species	Herbicide, herbicide sprayer, PPE	Fall 2022

Reassess site for herbaceous, native plant growth	Not applicable	Spring-Summer 2023
Spot-spray invasive species	Herbicide, herbicide sprayer, PPE	Spring-Fall 2023
Monitor native, woody plant growth	Not applicable	Fall 2023

Stand 4 Acres: 1.77

Stand Management Objectives:

- Gain control of invasive species through an integrated pest management strategy
- Improve habitat density through natural community restoration
- Maintain barrier between forest and bottomland

Description of Stand Condition

<i>Stand Data</i>				
BA/ac	TPA	Average DBH	Site Index	% Stocking
90	398	11.5	56	131%

Stand 4 is in the southwest corner of the property. It is bordered by the property boundary on the south and west side of the stand, and it is bordered by the stream on the north end of the stand.

The east boundary of the stand is a north-to-south line drawn from Garrison Spring.

The stand is mainly composed of mature sugar maple. In fact, over 70% of the trees sampled in the stand were sugar maple. Black walnuts, shagbark hickories, and hackberries are interspersed throughout the stand, but are mainly midstory level. The upper canopy is essentially large sugar maples and a few shagbark hickories. One large black walnut tree was sampled near the stream on the north end of the plot, and a few slippery elm trees were noted. Many of the sugar maples had DBH values of over 10 inches, which is quite exceptional.

Minimal invasive species were observed in the stand. Only a few bush honeysuckle plants and wintercreeper vines were observed during sampling. The stand is overstocked at 131% stocking and many of the small, understory species have regenerated due to a lack of grazing or fire. Regeneration of desirable species, such as white oak and black walnut, was non-existent. Invasive species populations and clusters of non-desirable tree species are occupying a very small area of the understory.

Desired Future Condition:

Conduct a sizeable amount of timber stand improvement to lower BA/ac. This will allow native woody species to regenerate more effectively. Also, some of the trees in the stand are not considered acceptable growing stock, so smaller trees, such as sugar maples, should be removed to improve growing stock percentages. Leave some small understory hackberries and hickories to provide future shade trees. The large overstory trees should be left alone to serve as crop trees for the next generation of upland hardwoods. Black walnuts and large shagbark hickories will need to be left alone to ensure proper regeneration occurs, while keeping invasives at bay. Smaller trees that are too close to crop trees need to be removed. A burn may be needed after invasive species removal to influence regeneration of secondary species. Make sure to leave a buffer on the north end to not disrupt the riparian zone. **As much as 35 ft²/acre of basal area removal is necessary to improve stand conditions.**

This strategy will create a unique habitat that mimics an upland hardwood forest. A variety of wildlife species are attracted to this habitat, including songbirds, small game mammals, and large game species, such as deer and turkey.

Management Schedule

This schedule should be implemented to follow management recommendations:

Description	Materials Needed	Date
Removal of invasive plant species	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Fall 2021-Spring 2022
TSI to remove approximately 35ft ² /acre of basal area	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Winter 2021-Spring 2022
Chip and dispose of slash	Woodchipper, PPE, chainsaw, chainsaw chaps	Spring 2022
Spray selective herbicide to invasive/non-desirable plants	Herbicide, herbicide sprayer, PPE	Spring-Summer 2022
Spot-spray missed invasive species and non-desirable species	Herbicide, herbicide sprayer, PPE	Fall 2022
Inventory and plan prescribed burn once slash is disposed	Biltmore stick, BAF prism	Winter 2022
Prescribed burn	Torch, shovels, rakes, blowers, water, fire hose, PPE	Early Spring 2023
Inventory stand post-burn	Biltmore stick, BAF prism	Spring 2023
Spot-spray invasive species	Herbicide, herbicide sprayer, PPE	Spring-Fall 2023

Stand 5 Acres: 2.66

Stand Management Objectives:

- **Gain control of invasive species through an integrated pest management strategy**
- **Improve habitat density through natural community restoration**
- **Maintain barrier between forest and bottomland**

Description of Stand Condition:

<i>Stand Data</i>				
BA/ac	TPA	Average DBH	Site Index	% Stocking
96	432	10.7	57	142%

Stand 5 is in the southeast corner of the property. It is bordered by the property boundary on the south and east side of the stand, and it is bordered by the stream on the north end of the stand. The west boundary of the stand is a north-to-south line drawn from Garrison Spring. A large collection of seeps are in the center of the stand and the stream is surrounded by forest on all sides.

The stand is mainly composed of mature sugar maples, box elders, and white oak. Over 40% of the trees sampled in the stand were sugar maple White oaks, shagbark hickories, and box elders are interspersed throughout the stand, but were mainly midstory level. The upper canopy is composed of large sugar maples and a few white oaks. Many of the sugar maples had DBH values of over 10 inches, which is quite exceptional and rare for an interior Ozark forest.

Minimal invasive species were observed in the stand. Only a few bush honeysuckle plants and wintercreeper vines were observed during sampling. The stand is overstocked at 142% stocking and many of the small, understory species have regenerated due to a lack of grazing or fire. Regeneration of desirable species, such as white oak, was non-existent. Invasive species populations and clusters of non-desirable tree species are occupying a very small area of the understory.

Desired Future Condition:

Conduct a sizeable amount of timber stand improvement to lower BA/ac. This will allow native woody species to regenerate more effectively. Some of the trees in the stand are not considered acceptable growing stock, so smaller trees, such as sugar maples, should be removed to improve growing stock percentages. Leave some small understory box elder and hickories to provide future shade trees. The large overstory trees should be left alone to serve as crop trees for the next generation of upland hardwoods. White oaks and large shagbark hickories will need to be left alone to ensure proper regeneration occurs, while keeping invasives at bay. Smaller trees that are too close to crop trees need to be removed. A burn may be needed after invasive species removal to influence regeneration of secondary species. Make sure to leave a buffer on the north end to protect the house and riparian zone. **As much as 35 ft²/acre of basal area removal is necessary to improve stand conditions.**

This strategy will create a unique habitat that mimics an upland hardwood forest. A variety of

wildlife species are attracted to this habitat, including songbirds, small game mammals, and large game species, such as deer and turkey.

Management Schedule

This schedule should be implemented to follow management recommendations:

Description	Materials Needed	Date
Removal of invasive plant species	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Fall 2021-Spring 2022
TSI to remove approximately 35ft ² /acre of basal area	Chainsaw, chainsaw chaps, hand saws, herbicide, herbicide sprayer, PPE	Winter 2021-Spring 2022
Chip and dispose of slash	Woodchipper, PPE, chainsaw, chainsaw chaps	Spring 2022
Spray selective herbicide to invasive/non-desirable plants	Herbicide, herbicide sprayer, PPE	Spring-Summer 2022
Spot-spray missed invasive species and non-desirable species	Herbicide, herbicide sprayer, PPE	Fall 2022
Inventory and plan prescribed burn once slash is disposed	Biltmore stick, BAF prism	Winter 2022
Prescribed burn	Torch, shovels, rakes, blowers, water, fire hose, PPE	Early Spring 2023
Inventory stand post-burn	Biltmore stick, BAF prism	Spring 2023
Spot-spray invasive species	Herbicide, herbicide sprayer, PPE	Spring-Fall 2023

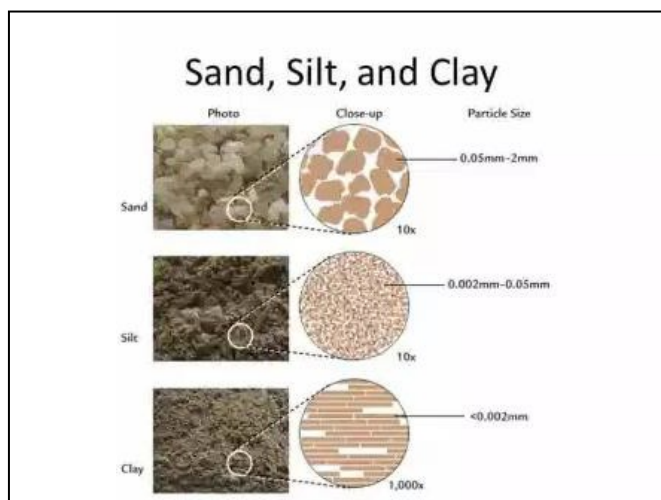
Soils

Soil is defined as a natural body comprised of solids (minerals and organic matter), liquid, and gases that occur on the land surface. Soils are characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material because of additions, losses, transfers, and transformations of energy and matter, or the ability to support rooted plants in a natural environment.

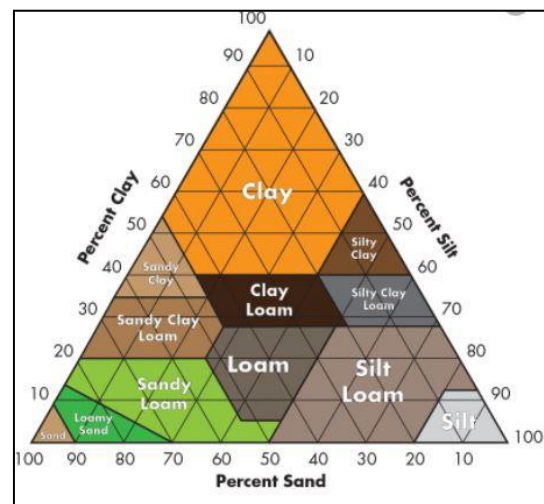
The upper limit of soil is the boundary between soil and air, shallow water, live plants, or plant materials that have not begun to decompose. Areas are not considered to have soil if the surface is permanently covered by water too deep (typically more than eight feet) for the growth of rooted plants.

The lower boundary that separates soil from the non-soil underneath is most difficult to define. Soil consists of horizons near the Earth's surface that, in contrast to the underlying parent material, have been altered by the interactions of climate, relief, and living organisms over time. Commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biological activity. For purposes of classification, the lower boundary of soil is arbitrarily set at six feet.

Soil can be classified into three main types known as texture. The combination of sand, silt, and clay percentages dictate which type of soil is present. The figure below is known as the “Textural Triangle”, and it is common practice for soil scientist to use the image to classify soil types. Missouri soils, specifically Ozark landscapes, are dominated by clay, are poorly drained, and saturate easily. Clay is the smallest soil particle of the three and has extreme water holding capacity. Clay particles can be suspended in water for days or weeks depending on the velocity of the water. This is known as flocculation, which is the term used to define clay suspension for an extended period.



Types of Soil Texture



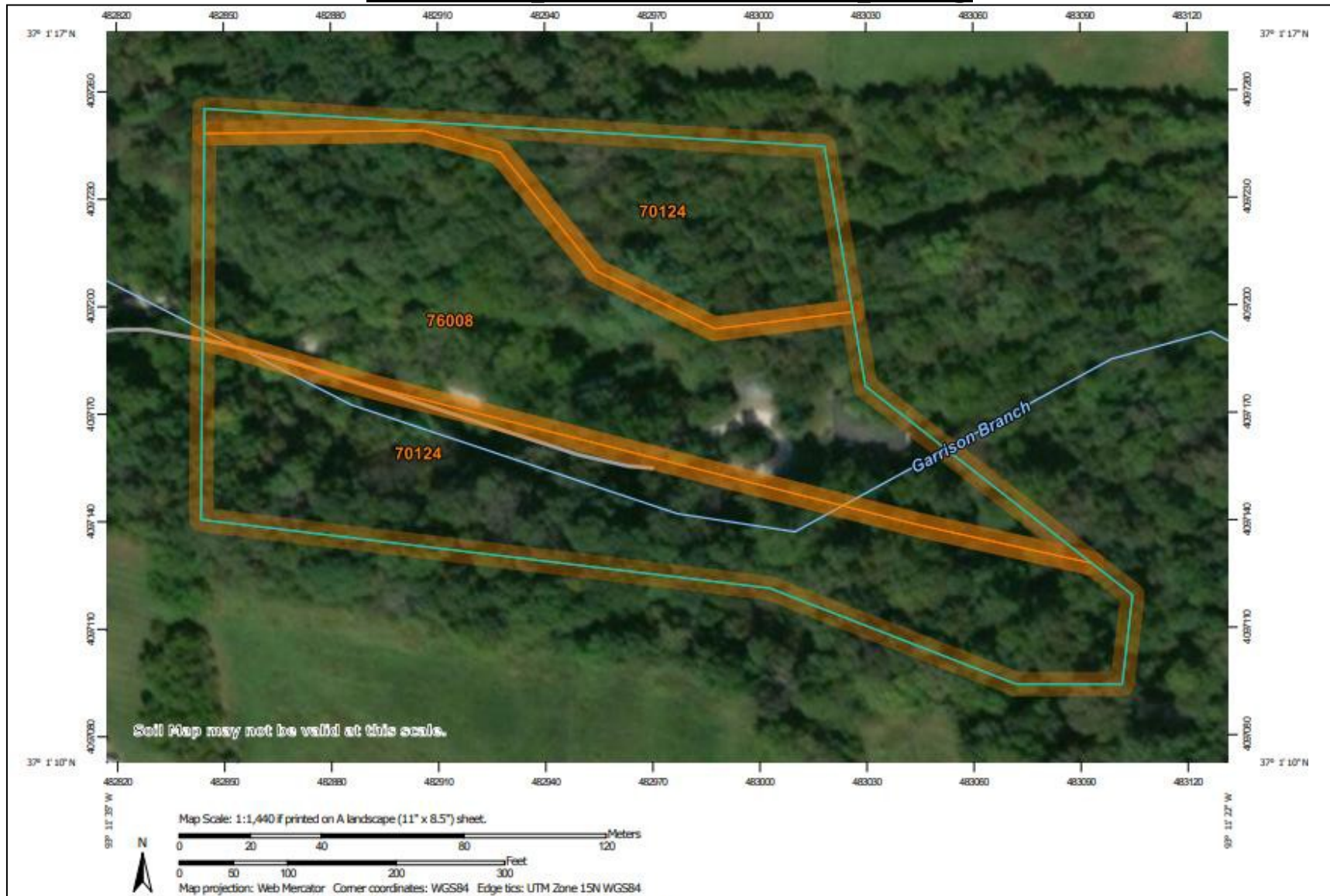
Soil Texture Triangle

The Natural Resource Conservation Service (NRCS) provides a free soils mapping application that can be used to estimate soil types and classify landscapes for management activities. The application is based off historical soil records and landscape factors. The program is free to the public and was used to delineate the property boundary, soil type, and landscape suitability for the proposed project area.

Below is a summary of the soils onsite with suitability for various activities on the property. While these are to be considered when implementing management practices and construction, it is important to remember that these are only estimates of soil type and not actual ground truth. Soil type boundaries are not clear cut and can extend well past estimated areas or be in a location not picked up by the soil survey. Overall, online soil maps are extremely reliable and give land managers a ballpark of soil type that is suitable for planning and implementing best management practices.

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
70124	Goss-Gasconade complex, 3 to 50 percent slopes	3.4	53.6%
76008	Cedargap gravelly silt loam, 1 to 3 percent slopes, frequently flooded	3.0	46.4%
Totals for Area of Interest		6.4	100.0%

Soil Map of Garrison Spring



Soils Description

Map Unit: 70124- Goss-Gasconade complex, 3-50 percent slopes

Component: Goss (65%)

This soil unit is comprised of two sub-components, identified as Goss and Gasconade. The Goss component has developed from slope alluvium over residuum weathered from limestone. Gasconade has developed from residuum weathered from limestone over limestone. It is generally found on hills and hillslopes from 3%-50%. Depth to a root restrictive layer is greater than 60 inches in the Goss component, and between 13-21 inches to bedrock in the Gasconade. This soil is naturally well drained to somewhat excessively drained. There is no zone of water saturation within a depth of 72 inches. This means that the soil is not suited for ponding. This is a moderately suited soil for black walnut and rated as a fair soil for white oak. The best suited soils in this map for black walnut growth are very deep, moderately well drained, or well drained, medium textured (silt), have a high available water capacity, no rock fragments in the upper 24 inches, and are subject to brief or very brief flooding duration. The best suited soils in the unit for white oak growth are also very deep, moderately well drained, or well drained, medium textured (silt), have a high available water capacity, and have no rock fragments in the upper 24 inches. Additionally, the best suited soils are protected on slopes that face north and east, away from direct sunlight. The Gasconade component is often associated with a woodland glade complex.

Map Unit: 76008- Cedargap gravelly silt loam, 1-3 percent slopes, frequently flooded

This soil is found on hills and drainage ways. The parent material consists of loamy alluvium over clayey alluvium. Slopes are one to three percent. Depth to a root restrictive layer is greater than 60 inches. This soil is naturally well drained. This soil is frequently flooded, but it does not usually pond. A seasonal zone of water saturation is at 48 inches during January, February, March, April, November, and December. This soil type may flood frequently, but its natural drainage ability makes it unsuitable for ponding. This is a good soil for white oak especially on protected slopes. The best suited soils for white oak growth are very deep, moderately well-drained or well-drained, medium textured (silt), have a high available water capacity, and have no rock fragments in the upper 24 inches. Also, the best suited soils are on protected slopes that face north and east, away from direct sunlight. This soil is also moderately suited for black walnut. The best suited soils in this map unit for black walnut are very deep, moderately well-drained or well-drained, medium textured, have a high available water capacity, no rock fragments in the upper 24 inches, and are subject to brief or very brief flooding duration.

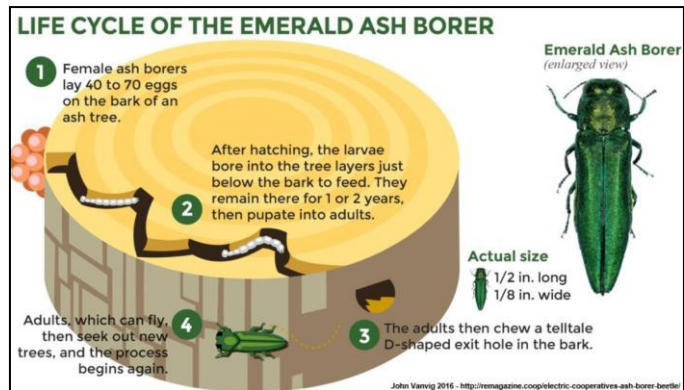
Source: [Garrison Spring Soil Report.pdf](#) via NRCS Web Soil Surve

Plant Diseases

Emerald Ash Borer

One of the most common insect pests in the United States, emerald ash borer (*Agrilus planipennis* Fairmaire) is an Asian beetle that has rapidly expanded in coverage and impact since the early 2000s. Only species of ash trees (*Fraxinus*) are targeted by the invasive insect. Missouri is home to six species of ash, and over 85 counties in the state have documented cases of emerald ash borer since 2008.

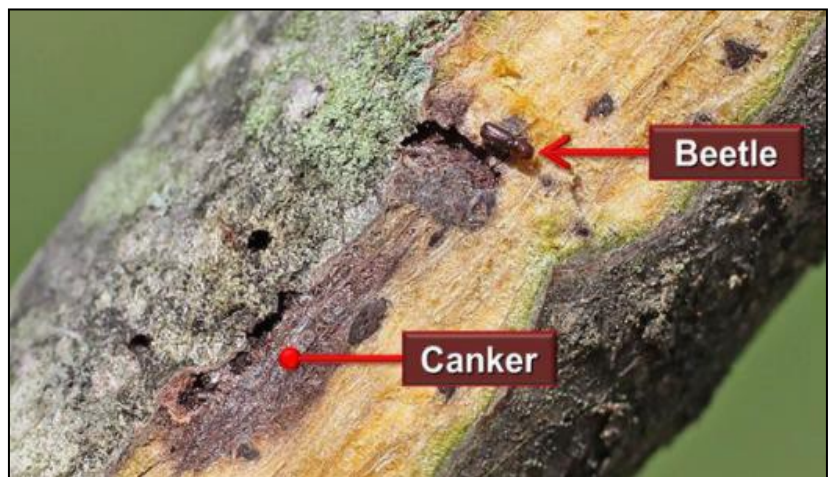
The adult beetles only cause minor defoliation to the trees, but it is the larvae of the borer that cause extreme harm to the tree. The adult beetles carve grooves into the inner bark of the tree and lay their eggs to hatch. Once the larvae are mature enough to consume plant material, they feed on the inner bark surrounding the hatching zone, disrupting the transport of vital nutrients and water throughout the tree. With time, the tree can no longer support plant function and less than three years from initial predation, mortality usually occurs.



Emerald ash borer poses an additional threat after the tree dies. Ash wood is a great source of firewood, and even after the tree is harvested, ash borers can remain in the cut wood. The transport of firewood from infested areas to non-infested areas have greatly increased the spread and damage of ash trees around Missouri. Because of this, it is now illegal to transport firewood across county lines, to reduce emerald ash borer transport.

Thousand Cankers Disease

A fungal disease carried by walnut twig beetles is responsible for thousands of walnut trees (*Juglans nigra*) becoming infected and dying since the 1990s. Thousand cankers disease is transmitted by the beetle into the tissue of the plant during feeding. Once the fungus becomes established in the tree, it kills plant tissue, disrupting plant function and nutrient allocation. Once the disease spreads outward

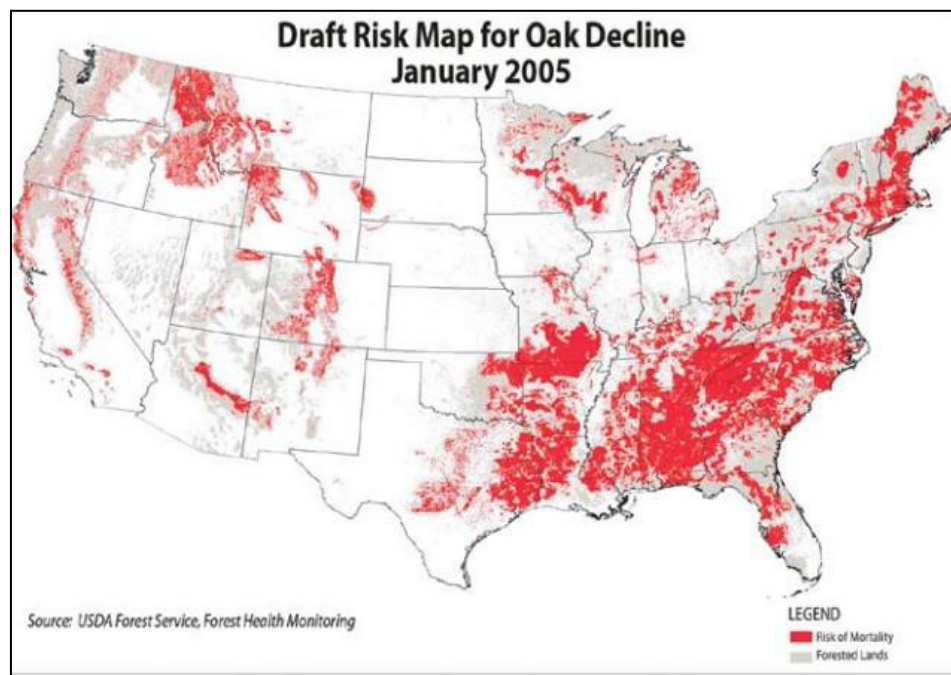


past the cambium layer of the walnut tree, it shows noticeable cankers on the bark where the beetles entered and attracts additional walnut twig beetles to prey on the tree.

As the population of twig beetles increase on the tree, nutrient transport focuses on combating the fungal diseases and not on regulating plant growth and function. Eventually the tree becomes weak due to a lack of nutrients and dies within three years of the initial infection, ruining commercial lumber and causing economic loss. While it is impossible to track the migration and location of walnut twig beetles, preventative harvest measures have been successful in mitigating impacts to large stands of walnut. It should be noted that this disease has not been observed in Missouri but has been found in the eastern region of black walnuts in the United States, including the bordering state of Tennessee.

Oak Decline

One of the most intriguing and difficult issues facing Missouri's hardwood forests is the phenomenon known as oak decline. While the event is complex in nature, it is reserved mainly for the black oak species group (red oak, scarlet oak, black oak) and it is being investigated by the Missouri Department of Conservation for possible white oak group influence. The overarching factors associated with oak decline are shallow soils, previous landscape abuse, and increased frequency of drought.



Acute pollution and the effects of other natural pests, such as root rotting fungi, red oak borers, and leaf-eating insects only increase the effects of oak decline in the Ozarks. The loss of overstory trees and dominant species reduces habitat for wildlife species and hard mast foraging opportunities for mammalian and avian species. This process promotes shade-tolerant species, which are not favorable for wildlife habitat. The presence of dead standing timber poses a safety hazard to recreational users, with many trees becoming unstable and liable to collapse without

warning. Many recreational opportunities in the Ozarks are focused on hardwood forested regions, which could be aesthetically altered by oak decline. Finally, increased oak mortality and dead timber in fire suppressed regions increases the amount of fuel on the ground, thus increasing the fire risk for affected areas.

While oak decline is still being investigated by scientists and biologists for its long-term effects, it will continue to be the dominant ecological factor in place across the Ozarks. An effort to diversify age classes within hardwood forests to produce un-even age structure is widely regarded as the best management practice currently available. A mix of primary and secondary tree species in different age classes, provides the best habitat for wildlife, while reducing the influence of oak decline.

Invasive Species

The most important task when managing invasive species is to correctly identify the species and properly apply the best management strategy possible. Mechanical and chemical methods of control are usually the types of management implemented in plant communities due to their simple design and general effectiveness. In the Ozarks and specifically Garrison Spring, a few noxious weeds and other invasives are present onsite. They will be discussed below in further detail.

Bush Honeysuckle

Bush honeysuckle (BH) (*Lonicera maackii*) is one of the most widespread invasive species in the Ozarks. The woody shrub is native to eastern Asia, specifically Korea, and grows in dense patches in all soil types. This type of honeysuckle is very aggressive and outcompetes native vegetation for resource acquisition and has many physical factors that allow it to sustain large populations.

The shrub exhibits an array of tactics to survive in the poor soils of southern Missouri. Bush honeysuckle is one of the first woody plants to leaf out in the early spring and is one of the last woody species to drop foliage in the late fall. This increased temporal period in respect to other native plants leads to increased photosynthetic mechanization and additional resources consumed by the plant. BH also produces fruit and flowers earlier than most other native plants. BH produces small red berries that attract wildlife such as birds and small mammals. The fruit, which contains the seeds of the plant, is consumed, and then deposited in fecal material in new regions. Birds are exceptional at spreading BH seed due to their extreme attractiveness to the fruit and ability to deposit seed miles away from the host plant.

BH is generally managed in three ways. First, if the plant is young and has not yet developed a large root system, it can be simply pulled from the ground by hand. It is important to remove the entire plant, roots included, to reduce the chance of resprouting. If the plant is less than three feet tall, but cannot be pulled from the ground manually, herbicide applications of glyphosate, triclopyr, or any broad-leaf specific herbicide are adequate options to terminate BH plants. Finally, if BH is too tall to spray or pull manually, a method known as “cut-stump” is required. In this method of treatment, the shrub is cut via saw at the base and then the stump is covered in higher concentrations of herbicide to promote transport down through the root system, terminating the plant.



Bush Honeysuckle with Fruit

Wintercreeper

Wintercreeper (WC) (*Euonymous fortune*) is a fast-growing vine that infiltrates disturbed sites and can completely cover ground surfaces and climb trees. The vine is native to Asia,

specifically the Philippines and Japan, and was introduced in the early 20th century as an ornamental ground cover species for landscaping purposes. However, like many introduced species, WC escaped cultivation and can be found in almost every urbanized city in the United States.

WC is aggressive in nature and can completely shade out native species while obtaining nutrients and other necessary resources through underground stems known as rhizomes, which can extend outwards of 30 feet from the host plant. Like bush honeysuckle, WC also has an extended period of growth, and never loses its foliage throughout the winter months. WC is unique in the sense that it will not produce seed unless it is six feet off the ground, so it climbs trees and other structures to produce fruit and seed. While climbing a tree, the vine taps into the cambium of the tree, stealing nutrients and water away from the tree in a parasitic role. WC reproduces via fruit that is red/orange in color and aggressively consumed by birds. The consumed seed is then deposited in a new region.

There are two methods of managing WC populations. First, the majority of wintercreeper is found on the ground surface, but it is usually too dense to manually remove by hand, so an application of a broad-leaf selective herbicide (triclopyr) is recommended for adequate management. September through November is the best time of apply herbicide to WC vines, because that is when active transport and growth rates are the highest. Complete foliar application of the vine is needed to terminate the plant. When WC climbs trees to reproduce, the best method for management is to cut the vine and apply a higher concentration of herbicide to the face of the cut, promoting transport throughout the vine down through the root system. WC is very hardy, which results in the need for multiple herbicide applications to adequately manage the invasive population.



Wintercreeper at Garrison Spring Park

Callery Pear

Callery or Bradford Pear (*Pyrus calleryana*) is an ornamental tree species that has rapidly advanced in cover across the United States since the 1980s. Native to Asia, it was introduced as a landscaping tree and was widely used in many subdivision developments as a fast-growing and aesthetically pleasing tree. However, the effects of introducing callery pears to the western world were adverse, with many fields, prairies, and woodlands becoming overrun by cultivar pears, resulting in degraded landscapes.

Callery pears are fast-growing and have many tactics to enhance the spread of seed and increase germination success. The tree is one of the first species in the country to produce flowers each year, usually before the last freeze/frost event in many areas. The flowers on the trees are pollinated and fertilized very early in the growing season, which enhances the ability of the tree to spread to other sites and cultivate quickly.

Callery pear can be managed in a few ways. The most practical management tactic is to cut the tree at the base of the stump and apply a small amount of non-selective, water-safe herbicide (Rodeo) to the stump to allow for termination of the roots and prevent resprouting. For smaller seedlings, a foliar application of triclopyr to the leaves will terminate the tree and prevent spread to other areas of the site. It is important to remove Bradford pears early in the growing season before they reach the flowering stage, so late fall and winter are the preferred times of the year for removal. Foliar applications are recommended in late spring and early summer after the tree flowers and leaves have become established on the branches.



Bradford pear tree in full bloom

Safety Hazard Issues

Ensuring the safety of recreationists while maintaining the balance of the ecosystem of Garrison Spring hinges on addressing current and future safety hazards. The following known hazards will be discussed:

- Flash flooding on Garrison Branch
- Wooden pedestrian bridges
- Erosion during trail construction
- Outdated irrigation
- Main road culvert

Flash Flooding of Garrison Branch

Like many small streams in the Ozarks, Garrison Branch is dependent on precipitation and the percolation of rainfall into the water table to sustain flow. It is a first order stream according to the United States Geological Survey and can rapidly rise after heavy rainfall due to its watershed topography, geology, soil type, and stream gradient. All these landscape factors collectively dictate the flow and runoff of the entire watershed area. The watershed of Garrison Branch is small compared to Finley Creek, but the entire Garrison Spring property lies within it. This landscape directly effects the streamflow and flooding impacts of downstream water bodies such as Finley Creek and the James River.

The spring branch, which exits from Garrison Cave east of the site, has its flow nearly doubled in discharge from seeps and springs throughout the valley after rainfall events. Based on records and conversations with adjacent landowners, the branch periodically floods the valley, making the road impassable to foot and vehicle traffic. The road leading into the park crosses over a tributary and the branch itself, making for two low-water crossings that frequently flood. These crossings are not located on the property but will need to be addressed to ensure safe access to the park. Most hydrograph reports show that the flooding occurs within a 24-hour period post-rainfall and recedes quickly back to safe levels for visitors and vehicles to enter the park.

Another factor that has increased the stream flow of Garrison Branch is the concrete culverts on the property, which funnel and discharge water from the residential area of the property directly into the branch. The culverts were constructed to help remove water from the floodplain and move water away from the stroll garden that currently resides in front of the house. The impermeable concrete reduces rainfall infiltration into the soil and increases discharge into the stream.

Recommended Action: The area should be closely monitored when inclement weather is forecasted. Signage and a line of communication should be established to warn visitors of potential flooding and closures of the park to ensure visitor safety.

Pedestrian Bridges

The park has been under private ownership and open to the public for many decades. One of the springs onsite is the focal point of the area and has been commonly used for portraits and photographs since the early 20th century. While these structures provide parkgoers with the opportunity to reach scenic and beautiful areas of the property, they serve as a liability due to poor construction and habitat degradation caused by increased access to sensitive areas.



Bridge over spring branch



Bridge near seep

Wooden pedestrian bridges were built over remnant concrete bridges to give visitors an up-close view of the karst features of the park. The bridges are a liability to maintain due to the flooding and constant foot traffic onsite.

The spring branch periodically floods as mentioned in the previous section, and residents said that the bridges have been washed away on multiple occasions over the years. With each reconstruction effort there has been additional disturbance to the streambank and karst features.

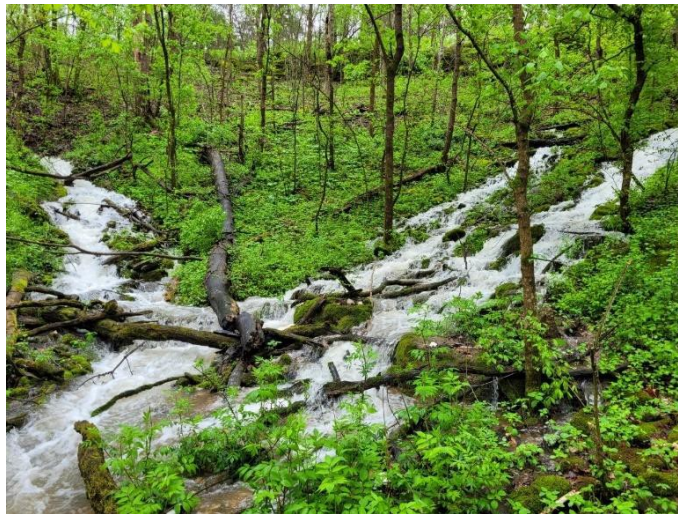
The ecological threat to the stream from foot traffic along the banks is noticeable. This area currently features mowed turf grass and lacks woody cover in the riparian zone, resulting in siltation of the branch. Many trees that once lined the edge of the stream have been removed due to the property owners desire to minimize the risk of injury to visitors from falling limbs and branches.

Recommended Action: Remove the pedestrian bridges and limit the amount of pedestrian traffic near the stream. This will mitigate the human impact on the karst features and maintain a safe buffer between the stream and potential trail(s). Plans to establish more riparian cover will need to be carefully designed to balance the protection of the stream and visitors view of the spring and stream.

Erosion During Trail Construction

Per the city of Ozark, a walking/hiking trail is to be establish in the park to give users a way to interact with the landscape and explore the area surrounding the springs and seeps. However, the NRCS Web Soil Survey rates most of the area as “poor” in non-motorized trial suitability. This is mainly due to the steep gradient of the valley that encloses the park. Also, the area of the park is less than 10 acres, which limits the area of possible pathways. The parent material of the Ozarks is mainly limestone, specifically chert, which is a difficult medium to develop trails on due to its tough substrate and low infiltration capacity. The slope of the valley increases runoff rates and consequently increases erosion rates as precipitation rates increase.

While the ability to construct a trail that meets safety standards and United States Forest Service trail gradient requirements is possible in theory, the potential erosion from construction would likely increase sediment runoff and siltation of the spring branch in the valley. The stream already has excess siltation due to a lack of native vegetation and an excessive amount of pedestrian foot traffic. Proper precautions and management practices will need to be carefully examined to ensure a minimization of erosion while establishing a satisfying and stimulating walking path.



The seeps at Garrison Spring form a small valley

Recommended Action: Carefully develop and construct a walking path that minimizes erosion risks and reduces the siltation of the spring branch. While it may be tempting to make the trail pass in proximity of the karst features, a buffer should be established around the ecologically sensitive areas of the park to ensure the sustainability and conservation of species and landscapes. The trail will need to satisfy USFS trail requirements and safety measures.

Outdated Irrigation & Unnecessary Piping

Pipes on the property conveyed water to the railyard and for irrigation purposes. None of these pipes are currently being used. The property currently boasts a small stroll garden in the bottom of the valley, adjacent to the spring branch. A primitive irrigation system that draws water from Garrison Spring has been installed, featuring multiple water spigots and hoses to provide access to water for the stroll garden. While this met the needs of the previous landowner, it will not be needed to restore and preserve the natural landscape of Garrison Spring.



A set of irrigation pipes extending from Garrison Spring

Recommended Action: To transform the park back to its natural landscape, the outdated infrastructure will need to be removed.

Main Road Bridge/Culvert

The current access to the park is through a main road that leads from Jackson Street in eastern Ozark to the private drive of Garrison Spring. Before entering the private drive, visitors must cross over a concrete box culvert that spans Garrison Branch. The culvert has become severely degraded and needs to be replaced with a modern structure. While the current plans for the park are to make the road walk-in only, vehicles will still need to cross the bridge to access the property for maintenance and ADA access.

One important aspect of the structure is fish passage. The current culvert blocks stream flow, reducing the ability of native fish species to travel up and down the stream. It is recommended

that the City of Ozark consult with the Missouri Department of Conservation regarding bridge design and the potential for cost share opportunities.



Concrete culvert on main road



Bridge over main road culvert

Recommended Action: Reconstruction of the culvert and bridge to provide safe vehicle crossing and ensure fish passage. While the design and construction of the culvert does not fall under the forest management plan, it is vital to have an accessible road into the park for visitor access and maintenance activities.

Future Considerations

Adjacent Property Acquisition

Downstream of the park are several private lots that do not have residential structures near the stream. While the road and private drive to the park run along the valley, it would be of good interest to explore purchasing options for the right-of-way on either side of the road. This would minimally infringe on private property areas and provide greater protection of the riparian corridor. This process would allow the park to manage over 50% of the entire length of Garrison Branch's riparian zone, a remarkable possibility.

Protection of Garrison Cave

Garrison Cave is on private property about one mile east of the Garrison Spring property. This well-known cave is the largest fully mapped cave in the state, running a total of 4.8 miles long (over 25,000 feet). The cave has a rich history with visitors. As early as the 1880s, locals would travel to the cave entrance to have a lunch. In 1897, the cave was explored by men hoping to find treasure left behind by Hernando de Soto. At the time, every cave in the Ozarks was thought to hold silver left behind by de Soto's crew. Instead, ashes and human bones were found. A class of geology students was the first to map the cave in the 1970s, going as far as a small dam near the entrance. In 1997, a project began to create a complete map of the cave, ultimately finishing in 2009. Further cave crawls in 2016-2017 added phantom passages to the map.

Garrison Cave is home to many bristly cave crayfish (*Cambarus setosus*), a species of special concern. Populations of this species are stable, but they have a limited range and habitat restrictions that can make them vulnerable to extinction. Owning the rights to the cave entrance would allow the city of Ozark to protect the crayfish populations. It would allow record-keeping of explorations, to limit human contact with the species. Signage and permit rights could also help keep visitors safe.

Conservation Easements

Conservation easements are binding agreements that extend maintenance and care of a landscape far beyond the original property owner. Garrison Spring would be an excellent candidate for an easement, ensuring the protection and care of the park for generations to come. Easements would be a binding legal document that entails all the management planning and the desired future conditions of the park. Easements can be adapted and changed over time but are generally considered to never expire.

The common pushback against easements is the appraisal side of the agreement. While the placement of an easement onto a property generally reduces the overall value of the site, that is not an issue for Garrison Spring. Since the site is to be a public park, there is no current intent of selling the property to a private party. The easement would serve as an agreement for the city of Ozark to apply for future grants, local funding, and conservation practices. Ozark Land Trust,

which has over 100 conservation easements in southwest Missouri, is the most well-known easement organization in the region. They are a 501(c)3 non-profit whose mission is to “help landowners preserve and protect the nature, history, and heritage of the Ozarks forever.” Their website is <https://ozarklandtrust.org/>.

Hiking Trail & Site Plan

Hiking Trail: A loop trail (not ADA-compliant) could circle most of the property (see map). In traversing steep areas along slopes, switchbacks may be needed to maintain the desired grade. The proposed trail will be about 1 to 1.5 miles in length. On the northeast and southeast sides of the property, where the trail is close to the property boundary, the trail should pass about 20 to 30 feet inside the boundary line. Where this trail crossed the creek, at the east end of the property and just upstream of Garrison Spring, rock “stepping stones” are recommended. These will be engineered to provide low cost, simple and stable crossings, and will not create maintenance headaches.

Hard Surface ADA-compliant trail: The entrance road to the house will serve as a hard surface trail, part of the inner loop. This can be constructed of pervious material as a demonstration of how to reduce runoff. The other leg of the loop will begin near the property entrance, follow the north edge of the floodplain where it begins to break to the valley wall, and ending at the house and gardens. This trail will be about one-half mile in length.

GARRISON SPRING PRELIMINARY SITE PLAN - OZARK, MISSOURI



1 inch = 40 feet

- GARRISON SPRINGS PARCEL BOUNDARY- CITY OF OZARK PARCEL
- GARRISON SPRING
- ADA COMPLIANT TRAIL (Hard surface trail)
- HIKING TRAIL (Maintain grades, keep 20' - 80' from property boundaries)
- STONE CROSSINGS
- OLD CONCRETE DAMS (1930's)
- SPRINGS
- HOUSE
- BARN
- SHED
- DRIVE
- STREAMS
- FORMAL GARDENS (Seating, hummingbird and butterfly gardens, etc)
- RESTORE RIPARIAN
- BRIDGES
- FOREST LEARNING STATION
- SPRING LEARNING STATION
- 10' CONTOURS
- 1' CONTOURS

Map compiled by: Curtis Capers, Inc. using GIS Desktop software, May 2011
Data sources: Christian County Assessor's Office, MISSOURI, 2009

Additional Resources

- Invasive Species: <https://mdc.mo.gov/trees-plants/invasive-plants>
- Timber Stand Improvement: <https://www.nrs.fs.fed.us/fmg/nfmg/docs/mn/TSI.pdf>
- Plant Diseases: <https://agriculture.mo.gov/plants/pests/>
- Christian County Assessor:
<https://christiangis.integritygis.com/H5/Index.html?viewer=christian>
- Web Soil Survey: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
- Garrison Spring News Release: https://ccheadliner.com/free/dept-of-conservation-funds-half-of-garrison-spring-purchase/article_681f700a-241f-11eb-bcef-23ff40cadd6b.html