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Invasive Species Management Environmental Assessment
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Shawnee National Forest

Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline and Union Counties, Illinois

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MAP OF PROJECT AREA

INTRODUCTION

NOTE: "Invasive species" is a term used throughout this environmental assessment. It is defined as "a plant that is **non-native to the ecosystem under consideration** and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." This is consistent with the definition in the *National Invasive Species Management Plan* (NISC 2008) and the Forest Service's *National Strategy and Implementation Plan for Invasive Species Management* (USDA FS 2004).

The USDA Forest Service is proposing to implement management activities on the Shawnee National Forest (Forest) to control the spread of invasive plant species. The Invasive Species Management project is located throughout the Forest in Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline and Union Counties, Illinois. The project area encompasses about 14,000 acres of National Forest System (NFS) lands.

The Invasive Species Management Project is designed to achieve multiple resource benefits and work towards Desired Future Conditions as established in the 2006 Shawnee National Forest Land and Resource Management Plan (Plan). It includes proposed activities that work towards meeting the Forest Plan goals and objectives for minimizing adverse effects from invasive plant species on National Forest resources.

We have prepared this environmental assessment of the proposed Invasive Species Management Project in compliance with the National Environmental Policy Act and other relevant federal and state laws and regulations. The analysis described herein is a summary of the data, methodology, analysis and findings set forth in the record. We intend for this assessment to be an analytical, science-based document that focuses on those issues identified during scoping as being most relevant to disclosure of environmental effects [40 CFR 1500.1(b); 1500.4(b), (c)]. We disclose the direct, indirect and cumulative environmental effects that might result from implementation of the proposed action and alternatives.

Additional documentation, including working papers with detailed analyses of project-area resources, maps of the areas with invasive species proposed for treatment, modeling, data and scientific references, is filed in the project record, located at the Shawnee National Forest Supervisor's Office, 50 Highway 145 South, Harrisburg, Illinois, and available on the Forest's website: www.fs.usda.gov/shawnee.

The document is organized into three parts and includes two appendices that support the analysis:

Chapter One. Purpose of and Need for the Proposed Action: This chapter includes information on the history of the project proposal, the purpose of and need for the project, and the proposal for achieving that purpose and need. It also details public involvement in the project, including identification of major and minor issues addressed in the environmental assessment.

Chapter Two. Description of Alternatives, including the Proposed Action: This chapter provides a description of the proposed action as well as alternatives developed to address public issues. It also provides a summary table of the environmental consequences associated with each alternative.

Chapter Three. Affected Environment and Environmental Consequences: This chapter describes the environmental effects of implementing the proposed action and other alternatives. It is organized by resource area. The affected environment sections describe the existing condition of the resource as it relates to the effects analysis. Finally, the direct, indirect and cumulative effects are disclosed.

CHAPTER 1 – PURPOSE OF AND NEED FOR THE PROPOSED ACTION

Background

– Problem Forest-Wide –

The Shawnee National Forest (Forest) has numerous and abundant populations of invasive plant species that pose an increasingly serious threat to plant and wildlife community health, diversity and resilience. Our use of integrated pest-management principles for the prevention/eradication/control of invasive species has lacked certain tools available for responsible control.

Garlic mustard
(*Alliaria petiolata*)

Kudzu
(*Pueraria montana*)

Chinese yam
(*Dioscorea oppositifolia*)

Amur honeysuckle
(*Lonicera maackii*)

Figure 1. Examples of invasive species infestations in southern Illinois.

Prevention measures have proven to be inadequate to stop the spread of the most aggressive invasive species. When we see many areas of the Forest infested and overcome by invasives and recognize the potential loss of biodiversity caused by their establishment, we know that the action threshold has been crossed, the action threshold being the point at which it is clear that the methods being used to control

invasives are not adequate. It is at this point we must analyze other methods, including herbicide-use, to manage invasive species on the Forest.

We have utilized mechanical and manual control methods with varying degrees of minimal success (see monitoring reports in project record). Invasive species can have serious adverse impacts in unique habitats such as barrens and seep-springs. They thrive in areas where they normally would be kept out by fire. They take up space that could be used by native species, and cause springs to go dry by de-watering the fragile ecosystems. Invasive plant species, displaced from their original ranges, often lack natural controls like disease, predators, parasites, or climate. They tend to out-compete and eventually replace native species (Eco-Pros 2013, Huxel 1999, NISC 2008, Thompson et al. 2009). Not only do invasive species compete with natives for resources, they can cause the loss of habitat and food for wildlife, alter soil structure and chemistry, modify fire regimes, alter plant succession, hybridize with natives to compromise local genetic diversity, and replace and possibly lead to the local extirpation of native plant species, including threatened, endangered and sensitive species (Beck et al. 2008, Pimentel et al. 2004, Westbrooks 1998).

Twining Screwstem (*Bartonia paniculata*)	**New York Fern** (*Thelypteris noveboracensis*)
Picture by Kay Yatskievych (www.discoverlife.org)	
Large Whorled Pogonia (*Isotria verticillata*)	**Brome-like Sedge** (*Carex bromoides*)

Figure 2. Rare species in seep-spring habitats threatened by invasive species and the lack of fire.

We have conducted field surveys and inventories of invasive species in designated natural areas on the Forest for over 20 years and recorded locations of invasives on the Forest for decades. In 2004, we partnered with Southern Illinois University-Carbondale to develop a database of existing inventory records of invasive species sites on the Forest. Over 1600 sites of invasive species infestation have been identified, involving

over 65 different species. Inventory information as of May 2013 has been used for this analysis. These data are the best available information regarding the type and extent of invasive species on the Forest.

Although over 65 invasive species are currently found on the Forest, a few are highly invasive and pose a measurably greater threat to natural resources. The project interdisciplinary team identified four highly invasive species that pose an increasingly serious threat to rare species or communities on the Forest: Amur honeysuckle, Chinese yam, garlic mustard and kudzu (Figure 1). The team based their determination on published scientific information, consultation with the Illinois Department of Natural Resources (IDNR) and other resource experts, and/or field observations of current conditions on the Forest (Jones 2003, Kaufman and Kaufman 2007, Landis and Evans 2005, Morrison 2007, Tu 2000, USDAFS 2004, USDAFS 2009, Wolfe 2008). These four species have characteristics that permit them to rapidly invade and dominate new areas and out-compete other vegetation for light, moisture and nutrients.

Since the initiation of this analysis other invasive species, such as Nepalese browntop and autumn olive, have spread rapidly into the Forest and come to the forefront as threats to native plant and animal communities. We propose to treat them in natural areas in this assessment, but we will address other locations in future.

– Problem in Natural Areas –

Since 1980, the Forest has cooperated with the State of Illinois Nature Preserves Commission in protecting the last remnants of Illinois' natural heritage. The initial Illinois Natural Areas Inventory in 1978 identified 1,089 of the state's rarest remaining areas, 80 of which are in the Forest. Recognizing the value of the unique features of these areas, the Forest designated the 80 sites as "natural areas" in the first Land and Resource Management Plan (Plan) in 1986 and affirmed the designations in the 2006 Forest Plan (USDAFS Shawnee 2006). Today we protect these areas under the Forest Plan Natural Area Management Prescription (Plan, page 76), which requires the protection and perpetuation of their significant and exceptional features. These features are generally ecological in nature, with unique plant and/or animal communities and habitats. However, due to a variety of reasons, most of the natural areas have not been actively managed in ten years or more, leading to the general degradation of their natural communities. Invasive plant species are encroaching on them; many limestone and sandstone barrens are reverting to forested conditions. This degradation is confirmed by field surveys and reports by IDNR that emphasize these communities require active management to maintain their integrity (IDNR 2008/February and July, 2011).

Today, we cooperate with the state's vision of sustainable natural areas, which addresses the challenges facing natural areas today, including invasive species, degradation and, increasingly, climate change. The primary goal of the vision in the short term is to protect the natural areas as they exist today, with their current ecological functions and biodiversity (Glosser 2011). Comprehensive information can be found at the Illinois Nature Preserves Commission website (dnr.state.il.us/inpc) and the Illinois Natural Area Inventory website (www.inhs.illinois.edu/research/inai/index.html).

Snow Springs, Kickasola Cemetery, Dean Cemetery West and Cretaceous Hills are natural areas designated for their ecological value. These areas contain acidic seep-springs, a unique habitat-type being adversely affected by invasive species and a lack of fire. Fire plays an important role in the maintenance of this habitat-type. Because of the lack of disturbance by fire, several native as well as invasive species have become established near and within the springs. Native species such as poplar, sugar maple, sweetgum, red maple and river birch are having a drying effect on the springs. Invasive species such as Nepalese browntop, Japanese honeysuckle and multiflora rose are crowding out several sensitive species. Monitoring indicates that management is required to prevent the loss of the twining screwstem, New York fern (Figure 2) and other species in seep springs on the Forest (IDNR 2011).

Purpose of and Need for Action

The purpose of this project is to restore and protect native ecosystems on the Forest by utilizing all environmentally responsible tools for the control or elimination of populations of invasive plants at the specified locations. Action is needed at this time because:

- invasive species are jeopardizing the survival of some ecological communities,
- invasive species are increasingly degrading native plant communities,
- established invasives populations are serving as a source for spreading infestations,
- taking action now can avert a more widespread and costly future problem,
- existing invasive species populations can spread to adjacent lands,
- past control efforts in small areas using mainly manual methods have been laborious and only marginally effective in preventing the establishment of invasive species populations,
- invasive species populations are persisting and continuing to spread, pointing to the need for a comprehensive and integrated approach to treatment, and
- prevention of the establishment of new infestations is more effective than trying to control and eradicate entrenched infestations.

Action is necessary to put in effect the guidance in the Forest Plan:

> The risk of damage from existing invasive species should be reduced through integrated pest management. Invasion-prevention measures should be implemented to maintain native ecosystems. Existing populations of invasive species should be eradicated, controlled and/or reduced. Effects of management activities on the encroachment and spread of invasive species should be considered and mitigated, if needed. Natural areas and lands adjacent to natural areas have the highest priority for the prevention and control of invasive species (FW34.2.1).

Proposed Action

The Forest Service proposes a dual approach to the control of invasive species:

1. **Forest-wide treatment with prescribed fire and manual, mechanical and/or chemical control methods of currently known sites of the four highly invasive species: Amur honeysuckle, Chinese yam, garlic mustard and kudzu.**
2. **Management of 23 natural area treatment zones, including control of invasive species, through the use of prescribed fire and manual, mechanical and/or chemical control methods.**

The proposed action would integrate various control methods—manual, mechanical and chemical—to eliminate or control invasive species populations. The proposed action generally would target aggressive invasive species, but also would manage specified native plants threatening unique ecosystems or degrading natural-area community integrity. The work would be accomplished over a number of years, with periodic reviews of the assumptions, data and analysis on which the responsible official bases his decision.

Decision Framework

Given the purpose and need, the responsible official, the Forest District Ranger, will review the alternatives in order to make the following decisions:

- Should herbicides, mechanical methods and prescribed fire be used to eradicate, control and/or reduce invasive species in the specified locations and to manage the specified natural areas?
- What design features and/or mitigation should be used to achieve resource objectives?
- What monitoring should be done to evaluate the implementation of the project?

Public and Agency Involvement

In April 2008 we mailed a scoping letter to about 350 individuals and governmental and non-governmental organizations about the proposed invasive plant management project and encouraged to comment on the proposal. The scoping letter, attachments and maps were also posted on the Forest's website. Responses were analyzed by the interdisciplinary team in order to identify issues. Most were supportive of invasives

control on the Forest; some differed on what species to control and what methods to use. Additional species and treatment methods were suggested. Some stated that herbicides should not be used due to concerns for human health and safety and possible effects on native species.

In addition, we partnered with the Sierra Club and the River-to-River Cooperative Weed Management Area to enlist the public's help in increasing our knowledge of invasive species distribution on the Forest. In 2008 and 2009 we worked with about 35 volunteers identifying invasives in natural areas. Between the volunteers and our staff we identified many new infestations, clarifying the extent of the threat.

In response to the original and the revised environmental assessment, we received comments from many individuals and governmental and non-governmental organizations, and three form letters. Our proposal has been endorsed by the IDNR, the Illinois Nature Preserves Commission, the Illinois Invasive Species Plant Council, the River-to-River Cooperative Weed Management Area, The Nature Conservancy and several individuals. Some individuals and organizations expressed concern and opposition.

Following the May 2011 publication of the Decision Notice and Finding of No Significant Impact, we received two appeals of the decision. After review and consideration of the issues, the Responsible Official withdrew his decision in order to revise the environmental assessment. A Decision Notice and Finding of No Significant Impact were published in January 2013. There was one appeal. Finding that risk assessments for glyphosate and picloram had been updated since the analysis, the responsible official withdrew his decision so that the project interdisciplinary team could review the analysis in light of the new risk assessment information. This revision is the result of that review.

Issues

Issues are points of debate, disagreement, or dispute about the environmental effects of a proposed action. Following scoping of the public and other agencies, the interdisciplinary team identified the issues related to the invasive species control proposal and divided them into two groups, key and non-key. Key issues are those directly or indirectly caused by implementing the proposed action or alternatives. (Non-key issues are listed and explained in the project record.) The list of issues was reviewed and approved by the responsible official.

Key Issues and Indicators:

- The application of herbicides may affect humans.
  - Human Health Indicator: We will discuss the response of the public in terms of the effects that the approved and properly applied herbicides could have on public health and employees/applicators.
- The establishment and spread of invasive species may affect natural areas and ecosystems, including plants and wildlife.
  - Plant Community Indicator: We will discuss the response of the plant community in terms of acres of invasive species reduced and native species restored/protected.
  - Wildlife Community Indicator: We will discuss the response of federally listed species in terms of potential changes in their habitat.
- The application of prescribed fire and mechanical treatments may affect designated natural areas and ecosystems, including soil, water, plants and wildlife.
  - Soil and Water-Quality Indicator: We will discuss the predicted amount of soil erosion in terms of tons/acre/year.
  - Plant Community Indicator: We will discuss the response of the plant community in terms of potential changes in the number and frequency of invasive and native plant species.
  - Wildlife Community Indicator: We will discuss the response of Regional Forester's Sensitive Species and species with viability evaluation in terms of potential changes in the habitat.

- The application of herbicides may affect designated natural areas and ecosystems, including soil, water, plants and wildlife.
  - Soil and Water Quality Indicator: We will discuss the potential persistence of the proposed herbicides in the environment.
  - Plant Community Indicator: We will discuss the response of plant communities in terms of the potential effects on natural areas' significant and exceptional features.
  - Wildlife Community Indicator: We will discuss the response of the wildlife community to the proposed action in terms of potential changes in the habitat of management indicator species.

Chapter 2 – Alternatives

This chapter describes each alternative and compares the alternatives considered.

NOTE: All descriptions of area measurement are approximate.

Common to All Alternatives: Prevention and Education

Prevention and education are important elements of our overall invasive species management strategy (project record). Prevention of the spread of invasive species is recognized as a primary part of the mission of the Forest Service (USDA FS 2003) and the Forest is implementing prevention measures currently, including ensuring the revegetation of treated invasive species sites, the placement of hiker boot-brush stations, and education.

Our invasive species prevention and education program includes our participation in the River-to-River Cooperative Weed Management Area (CWMA) (CWMA 2009-2011). This is a group effort of 12 federal and state agencies, organizations and universities whose goal is the coordination of efforts and programs for addressing the threat of invasive plants in southern Illinois. The CWMA was established in 2006 and addresses invasive plant species through collaborative projects and activities focused on education and public awareness, early detection and rapid response, prevention, control and management, and research.

Alternative 1 – No Action

Under this alternative, we would continue to implement current strategies of invasive species management, pulling and torching about 50 acres of invasives annually, inventorying and mapping infestations and burning about 6,000 acres per year to set back invasive species, including in some natural areas. We would continue openlands management, mowing, disking and bush-hogging about 150 acres per year, contributing to a reduction in invasive species. We would continue to apply herbicides in campgrounds and at administrative sites (about 50-100 acres per year), contributing to invasive species control in those areas. No ground-disturbing mechanical treatments could be done in the proposed treatment locations, nor could herbicide be applied outside of administrative sites and campgrounds.

Alternative 2 – Proposed Action

Under this alternative, we would treat invasive plant infestations using an integrated combination of prescribed fire and manual, mechanical and/or chemical methods. As we said above, our employment of integrated pest-management principles for the prevention/eradication/control of invasive species has lacked all the tools available for responsible control. Prevention measures have been inadequate to stop the spread of the most aggressive invasive species. We have tried mechanical and manual control methods with varying degrees of minimal success. We will continue to use public information and education to increase awareness of invasive species issues. Under our proposal, we would treat specified areas of the Forest (see maps) given available time and resources. Post-treatment monitoring would evaluate effectiveness and success, which we would disclose in our annual monitoring reports. Our proposal is a dual approach to treating invasives:

1. Treatment of all known sites with four highly invasive species:

The project interdisciplinary team reviewed the many invasive species on the Forest and identified four as priorities to be targeted across the Forest:

- Amur honeysuckle *(Lonicera maackii*), infesting 411 acres at 20 sites, 37 acres of which are divided among 7 sites in natural area treatment zones
- Chinese yam *(Dioscorea oppositifolia*), infesting 253 acres at 22 sites, 1½ acres of which is distributed throughout 7 sites in natural area treatment zones
- Garlic mustard (*Alliaria petiolata*), infesting 467 acres at 31 locations, 13 acres of which are divided among 6 sites in natural area treatment zones
- Kudzu (*Pueraria* m*ontana*), infesting 77 acres at 9 locations, 10 acres of which are located at 1 site in a natural area treatment zone (see maps for locations)

For the most part, these species were chosen because of their high degree of invasiveness and/or ability to suppress or extirpate native vegetation by their aggressive growth characteristics or allelopathic abilities (Jones 2003, Kaufman and Kaufman 2007, Landis and Evans 2005, Morrison 2007, Tu 2000, USDAFS 2004, USDAFS 2009, Wolfe 2008). Kudzu might not appear to fit the description of "highly invasive" in Illinois. We are targeting this species not only because it is highly invasive and could become more vigorous as climate change continues to warm our region, but also because the State of Illinois has an aggressive kudzu eradication program based on the "Illinois Noxious Weed Law" (ILCS 505/1). Under Section 2 of this law:

> Every person shall control the spread of and eradicate noxious weeds on lands owned or controlled by him and use such methods for that purpose and at such times as are approved and adopted by the Director of the Department of Agriculture.

Although not bound by this law, the Forest Service is a partner of the state in its effort to eradicate invasive species, especially in natural areas/nature preserves. Therefore, we are including kudzu—listed as a noxious weed by the state—as a priority species in this proposal. Garlic mustard is very invasive and has allelopathic properties that suppress native vegetation and change soil properties to favor its own growth. Its control is a high priority, with kudzu, Chinese yam and Amur honeysuckle following. Published science, monitoring and field studies indicate that active management of these species can greatly reduce both their current and potential adverse effects on native plants and wildlife with minimal impact on the surrounding environment. We propose integrated treatment using manual and mechanical methods and herbicides where appropriate to control and eliminate these species where they are currently known to occur (see maps for locations).

Amur honeysuckle is a large woody shrub that can occur as dispersed individuals or develop dense, coarse, spreading thickets. It tolerates high to moderate light-levels. Once treatment is initiated, we expect control within four years. (See Table 4 for treatment details.) Chinese yam and garlic mustard, treated as described in Table 4, would require follow-up treatments to deplete the seedbank of garlic mustard and eliminate Chinese yam from the natural area treatment zones. Eliminating these plants would increase the light and nutrients available to affected sites. With the associated increase in soil temperature facilitating native seed germination and increased photosynthesis, we expect that available water and nutrients will stimulate native plant species and seeds in treated areas, leading to reoccupation of the areas by native species.

Kudzu sites exhibit complete coverage by the plant. Most plants and trees covered by kudzu have died from the elimination of light. As kudzu plants occupy sites, their density is such that the ground surface cannot be seen, and the depth of the kudzu and dead plants beneath can be several feet. On the periphery of the occupied site, the kudzu plants extend runners into adjacent forest, further occupying the area by climbing trees and shrubs and eventually killing the plants. Given the extensive root reserves of kudzu, we anticipate multiple treatments over several years (see management methods in Table4).

2. *Management of 23 designated natural areas and their treatment zones:*

The interdisciplinary team reviewed the information on invasive species in natural areas and identified those most threatened with vigorous infestations or with the most vulnerable natural communities. Based on these factors, the team selected 23 high-priority natural areas for this analysis (Table 1). To enable maximum protection of the selected areas, the team configured treatment zones along streams, roads and trails—the main pathways of invasive species infestation—adjacent to and generally upstream of the natural areas. As detailed in Table 4 and Appendix A, we would treat all invasive species in the natural area treatment zones, following the published guidance of the Illinois Nature Preserves Commission (INPC 1990).

Table 1. High-Priority Natural Areas.

Name*	Location	Name*	Location
Ava ZA	Jackson County T7.5S, R4W	Keeling Hill South EA	Hardin County T12S, R8E
Barker Bluff RNA-EA	Hardin County T12S, R8E	Kickasola Cemetery EA	Pope County T15S, R6.5E
Bell Smith Springs EA	Pope County T11.5S, R5E	LaRue-Pine Hills RNA-EA	Union County T11S, R3W
Bulge Hole EA	Johnson County T12S, R3E	Massac Tower Springs EA	Pope County T15S, R6.5E
Cretaceous Hills EA	Pope County T15S, R6E	Odum Tract EA	Johnson County T12S, R3E
Dean Cemetery West EA	Pope County T15S, R6E	Panther Hollow RNA-EA	Hardin County T11S, R10E
Double Branch Hole EA	Pope County T11.5S, R5.5E.	Poco Cemetery East EA	Pope County T15S, R6.5E
Fink Sandstone Barrens EA	Johnson County T11.5S, R4E	Poco Cemetery North EA	Pope County T15S, R6.5E
Fountain Bluff GA	Jackson County T10S, R4W	Reid's Chapel EA	Saline County T10S, R5E
Hayes Creek/Fox Den EA	Pope County T11.5S, R5.5E	Russell Cemetery EA	Hardin County T10.5S, R8E
Jackson Hole EA	Pope County T11.5S, R5.5E	Snow Springs EA	Pope County T15S, R6.5E
Keeling Hill North EA	Hardin County T12S, R8E		

* BA = botanical area, EA = ecological area, GA = geological area, RNA = research natural area, ZA = zoological area

Management would include the application of prescribed fire on 12, 400 acres in and around the natural area treatment zones. Existing fire-breaks, such as roads, trails, streams and other natural features, would be used as firelines where possible; but we would mechanically construct firelines where necessary. We expect to install 14 miles of lines using leaf-blowers, which cause no earth-disturbance, and 6 miles mechanically, which would be earth-disturbing. These lines would be restored promptly in accordance with Forest Plan guidelines in Appendix F and Illinois Forestry Best Management Practices (see Table 6).

We would burn the natural area treatment zones at intervals of 1-3 years, depending on our monitoring and assessment of effects to determine the need for additional fire, as well as fuel availability. The fire would help restore native vegetation and set back the progression of invasive species. We would do further burns as needed to maintain the areas' ecological integrity once invasive vegetation has been suppressed.

We could apply herbicides to control invasive species in the natural area treatment zones either before or after the application of fire, depending on species present (see Table 4 and Appendix A). Some, such as grasses, grow well in response to fire and would be targeted before the burns or following, when new growth appears. Others, such as Japanese honeysuckle and multiflora rose, are generally set back by fire, so our burning them off before applying herbicides would limit the amount required for control or eradication. We would apply herbicides as needed until infestations are controlled or eliminated.

Herbicide application methods include thin-line application, basal-bark treatment and "hack-and-squirt" (cutting into the cambium and applying herbicide). We would cut and stump-spray and/or girdle some native trees and shrubs on about 275 acres of barrens, glades and seep-springs to improve growing conditions for the natural communities. Barrens and glades are unique native plant communities with sparse vegetation. Because of the exclusion of fire, some of these areas have grown up in shrubs and trees that shade out native and sensitive plant species, limiting the diversity of the plant community. Thinning the barrens and glades helps to restore their naturally dry condition and the species adapted to it. Similarly, we would control trees and shrubs encroaching on seep-spring areas and de-watering their rare plant communities.

The high-priority natural areas for prescribed fire and herbicide treatment are those with acid seep-springs: Cretaceous Hills, Dean Cemetery West, Kickasola Cemetery, Massac Tower Springs and Snow Springs. These are most threatened by invasive species and changes. The encroachment of aggressive invasives into these areas threatens to dry up the springs and degrade the plant community, destroying the spring habitat. Rare plant resources rely on this habitat type, including Regional Forester's Sensitive Species such as twining screwstem (*Bartonia paniculata*), purple five-leaf orchid (*Isotria verticillata*), longbeak arrowhead (*Sagittaria australis*) and New York fern (*Thelypteris noveboracensis*). Additional plant species of this community-type, including several listed as threatened or endangered by the State of Illinois, are also vulnerable to local extirpation without immediate management.

Of the remaining 18 natural areas, 11 have Regional Forester's Sensitive Species and numerous other rare plant resources: Double Branch Hole, LaRue Pine Hills, Poco Cemetery East, Poco Cemetery North, Bulge Hole, Fink Sandstone Barrens, Bell Smith Springs, Hayes Creek-Fox Den, Panther Hollow, Jackson Hole and Barker Bluff. Streams run through, or are adjacent to, all these areas, providing a corridor for invasive plant species, especially Nepalese browntop. These areas are our second priority for invasives treatments.

The remaining seven areas, Fountain Bluff, Ava, Keeling Hill North, Keeling Hill South, Odum Tract, Russell Cemetery and Reid's Chapel, contain dry to dry-mesic barren-communities with a unique assemblage of rare plant resources. These areas are our third priority for treatment. The other 57 natural areas also contain invasive species; however, in order for us to systematically control and eradicate invasives, it is imperative that we prioritize the natural areas that require immediate attention to preserve their integrity.

– Herbicide Treatments –

Table 2. Herbicides Proposed for Use in Alternative 2.

Chemical Name	Examples of Trade Names	Targeted Use	Examples of invasive plants to be targeted	Risk Assessment
Clopyralid	Curtail™ Reclaim™ Transline™	Foliar spray; broadleaf selective–especially legumes, smartweeds and composites	kudzu, lespedeza, oxeye daisy, crownvetch	Durkin 2004a
Glyphosate	Accord® Foresters®	Woody and broadleaf plants: stump treatment, 10-20% solution; foliar spray; non-selective;	Amur honeysuckle, autumn olive, Japanese honeysuckle, garlic mustard, multiflora rose	Durkin 2011a
Glyphosate (aquatic)	Aquamaster® Rodeo®	Foliar treatment, invasives near open water, non-selective	purple loosestrife, common reed, any species near open water	Durkin 2011a
Picloram	Tordon K Tordon 22k; Grazon	Stump and/or basal-bark treatment	kudzu	Durkin 2011b
Sethoxydim	Poast® Vantage®	Foliar spray; narrowleaf selective (grasses)	Nepalese browntop, Canada bluegrass, bald brome	Durkin 2001
Triclopyr	Crossbow™ Garlon™3A Garlon™4 Habitat®; Pasturegard™ Vine-X®	Stump and/or basal-bark treatment, foliar spot spray; broadleaf selective; woody plants	Chinese yam, kudzu, Amur honeysuckle, autumn olive, lespedeza, clover, Japanese honeysuckle	Durkin 2011c

(http://www.fs.fed.us/foresthealth/pesticide/risk.shtml)

In this environmental assessment, we analyze the annual treatment with herbicides of 1750 acres of invasive species infestation in the Forest (see totals at end of Appendix A). We propose to treat invasives with five herbicides: triclopyr, clopyralid, glyphosate, sethoxydim and picloram (Table 2). We selected these herbicides in consultation with IDNR and the River-to-River Cooperative Weed Management Area, both of which have extensive experience with these herbicides. With the exception of picloram, which we propose to apply only to the cut stumps of kudzu in limited quantity and locations, each herbicide is the least toxic, least persistent chemical available to meet our purpose and need. We followed the published guidance of the Illinois Nature Preserves Commission (INPC 1990) and The Nature Conservancy (TNC 2004) in selecting and planning the use of these commonly used, generally low-impact herbicides that should provide effective treatment. We also propose to use the most controllable application methods with the least residual impact:

1) a hand-held applicator, hack-and-squirt, sprayer, brush or wick applicator
2) backpack sprayer
3) boom-mounted spray rig (on an all-terrain or utility vehicle, pickup truck, or tractor)

We do not propose aerial applications.

On Glyphosate: Since we completed our earlier analysis, the Forest Service has received an updated risk assessment of glyphosate that focuses on the differences among the various commercial formulations of herbicides using glyphosate (Durkin 2011a). More than 50 formulations were considered in the current risk assessment, which reports that there are obvious and often substantial differences among toxicities of technical grade glyphosate, formulations with no surfactant and formulations with polyoxyethyleneamine surfactants. Table 3 displays a classification of formulations that discriminates between less toxic and more toxic formulations. In implementing our proposal, we would employ only those formulations with less than high toxicity, as reported in Table 3. Our analysis of glyphosate effects is based on this.

Table 3. Classification of Glyphosate Formulations (Durkin 2011a).

	Apparent Toxicity					
Confidence	**Low**		**Medium**		**High**	
High	Accord	Glyfos Aquatic			Buccaneer	Roundup Orig.
	Accord Conc.	Glyphosate VMF			Cornerstone	Roundup Pro
	AquaMaster	Glypro			Eliminator	Roundup Pro Conc.
	AquaNeat	Rodeo			Gly Star Plus	Roundup ProDry
	Foresters				Honcho	Roundup ProMax
					Ranger pro	Roundup UltraMax
Medium	Diamondback		Accord SP	Glyphomax Plus	Glyphogan	
			Buccaneer Plus	Gly-4 Plus	Glyphos X-TRA	
			Cornerstone Plus	Honcho Plus	Roundup Orig. Max	
Low	Aqua Star		Accord XRT		Accord XRT II	RapidFire
			Durango		DuraMax	Roundup WeatherMax
			Glyphomax XRT		Durango DMA	RT 3
			Mirage		Helosate Plus	

As specified in the Design Criteria in Table 6, we would apply herbicides at or below label-recommended rates, using only those registered by the Environmental Protection Agency (EPA) for the specific type of site and use we propose. We would follow all applicable state and federal laws. We would apply herbicides within the natural area treatment zones in accordance with the guidance published by the Illinois Nature Preserves Commission and The Nature Conservancy, and monitor our use in compliance with the project design criteria, best management practices and direction in the Forest Service Manual (2080, 2150 and 2200). We would prepare a Pesticide Use Proposal (FS-2100-2) and safety plan (FS-6700-7) prior to herbicide use. We would post signs to alert the public to the location and types of treatments being done and the date when a treated area could be re-entered.

We would apply herbicides during the time of year when application is most effective for a particular species and its life-cycle (see Table 4). If the first application of an herbicide is not as effective as expected, we would re-treat with the appropriate herbicide of those proposed to ensure complete removal or control. We would ensure the re-establishment of native vegetation on a treated site through monitoring after removal of the invasives, and reseeding and/or planting native species if necessary to repopulate the site.

Control techniques could vary depending on the size or location of the infestation (see Table 4). We developed our proposed methods after review of the guidance published by the Illinois Nature Preserves Commission and The Nature Conservancy, scientific literature, the field experiences of Forest botanists and wildlife biologists, and discussions with invasive species experts.

Table 4. Proposed Treatment Methods under Alternative 2.
Treatments in Natural Areas Are Based on Recommendations of the Illinois Nature Preserves Commission for Natural Area Protection (INPC 1990).

Broadleaf Plants	
Adam's needle (yucca)	Remove entire plant by hand and grub out root.
Asiatic dayflower	Hand-pull where control is desired.
Chinese yam (PRIORITY SPECIES)	Difficult to control, Chinese yam is so widespread that complete eradication is not likely possible; however, it is important to eradicate populations and sources in and around natural areas. Apply triclopyr on dormant or early-germinating bulbils in early spring through April.
Common sheep sorrel Beefsteakplant	Apply triclopyr before bloom or seedset in areas where broadleaf-selective herbicide is preferable; alternatively, glyphosate may be applied where non-selective herbicide is acceptable.
Creeping jenny (bindweed)	Apply glyphosate on heavy infestation in summer-early fall. Extensive root systems of established infestations may require repeat applications.
Curly dock Common dandelion	Hand-pull individuals where possible, removing taproot. Alternatively, apply triclopyr to young, growing plants, ideally before seeding.
Garlic mustard (PRIORITY SPECIES)	Control of garlic mustard requires depletion of the seedbank; treatment may be required for several years. Hand-pull light/small infestations anytime soil is not frozen, removing all parts of plant. Apply glyphosate in spring or fall. Apply in spring to head off seeding, but take care not to affect early ephemerals that may be in proximity; or, apply in fall/dormant season when garlic mustard is still green. This process may need to be repeated, depending on persistence of seedbank.
Japanese knotweed	Apply glyphosate or triclopyr in fall when leaves are translocating to rhizomes.
Oriental lady's-thumb	Apply glyphosate when plant is actively growing.
Periwinkle	Cut plants, then apply glyphosate to new growth.
Queen Anne's lace Garden yellowrocket	Apply glyphosate to rosettes; apply triclopyr to rosettes the following year if necessary. Plants are biennial; goal is to treat before seeding.
Common St. Johnswort Sleepydick	Apply glyphosate.

Table 4. Proposed Treatment Methods under Alternative 2. **Treatments in Natural Areas Are Based on Recommendations of the Illinois Nature Preserves Commission for Natural Area Protection (INPC 1990).**	
Grassy Plants	
Bald brome Canada bluegrass Kentucky bluegrass	Apply fire in late spring after plants are growing, and in late season to ensure control. If application of fire or repeat fire is not possible, apply sethoxydim to new growth.
Japanese bristlegrass	Do not burn. Apply glyphosate or sethoxydim in late spring before warm-season grasses appear; the former where use of non-selective herbicide is acceptable, the latter where a grass-selective herbicide is more desirable.
Johnsongrass	Apply glyphosate during June, just prior to seed maturity.
Nepalese browntop	Efforts to eliminate or prevent seedbank are critical to control. Plant is easily pulled and can be cut or burned prior to seed production. Where chemical control is necessary in large infestations, apply sethoxydim when plants are 6-8 inches high, actively growing, and not under stress. Depending on persistence of seedbank, repeat applications may be required.
Orchardgrass Tall fescue	Single clumps can be dug, ensuring whole plant and all stems are removed. If digging is not practical, apply glyphosate when plants are actively growing and not stressed.
Reed canarygrass	Apply fire in late spring; apply glyphosate in June and September to ensure control.
Leguminous / Composite Plants	
Annual ragweed	Control with prescribed fire and/or remove by cutting/mowing, most effectively prior to seeding. If these methods are not possible, apply triclopyr before seeding. An herbicide containing at least 40% clopyralid could also be used at the rate 21 ounces to the gallon.
Bristly oxtongue	Remove by digging if possible. If large infestation, apply glyphosate.
Bull thistle	Apply fire in late spring, if possible, to increase exposure of rosettes to herbicide application. Apply glyphosate to plants in late bud-stage or early bloom-stage and root reserves are lowest.
Common dandelion Common plantain Common yarrow	Remove by digging individual plants, if possible, ensuring removal of taproot or rhizomes (yarrow). If digging is not practical, apply glyphosate to actively growing plants/rosettes.
Common mullein	Mullein is prolific seed-producer; treatments should be done prior to seeding to effect control. Cut plant below crown prior to seeding, if possible. Alternatively, apply glyphosate or triclopyr to rosette when plant is actively growing.
Crownvetch	Apply triclopyr before seed maturity; clopyralid if a more legume-specific herbicide is desired.
Field clover Yellow sweetclover Red clover Korean clover	Apply glyphosate or triclopyr to actively growing plants; the former where use of non-selective herbicide is acceptable, the latter where a broadleaf-selective herbicide is more desirable.
Kudzu **(PRIORITY SPECIES)**	Eradication by direct root removal is not practical because of the nature of the root system. Total eradication of kudzu is necessary to prevent regrowth. Cut and remove all parts of the plant, or burn where possible. Apply an herbicide containing at least 40% clopyralid at 21 ounces to the gallon to remaining growth during the period August 15 to October 15. Add a non-ionic surfactant to the mixture to help penetrate the leaf cuticle. (Clopyralid targets legumes and composites, so will not harm non-leguminous trees beneath the kudzu.) A second application can be made during the specified timeframe. Follow-up treatments can be made to young stems and leaves in early summer using an herbicide containing at least

Table 4. Proposed Treatment Methods under Alternative 2. **Treatments in Natural Areas Are Based on Recommendations of the Illinois Nature Preserves Commission for Natural Area Protection (INPC 1990).**	
	44% triclopyr. The target area should be monitored and if residual plants are located treat them with the clopyralid mixture. If follow-up treatments are not made, kudzu will quickly reclaim an area. Picloram can be applied directly to cut stumps to further effect eradication. Outside of natural areas, thin-line and hack-and-squirt herbicide application could be done using clopyralid or triclopyr at the specified solutions.
Lespedeza	Apply triclopyr during June to mid-July when plants are still vegetative and during early flowering. An herbicide containing at least 40% clopyralid could also be used at the rate 21 ounces to the gallon.
Lesser burdock	Apply glyphosate to actively growing plant rosettes.
Oxeye daisy	Apply an herbicide containing at least 40% (21 ounces to the gallon) clopyralid to actively growing plants.
Woody Plants	
Amur honeysuckle (PRIORITY SPECIES) Bush honeysuckle	Apply prescribed fire if sufficient fuel is present to sustain fire; treat resprouting with glyphosate. In heavy infestations of honeysuckle, spray foliage with glyphosate in late fall when non-target plants are dormant and honeysuckle is still actively growing. Outside of natural areas, thin-line and hack-and-squirt herbicide application could be done using glyphosate at the specified solution.
Autumn olive Multiflora rose Tree-of-heaven	Cut plant at main stem(s); apply glyphosate to cut surfaces late in growing season—July – September. For tree-of-heaven, apply glyphosate at 20-50% solution to cut surfaces in summer to late fall. Additionally, for multiflora rose, routine application of prescribed fire will hinder invasion and prevent establishment. Outside of natural areas, thin-line and hack-and-squirt herbicide application could be done using glyphosate at the specified solution.
Black locust Princess-tree	Cut plant at main stem(s); apply triclopyr at 50% solution to cut stump at any time of year, preferably in dormant season. Outside of natural areas, thin-line and hack-and-squirt herbicide application could be done using triclopyr at the specified solution.
Burningbush Japanese meadowsweet Mock orange	Apply prescribed fire if sufficient fuel is present to sustain fire; treat resprouting with glyphosate. Alternatively, cut plant at main stem(s); apply glyphosate at 10-20% solution to cut surfaces. Outside of natural areas, thin-line and hack-and-squirt herbicide application could be done using glyphosate at the specified solution.
Japanese honeysuckle	Apply prescribed fire and treat resprouting with glyphosate. Cut any vining in canopies before burning.
Wintercreeper	Hand-pull and grub small populations, removing all parts of the plant from the site. Otherwise, cut plant as close to ground as possible and apply triclopyr to cut surfaces.

Alternative 3 – Invasives Treatment without Synthetic Herbicides

Under this alternative, we would use no synthetic herbicides to control invasive species, but would rely on aggressive manual or mechanical treatments as the first course of control. Natural weed-killers could be applied where manual and mechanical methods are ineffective. We developed this alternative in response to the concerns of some about the use of synthetic herbicides. It is designed to control some invasive species, but would not eradicate many populations because the natural weed-killers only top-kill the plants.

1. Treatment of all known sites with four highly invasive species:

Under this alternative we would concentrate on the same four highly invasive species as under the proposed action—Amur honeysuckle, Chinese yam, garlic mustard and kudzu—but would use manual and mechanical methods as a first line of treatment (Table 5).

Amur honeysuckle is a large woody shrub that can occur as dispersed, individual plants or develop dense, coarse thickets, spreading in the local area. It tolerates high to moderate light-levels. Once treatment is initiated, control can be expected within four years. (See Table 5 for treatment details.)

Table 5. Proposed Treatment Methods under Alternative 3.

1. Priority Species		
Species	**Methods***	**Acres**
Garlic mustard	pulling, torching	467
Kudzu	burning, bulldozer/backhoe	78
Amur honeysuckle	cutting, pulling, torching	412
Chinese yam	repeated clipping, torching,	253
	Subtotal	1210
2. Invasives in Natural Area Treatment Zones		
Example Species	**Methods***	**Acres**
Nepalese browntop	pulling, weed-whipping	166
Sweetclover	burning, cutting, pulling	2
Autumn olive	cutting, grubbing	18
Multiflora rose	cutting, grubbing	56
Tall fescue	tilling, smothering	9
Sericea lespedeza	pulling, weed-whipping, cutting	4
Japanese honeysuckle	torching, cutting, grubbing	365
Asiatic dayflower	pulling, grubbing	1
Common sheep sorrel	pulling, grubbing	1
Common periwinkle	pulling, grubbing	1
Tree of heaven	pulling, grubbing, cutting	1
Beefsteak plant	pulling, grubbing	1
Queen-Anne's lace	pulling	1
	Subtotal	626
	Total	**1836**
Methods	**Pulling, Cutting, Grubbing**	**1496**
	Bulldozer / Backhoe	**78**
	Tilling, Smothering, Clipping, Torching	**1100**

* Natural weed-killer or hot-foam could be used to treat all species.

Chinese yam and garlic mustard, once treated as described in Table 5, would require follow-up treatments for several years to deplete the seedbank of garlic mustard and to eliminate Chinese yam from natural areas and their treatment zones. Eliminating these plants would increase the light and nutrients available to the affected sites. Higher levels of light—with the associated increase in soil temperature facilitating native seed germination and increased photosynthesis—and available water and nutrients will stimulate native plant species and seeds in the treated areas. This will lead to reoccupation of the areas by native species.

Kudzu sites exhibit complete coverage by the plant. Most plants and trees covered by kudzu will have died from the elimination of light. As kudzu occupies the site, its density is such that the ground surface cannot be seen and the depth of the kudzu and dead plants beneath can be several feet. On the periphery of the

occupied site, the kudzu extends runners into adjacent forest, further occupying the area by climbing trees and shrubs and eventually killing the plants. Given the extensive root reserves of kudzu, multiple treatments, as described in Table 4, over several years are anticipated.

Natural herbicides are simple substances that directly top-kill plants upon application. These substances are encountered naturally, but in small quantities. Food-grade vinegar and clove oil are the main active ingredients in one type of natural herbicide. However, the concentrations used in the natural weed-killers are higher than available at a grocery store. Vinegar at the grocery store is usually 5 percent acetic acid, while the natural weed-killer contains a 20-percent solution. These ingredients are relatively well known and normally not harmful to humans or animals. However, when applied in large doses, the results are usually obvious in a very short time. After treatment, their damaging effect is quickly dissipated. Vinegar is acetic acid along with other weak organic acids. Clove oil is an essential oil from the clove plant (*Syzygium aromaticum*). This mixture works by disrupting plant membranes and causing the leakage of cells. The damage to plants appears rapidly, in 1-2 days.

A hot-foam machine could be used from roads and some trails to steam-kill invasive species. The Waipuna® hot-foam system, for example, is comprised primarily of a diesel-powered boiler and foam generator that deliver hot water with a foam surfactant to target weeds via a supply hose and a treatment wand. The superheated hot foam (sugar is added to achieve a higher boiling point) is applied to the targeted vegetation at about 200°F and low pressure; the foam traps the steam, giving it time to "cook," or "blanch," the vegetation, causing a cellular collapse of the vegetation. This control method is limited in mobility and is best used near developed sites such as campgrounds and trailheads and along roadsides and accessible trails.

2. Management of 23 designated natural areas and their treatment zones:

All invasive species within the natural area treatment zones (Table 1) would be treated using the methods in Table 5. Management also would include the application of prescribed fire on 12,400 acres in and around the natural area treatment zones. Existing fire-breaks, such as roads, trails, streams and other natural features, would be used as firelines where possible; but mechanically constructed firelines would be used where necessary. We expect to install about 14 miles of lines by hand and 6 miles mechanically.

We would burn the natural area treatment zones at intervals of 1-3 years, depending on our monitoring and assessment of effects to determine the need for additional fire, as well as fuel availability. The fire would help restore native vegetation and set back the progression of invasive species. Further burns would be done as needed to maintain the areas' ecological integrity once invasive vegetation has been suppressed. Manual and mechanical weed-treatment methods would be applied to manage invasive species either before or after the initial burns, depending on the species present.

The highest priority natural areas for prescribed fire and natural herbicide treatment are those with acid seep-springs: Cretaceous Hills, Dean Cemetery West, Kickasola Cemetery, Massac Tower Springs and Snow Springs. These are the most threatened by invasive species and changes. The encroachment of aggressive invasive species into these areas threatens to dry up the springs and degrade the plant community, destroying the spring habitat. Rare plant resources rely on this habitat type, including Regional Forester's Sensitive Species such as twining screwstem (*Bartonia paniculata*), purple five-leaf orchid (*Isotria verticillata*), longbeak arrowhead (*Sagittaria australis*) and New York fern (*Thelypteris noveboracensis*). Additional plant species of this community-type, including several listed as threatened or endangered by the State of Illinois, are also vulnerable to local extirpation without immediate management.

Of the remaining 18 natural areas, some have Regional Forester's Sensitive Species and numerous other rare plant resources: Double Branch Hole, LaRue Pine Hills, Poco Cemetery East, Poco Cemetery North, Bulge Hole, Fink Sandstone Barrens, Bell Smith Springs, Hayes Creek-Fox Den, Panther Hollow, Jackson Hole and Barker Bluff. Streams run through, or are adjacent to, all of these areas, providing a corridor for invasive plant species, especially Nepalese browntop. These areas would be the second priority for invasives treatments.

The remaining seven natural areas, Fountain Bluff, Ava, Keeling Hill North, Keeling Hill South, Odum Tract, Russell Cemetery and Reid's Chapel, contain dry to dry-mesic barren-communities, which provide a unique assemblage of rare plant resources. These areas would be our third priority for treatment. The other 57 natural areas also contain invasive species; however, in order for us to systematically control and eradicate invasive plant species, it is imperative that we prioritize the natural areas that require immediate attention to preserve their integrity.

Elements Common to Alternatives 2 and 3

Field Assessments

We would conduct field assessments to identify which method(s)—manual, mechanical and/or chemical (under Alternative 2) we would utilize at a given location. The field assessment would consider:

- Species to be treated
- Distances between the plants to be treated and any sensitive species
- Presence of surface water, wetlands
- Optimum seasonality of treatment
- Need for and timing of prescribed fire
- Condition of terrain and accessibility to treatment site

Based on consideration of these factors, we would develop treatment protocols for a given site utilizing one or more of the manual or mechanical treatment methods described below or herbicide treatments described on pages 14-18, as well as implementing the project design criteria (Table 6).

Manual and Mechanical Treatments

We have used manual and mechanical control methods with varying degrees of minimal success. Manual treatments involve the use of the hands alone or the hands with tools: pulling using hands or a weed-pulling tool, cutting/clipping using cutting tools, grubbing using a grub-hoe or similar tool, smothering using environmentally benign materials to cover targeted plants, and scorching using a gas-flamed torch to burn up targeted plants. Manual treatments generally are employed in small areas that can be affected by the selected method. These methods are useful on small infestations of herbaceous invasive plants.

Mechanical treatments utilize machines—a bulldozer or tractor with bushhog, for example, to remove targeted plants. These would be employed to remove usually larger, densely growing, woody plants. The bulldozer could also be used to prepare firelines around the natural area treatment zones.

Restoration of Native Vegetation

Following treatment and control/elimination of targeted plants, we would ensure the repopulation of the treated areas by native plant species. We expect that dormant native seedbanks would once again germinate and restore the areas to native species. However, if monitoring indicates that this is not occurring following a growing season, we would take action to reseed or replant the areas with native species.

Design Criteria

In order to minimize impacts on the environment and habitats from invasive species management, we would apply several design criteria under both action alternatives (Tables 6 and 7). These criteria are based on requirements of Forest Service regulations, the Forest Plan, IDNR Forestry Best Management Practices and herbicide label directions. They are part of the design of the project rather than mitigations developed as responses to concerns or ongoing effects. All treatment locations will be recorded with global positioning systems and tracked in a database to plan out-year program needs.

Table 6. **Design Criteria for Invasive Species Management.**		
Resource	**Design Criteria**	**Rationale / Effectiveness**
Public Affairs	Continue to raise awareness and inform and educate the public and Forest visitors and staff about 1) the issue and effects of invasive species on the Forest, 2) prevention activities and 3) opportunities to participate in low-impact invasive species removal activities.	Public awareness of the spread of invasive species and the resulting adverse effects on Forest biodiversity is critical to help prevent the introduction and/or spread of invasives in the Forest.
Invasive Plant Treatments	Clean all equipment before entering and leaving project sites.	Minimizes spread of noxious weeds from one site to the next (USDA-FS 2004). Guide to Noxious Weed Prevention Practices (2001).
	Workers should inspect, remove and properly dispose of plant parts found on clothing and equipment before entering or leaving the project area.	
	Minimize soil disturbance to avoid creating favorable conditions that encourage invasives establishment.	
	All treatment locations will be recorded with global positioning systems and tracked in the database of record.	
	Known or new occurrences that cross ownership boundaries will be noted and data shared with landowners and other agencies.	Improves effectiveness of control and increases opportunities for treatment on other lands.
Botanical	Protect rare plant resources, including state-listed threatened and endangered species, from mechanical or chemical treatments.	Protection of state-listed rare plant resources and habitat enhancement at request of IDNR.
Wildlife	Retain all standing dead trees unless necessary to cut for human safety or to accomplish project objectives.	These criteria are required "terms and conditions" or "reasonable and prudent measures" in USFWS Biological Opinion for the Forest Plan (Forest Plan, Appendix H, C.1.b. and C.1.c.).
	To reduce the chances of affecting bat maternity roosts and foraging habitats, no prescribed burns shall be done in upland forests from 5/1-9/1.	
	Burning near known timber rattlesnake den locations will be done only during hibernation - 11/1-3/31.	Den sites are extremely important to the maintenance of populations (Forest Plan).
	For protection of nesting migratory birds, burns should be done as early or late in the season as possible, preferably before 4/1 and after 8/1.	For the protection migratory birds (Forest Plan, FW51.1.2.6.
	In order to protect eastern small-footed bats, fires will not be ignited near known-occupied rock outcroppings or cave entrances. No firelines will be constructed in or immediately adjacent to cave habitat.	This species requires additional RFSS protection identified in the Forest Plan (USDA 2006).
	High-intensity prescribed fire should not be applied to known locations of the carinate pillsnail in LaRue-Pine Hills Research Natural Area.	Suggested in the conservation assessment for the carinate pillsnail (Anderson 2005).
Heritage	The Area of Potential Effects will be reviewed and inventoried as needed to ensure that all heritage resources are adequately protected.	Implementing protocol methods will ensure protection of heritage resources (SHPO/IHPA 2009).
Recreation and Visual	Ensure visitor safety before, during and after burning activities. Burn areas should be closed to the public.	Forest Plan, Chap. I, B; FW23.2 & FW23.3.
	Protect recreational improvements (campgrounds, trailheads and trail-signing).	Forest Plan, FW23.2
	Damage to trails and roads used as firebreaks or for access should be repaired to standard.	Forest Plan, Chap. FW23.3
Wilderness	Ensure non-motorized invasives treatments are utilized.	Wilderness Act of 1964, Forest Plan WD19.3
	Avoid treatments during periods with typical high visitor volume (holidays).	Mitigate impacts on solitude.
Soil and Water	Use erosion-control measures, including seeding, for firelines that could erode soil into water resources.	Illinois Forestry Best Management Practices are designed to ensure that prescribed fire does not degrade the forested site and that waters associated with these forests are of the highest
	Avoid intense burns that remove forest-floor litter and expose excessive bare soil.	

Table 6. Design Criteria for Invasive Species Management.		
Resource	**Design Criteria**	**Rationale / Effectiveness**
Soil and Water	Maintain soil-stabilization practices until the site is fully revegetated and stabilized.	quality (IDNR et al. 2000). We have monitored the effectiveness of mitigation measures on several past prescribed fire projects and found that the measures were effective in minimizing soil erosion and subsequent sedimentation in streams.
	Avoid operating heavy equipment to cause excessive soil displacement, rutting or compaction.	
	Apply guidelines for protection of water quality and riparian areas; guidelines for the reduction of bare-soil disturbance; retain native vegetation and limit soil disturbance as much as possible.	Implementation of the protection measures and management recommendations at Forest Plan FW25 will prevent excessive sedimentation.
	Revegetate soils disturbed by management activities by allowing growth of existing on-site vegetation where possible and desirable or by planting or seeding native vegetation.	Adherence to Forest Plan direction and Illinois Department of Natural Resources Best Management Practices regarding protection of aquatic habitats will prevent damage to these areas.
	Fueling or oiling mechanical equipment must be done away from aquatic habitats.	
	When using pesticides in riparian areas and within 100 feet of sinkholes, springs, wetlands and cave openings, adhere to the following: Minimize the use of herbicides; use only herbicides labeled for use in or near aquatic systems; and use only herbicides based on analysis that shows they are environmentally sound and the most biologically effective method practicable.	
	No triclopyr (ester formulation) or surfactants used with glyphosate (terrestrial version) will be applied within riparian areas or within 100 feet of lakes, ponds, sinkholes or wetlands to prevent accidental contact of the herbicides with aquatic resources.	Compliance with herbicide label directions will prevent misuse of chemicals used for treatment of invasive species.
	Consider prevailing weather conditions and use lower volatility formulations under conditions that might result in a high risk of volatilization.	

Table 7. Design Criteria for Human Health and Safety.
Safe handling and application ensures protection of the health and safety of employees and the public. We will review and follow Job Hazard Analyses, Material Safety Data Sheets and product labeling in order to preserve and protect human health and safety. We will train applicators in the safe handling and application of all herbicides. All Safety and Spill Plan requirements will be followed. We will adhere to the following standards:
Pre-application • Herbicides will be used only when they will provide the most effective control relative to the potential hazards of other proposed management techniques; choose the most effective herbicide requiring the least number of applications. • The use of pesticides must comply with the product label. • All applications will be under the direction of a certified pesticide applicator. • All individuals working with herbicides will review corresponding Material Safety Data Sheets. • Herbicide label directions will be carefully followed. This could include temporary closure of treatment areas in order to prevent or limit public exposure and insure public health and safety. • Weather forecasts will be obtained prior to herbicide treatment. Treatment will be halted or delayed, if necessary, to prevent runoff during heavy rain or high wind. Herbicide will be applied only when wind speeds are less than 10 mph, or according to label direction, to minimize herbicide drift. Appropriate protective gear will be worn by herbicide applicators.
Application • Use the lowest pressure, largest droplet size, and largest volume of water permitted by the label to obtain adequate treatment success; use the lowest spray boom and release height possible consistent with operator safety. • Apply pesticides during periods of low visitor use when possible; areas treated with pesticides shall be signed, as appropriate, to ensure users are informed of possible exposure. • When using herbicides where runoff may easily enter the water table, (i.e. creeks, rivers, wetlands, caves, sink-holes, or springs), minimize the use of pesticides, herbicides, fertilizers or hazardous materials; use only pesticides labeled for use in or near aquatic systems.

Table 7. Design Criteria for Human Health and Safety.
Post-Application • All herbicides will be stored in approved buildings when not in use. • Herbicides will have Material Safety Data Sheets per Forest Service guidelines. • Washing and rinsing of equipment used in the mixing and application of pesticides will be done in areas where runoff will not reach surface waters, wetlands, fens, sinkholes, or other special habitats. • Rinse water from cleaning or rinsing actions in conjunction with herbicide treatment will be disposed of according to the Federal Insecticide, Fungicide and Rodenticide Act (http://www.purdue.edu/dp/envirosoft/pest/src/container.htm). • Herbicide containers will be stored and disposed of following label specifications.

Monitoring

We will monitor our implementation of either alternative in cooperation/collaboration with interested parties and the public to determine whether or not we are accomplishing expected outcomes (Table 8). If monitoring reveals unacceptable outcomes, we will implement appropriate measures to correct problems.

Table 8. Monitoring under Any Alternative.

Monitoring Activity	Description	Location and Timing
Soil Resources	Visual inspection for sheet, rill and gully erosion. Inspection of soil disturbance.	Before, during and after project activities are completed in project area.
Invasive Species	Samples of project area would be surveyed to assess invasive species increase/decrease.	Selected locations would be monitored before and after implementation.
	Ensure that invasive species design criteria are implemented.	Selected locations would be monitored during and after implementation.
Rare Plant Resources	Monitor known rare plants to ensure no adverse impacts.	Selected locations would be monitored during and after implementation.
Heritage Resources	Ensure that heritage resources are protected during and after implementation.	This project would be checked annually to assess damage to historic properties.
Native Species	Visual inspection to determine presence / repopulation of treated areas by native species.	In treated areas following a growing season.

Comparison of Alternatives

Table 9 provides a summary of the effects of implementing each alternative.

Table 9. Effects of Alternatives on Key Issues.

Issue: The application of herbicides may affect humans.			
Indicator	**Alternative 1**	**Alternative 2**	**Alternative 3**
Effect on public health and employees/applicators.	Minimal herbicide exposure; minimal exposure to smoke.	Minimal herbicide exposure; minimal exposure to smoke.	Minimal natural herbicide exposure; minimal exposure to smoke.
Issue: The establishment and growth of invasive species may affect natural areas and ecosystems, including plants and wildlife.			
Indicator	**Alternative 1**	**Alternative 2**	**Alternative 3**
Plant community response: invasive species reduced and native species restored.	Overall, invasives will increase and native species decline.	Invasive species will be managed/controlled fairly rapidly and native species will increase in treated areas.	Invasive species will decrease over time with repeated treatments and native species will increase in treated areas.
The response of the federally listed species will be discussed in terms of potential changes in the habitat.	Little to no effect.	Invasive species removal and habitat restoration will have beneficial effects.	Similar to Alternative 2, but to a lesser extent over longer time.

Table 9. Effects of Alternatives on Key Issues.			
Issue: The application of prescribed fire may affect designated natural areas and ecosystems, including soil, water, plants and wildlife.			
Indicator	**Alternative 1**	**Alternative 2**	**Alternative 3**
Predicted soil erosion (tons/acre/year).	Less than 1 ton/acre	Average less than 2-5 tons/acre from prescribed burning and mechanical treatments. (Natural Resource Conservation Service acceptable level)	Average less than 2 – 5 tons/acre from prescribed burning and mechanical treatments. (Natural Resource Conservation Service acceptable level)
Plant community response: invasive species reduced and native species restored.	Overall, invasives will increase and native species decline.	Invasive species will be controlled fairly rapidly and native species will increase in treated areas.	Invasive species will decrease over time with repeated treatments and native species will increase in treated areas.
The response of the Regional Forester Sensitive wildlife species and Species with Viability Concern.	Adverse effects as invasive plants replace native species.	Invasive species removal and habitat restoration will have beneficial effects.	Similar to Alternative 2, but to a lesser extent over longer time.
Issue: The application of herbicides may affect designated natural areas and ecosystems, including soil, water, plants and wildlife.			
Indicator	**Alternative 1**	**Alternative 2**	**Alternative 3**
Persistence of herbicide used.	Limited herbicide use in campgrounds and administrative buildings, with minimal persistence in the environment.	Selected herbicides generally demonstrate minimal persistence in the environment.	Limited herbicide use in campgrounds and around administrative buildings and natural weed-killer use, both with limited persistence in the environment.
Effect on the natural area's significant and exceptional features.	Habitat for rare plant resources will continue to decline.	Habitat for rare plant resources will be improved.	Habitat for rare plant resources will be improved.
Changes in management indicator species habitat.	Negative effects as invasive plants replace native species.	Positive effects on habitat with reduced invasive plants.	Similar to Alternative 2 but to a lesser extent.

Alternatives Eliminated from Detailed Study

Treatment of Invasive Species without Prescribed Fire

The interdisciplinary team considered an alternative that would not utilize prescribed fire to treat invasive species. After discussion, the team determined that prescribed fire was needed for two important reasons: First, the use of fire would reduce the density of some invasive species and, so, reduce the amount of herbicide required for control; second, the team concluded that the ecological benefits of prescribed fire were needed in the natural areas, which require fire to maintain the diversity of species in their habitats. Additionally, kudzu sites are too dense to treat without the use of fire to burn away cover and expose hazards to applicators. Thus, we concluded that this alternative would not meet the purpose and need.

Use of Goats or Other Grazers to Reduce Invasive Species

The team also considered the use of goats or other grazers to treat infestations and reduce the vigor and density of some invasive species. We visited sites where goats were used to control invasives and observed that they were hard on the land, indiscriminate as to the vegetation they consumed—and, so, a threat to any sensitive plant species requiring protection—and achieved no real control of the targeted invasive species. The locations of the invasive species infestations we propose for treatment are in protected, sensitive areas and in specific areas distributed broadly across the landscape. The use of goats or other grazers would require the fencing of the animals into many discrete areas and the provision of supplemental feed and water, requirements that would be overly burdensome, both practically and economically. This is especially true since we would need to move/ transport the animals many times for their use to be effective. After careful consideration in light of our proposal, the team recommended that this alternative be eliminated from further study, as it would be impractical and not meet the purpose and need.

Chapter 3 – Affected Environment and Environmental Consequences

We describe in this chapter, by resource area, the physical, biological and health and safety conditions that may be affected by the alternatives. As directed by the Council on Environmental Quality's implementing regulations for the National Environmental Policy Act, the discussion focuses on resource conditions associated with the key issues. The discussion of environmental consequences forms the scientific and analytical basis for comparing the alternatives. Environmental consequences are discussed in terms of direct, indirect and cumulative effects. The discussions are drawn from working papers for each resource area; these may be found in the project record at the Forest Supervisor's Office and on the Forest website: www.usda.gov/shawnee.

Direct effects are caused by the proposed activities and occur at the same time and place. Indirect effects are caused by proposed activities and occur later in time or are further removed in distance. Cumulative effects result from the incremental effects of proposed activities when added to other past, present and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions.

This analysis is tiered to the 2006 Forest Plan programmatic final environmental impact statement and incorporates by reference the programmatic biological assessment and opinion for the Plan. The U.S. Fish and Wildlife Service issued the biological opinion with restrictions to ensure that plan implementation would not likely affect federally listed species on the Forest. This analysis also incorporates by reference the human health and ecological risk assessments of the herbicides proposed for use.

– Cumulative Effects –

Our analysis was prepared in accordance with the Council on Environmental Quality's cumulative effects guidance. Resource specialists on the project interdisciplinary team analyzed the cumulative effects on their resource areas from implementing the alternatives and disclosed these in the resource sections of this chapter. Spatial and temporal boundaries for cumulative effects analyses may differ for each resource area. We considered the effects of the past, present and reasonably foreseeable future actions.

Past Actions

Activities over the years on National Forest System and private lands in project-area watersheds include, but are not limited to: farming—including herbicide use—and grazing; mining; timber harvest; wildfires and 3,000-5,000 acres of prescribed fires; development and use of system and non-system equestrian and hiker trails; wildlife management, including wildlife openings and pond and waterhole construction; outdoor recreational use, including picnicking, hunting, fishing, hiking; use of authorized and unauthorized all-terrain vehicles and off-highway vehicles; artifact hunting and collection; special-use permits; construction, maintenance and use of recreational facilities and roads; tree-planting and timber-stand improvements, including tree-thinning; powerline construction and maintenance, including extensive herbicide use. Activities occurring on National Forest System and private lands in the project area are included in Table 9.

Present Actions

Many types of the past activities on Forest and private land in project-area watersheds are still occurring; however, the prevalence of many of the past activities has changed. Present actions in the project area include, but are not limited to: trail construction, maintenance and use; powerline maintenance; development and use of non-system trails; campground maintenance; all-terrain vehicle use, authorized and unauthorized; timber harvest; agricultural management, with row-cropping, pasturing and pesticide use; wildfire, prescribed fire on 6-10,000 acres, and fire suppression; road maintenance and use; tree-planting; equestrian use; public visitation and outdoor recreational use, hiking and hunting; special-use permitting and openlands management.

Table 10. Past, Present and Reasonably Foreseeable Future Actions in Project Area HUC6 Watersheds (Includes National Forest System and Private Lands).	
Action	**Scope of Action**
Agriculture (cultivated/row-cropping)* (Includes fertilizer and pesticide use)	About 230,000 acres (past, present and future), HUC 6 watersheds
Agriculture (cultivated/row-cropping)* (Includes fertilizer and pesticide use)	About 1,054,168 acres (past, present and future), HUC 4 watersheds
Agriculture (pasture)* (Includes fertilizer and pesticide use)	About 230,000 acres (past, present and future), HUC 6 watersheds
Agriculture (pasture)* (Includes fertilizer and pesticide use)	About 784,548 acres (past, present and future), HUC 4 watersheds
Prescribed fire **	About 3,000-5,000 acres per year (past). About 6,000-10,000 acres per year (present and future).
Wildfires	About 85 acres per year (past). About 100 acres per year (future).
Timber harvest/firewood cutting Includes Harris Branch timber sale	About 1,000 acres per year (past, present and future).
Timber stand improvement (some herbicide use)	About 800 acres per year (past, present and future).
Recreational use ***	About 300,000 people visited the Forest for recreation. About 37,000 for horseback riding About 150,000 for hiking or walking About 37,000 for hunting About 16,000 for fishing About 5,000 for gathering mushrooms, berries and others. About 600 for bicycling.
ATV use	Variable use in watersheds (past, present and future).
Road (including right-of-way) maintenance (Includes herbicide use.)	About 300 miles per year (past, present and future).
Tree planting	About 500 acres per year (past, present and future).
Utility ROW maintenance (Includes herbicide use.)	About 250 miles per year (past, present and future).
Trail construction, reconstruction and maintenance	About 75 miles maintained per year (past, present and future).
Non-system trails	Less than 100 miles of trail (past, present and future).
Special-use permits -telephone, electric, driveways.	Less than 20 acres per year (past, present and future).
Residential use and Invasive species control (Includes fertilizer and pesticide use.)	About 1,000 acres treatment per year (past, present and future).
Openlands management	Disking and planting about 200 acres (past). Disking and planting about 100 acres (future).
Residential development	About 2,000 new houses per decade (past and future).
*Agriculture data is based on watershed size. The Hydrologic Unit Code (HUC) is a system of defining watersheds based on size. HUC6 are smaller, 10,000-30,000–acre, watersheds; HUC4 are larger, hundreds of thousands of acres. For example, the Lusk Creek watershed is a HUC6, while the Big Muddy River watershed is a HUC4. ** The Forest is planning to burn about 8,000-12,000 acres per year in the future. The prescribed burns in the proposed project (about 12,000 acres) would be included in these acres. *** Based on the 2008 National Visitor Use Monitoring Survey.	

Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions on National Forest System and other public and private lands include activities similar to the present as well as those awaiting implementation, planned or listed in out-year schedules such as the quarterly Schedule of Proposed Actions. Activities similar to past and present actions on National Forest System and other public and private lands are reasonably foreseeable in the future (see Table 10). In the next 15 years, the Forest plans to continue to maintain roads and construct and maintain trails; remove trees for ecological restoration; issue special-use permits for access-roads, utilities and outfitter-guides; suppress wildfires as they occur, and implement prescribed burning. Generally, special-use permits allow activities like communications, outfitting and guiding for hunting, hiking and horseback riding, roads, water, power, gas and telephone utilities, commercial and non-commercial recreation events, and cemetery and church access.

Human Health and Safety

Affected Environment

Of prime importance to the Forest Service are the safeguarding of human health and safety and protection of the environment. Human health and safety is a primary issue related to our proposal to apply herbicides since we propose to use potentially hazardous materials. Trained Forest Service personnel, partners or contractors would be applying these chemicals and participating in other invasive species management activities that may have an effect on health and safety.

The boundaries for this project were determined through an analysis of the proposed treatments, chemical, mechanical and manual; protections resulting from implementing treatment protocols and design criteria prescribed to prevent herbicides from drifting and entering waterways; the limited mobility of the proposed herbicides; the relatively quick decomposition of the herbicides; and the inability of the Forest Service to predict or control activities beyond Forest boundaries: on nearby and adjacent private lands, on cropland and around homes, many of the same or similar herbicides are used.

Design Criteria – The Forest Service implements a Safety and Health Program that is an integral part of the mission of the agency. The Health and Safety Code Handbook is the main source of standards for safe and healthful workplace conditions and operational procedures in the Forest Service. The handbook is consistent with the standards and regulations of the Occupational Safety and Health Administration (OSHA). The design criteria included in Table 4 is consistent with all safety practices and procedures included in the Forest Service Handbook and Manual.

The handbook includes safety practices and procedures for activities included in the action alternatives, such as manual and mechanical vegetation treatment, prescribed fire (brushing and piling, torching, and chainsaw operation), herbicide application and other activities associated with invasive species management. Personal protective equipment (e.g., goggles, long sleeves, gloves) is required for use by all applicators. A Job Hazard Analysis is also required. This is a process used to identify and mitigate safety and health hazards in work projects or activities. It is used to identify potential hazards and develop actions to reduce those hazards.

The agency's Forest Health Protection staff is responsible for managing and coordinating the proper use of pesticides on national forests. It is responsible for providing technical advice and support and conducting training to maintain technical expertise. In order to achieve this function, the Forest Service maintains a cadre of pesticide coordinators and specialists located at regional offices and some forest offices. Forest Service policy and direction on pesticide use is in the Forest Service Manual at chapter 2150.

The Forest Service is authorized by the Federal Insecticide, Fungicide and Rodenticide Act and Cooperative Forestry Assistance Act to use pesticides for multiple-use resource management and to restore and maintain the value of the environment, within the legal framework provided by the National Environmental Policy Act and the Council on Environmental Quality regulations.

- The Federal Insecticide, Fungicide and Rodenticide Act, as amended, is the authority for the registration, distribution, sale, shipment, receipt, and use of pesticides. The Forest Service may use only pesticides registered or otherwise permitted under this act;
- The Cooperative Forestry Assistance Act of 1978, as amended by the Food, Agriculture and Trade Act of 1990, is the authority for assisting and advising states and private land-owners in the use of pesticides and other toxic substances applied to trees and other vegetation and to wood products;
- The Clean Water Act requires a National Pollutant Discharge Elimination System permit for herbicide applications on or near the "waters of the United States";
- The provisions of the National Environmental Policy Act and the Council on Environmental Quality regulations apply to pesticide management proposals.

Federal law requires that before selling or distributing a pesticide in the United States, a person must obtain a registration or license from the U.S. Environmental Protection Agency (EPA). Before registering a new pesticide or new use for a previously registered pesticide, the EPA first ensures that the pesticide, including

all adjutants, surfactants, or other ingredients of the product, when used according to label directions, can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, the EPA requires more than 100 scientific studies and tests from applicants (US EPA 2004). In 1966, Illinois became one of the first states to regulate pesticides and continues to have one of the most thorough licensing and enforcement programs.

The Illinois Department of Agriculture Environmental Program administers programs for the control and eradication of plant pests and diseases. It regulates pesticide use by registering products, certifying and licensing applicators, and investigating suspected misuse. Department of Agriculture staff also administer programs concerning proper pesticide recordkeeping and waste reduction; pesticide and fertilizer storage, containment and disposal; pesticide container recycling; noxious weed control; and underground water protection initiatives. A department laboratory tests underground water, plant, animal and soil samples for pesticide residues.

Alternative 1 – Direct and Indirect Effects

Effects on human health and safety would continue to relate to current levels of manual, mechanical, or chemical control measures, including the pulling or spot-torching of 50 acres of invasive species. Openlands management, including mowing, disking and bush-hogging 150 acres per year, would also contribute to a reduction in invasive species. Herbicides are applied in campgrounds and at administrative sites on about 50-100 acres per year, also contributing to invasive species management. Hand-pulling or spot-torching of invasive species such as garlic mustard and Nepalese browntop (also called Japanese stiltgrass) would have no adverse effect on human health and safety.

We have been applying prescribed fire to about 6,000 acres per year. As a result, there currently are short-term effects from the use of prescribed fire. Smoke from prescribed fire can temporarily reduce visibility and produce some pollutants, especially near the fire. Some, including firefighters, might experience short-term irritation (coughing, watery eyes and runny noses). Particulate matter from smoke in the air can cause a health problem for individuals in proximity to the fire who have respiratory disease, or who are elderly (Core and Peterson 2001; Hall 2009; USDA 2001).

Past experience has shown us that these effects are greatly diminished with increasing distance from the fire: the greater the distance, the more air is available to dilute any harmful effects of smoke. Smoke usually lasts only 4-6 hours, although smoldering may occur over several days. In addition, some characteristics of smoke accumulation are predictable based on wind speed and direction, and can be managed effectively to reduce effects on humans. This management is an elemental part of approved burn plans that stipulate beneficial wind direction and speed and atmospheric conditions. These plans also incorporate the state burning permit, discussed below. The burn-plan development process also requires notification of individuals living in a burn-area of upcoming burns.

The Illinois EPA has developed a statewide management plan for smoke from prescriptive fires used to achieve resource benefits. The goals of the plan are: coordination with land managers to develop a basic framework of procedures and requirements for managing smoke, avoidance of significant deterioration of air quality and potential national ambient air-quality standards violations, and mitigation of the nuisance and public safety hazards posed by smoke in populated areas. Prescribed fires in the Forest are in compliance with this plan and follow detailed burn plans and strict prescription standards. Prescribed burns are also evaluated using smoke-management models (V-Smoke and/or SASEM). Because prescribed fires are planned and can have some short-term, indirect effects from smoke, people living or working in areas adjacent to a burn-area who might be at risk are notified.

At least one species of invasive plants poses a potential risk to human health: tree-of-heaven. It has been reported that exposure to the sap of tree-of-heaven by workers clearing infested areas has caused fever, chills, chest pain and shortness of breath, as well as inflammation of the heart. Its pollen is also suggested to have caused rhinitis, conjunctivitis and asthma (Beck et al. 2008; Ballero et al. 2003). Tree-of-heaven is known in a number of locations across the Forest. Although no injury has been reported to date, under Alternative 1,

failure to control tree-of-heaven infestations on National Forest System lands could indirectly pose a health threat to workers and Forest visitors as it is allowed to spread.

Alternative 2 – Direct and Indirect Effects

Based on our review of the human health risk assessments of each of the herbicides we propose to use, we can reasonably state that there would be no significant, direct or indirect, adverse effects on human health and safety as a result of implementing the proposed action. The proposed manual, mechanical and/or chemical control-methods pose extremely minimal safety risks to workers or the public, since we would implement stringent safety practices. These practices address hazards related to operating mechanical equipment such as weed-wrenches, brush-cutters and spot-torches, as well as exposure of workers to tree-of-heaven sap and other natural hazards, such as poison ivy, stinging insects, or falling branches. Non-Forest personnel working to eradicate invasive species on the Forest would be provided with safety orientation, training and personal protective equipment.

Table 11. Human-Health Risk-Characterizations for Proposed Herbicides in Alternative 2 (Durkin 2001; 2004; 2011a; 2011b; 2011c; Tu et al. 2001).
Clopyralid:
• Can cause persistent damage to eyes if direct contact occurs. • Harmful if inhaled. Does not readily volatize. • Transient dermal redness; does not cause skin sensitization. • No evidence of cancer from use • Does not produce developmental effects at doses that do not produce maternal toxicity. • Highest hazard quotient (HQ) for chronic exposure is 0.3
Glyphosate:
• Non-irritating to slightly irritating with direct contact; no permanent damage reported. • Inhalation is not an important exposure route because of its low volatility. • Poorly absorbed through skin. • Classified as Group E pesticide by US EPA: "Evidence of non-carcinogenicity for humans." • Adverse human reproductive effects have not been noted in the United States. • Highest HQ for accidental exposure of one hour is 0.003.
Picloram:
• Can cause irritation to the eyes. • No toxic effects from acute inhalation exposure to aerosolized picloram. • Although picloram is not a strong skin irritant, repeated dermal exposures may lead to skin sensitization. • Does not produce reproductive or developmental effects at doses that do not produce maternal toxicity. • Method of proposed application poses no hazard. • At typical application rates, no HQ above level of concern (HQ=1).
Sethoxydim:
• Irritating upon direct contact. • Some irritation at high exposure levels. Does not readily volatize. • Irritating to the skin. • Based on studies, no evidence of cancer risk. • Based on studies, no evidence of reproductive risks. • Highest HQ for exposure to drinking water contamination ranges from 0.008 – 0.04.
Triclopyr:
• May cause irritations to eyes. • Inhalation exposures to not be of toxicological concern. Ester formulations can be volatile, and care should be taken during application. Salt formulation is much less volatile than the ester formulation. • May cause irritations to skin. • The U.S. EPA/OPP has reviewed these studies and determined that the evidence for carcinogenicity is marginal (Group D pesticide). • Does not produce reproductive or developmental effects at doses that do not produce maternal toxicity. • Highest HQ for accidental direct spray of a child ranges from 0.02 – 0.07.

We selected the proposed herbicides largely for their low toxicity to humans and the environment (see Table 11). To assess the potential health effects of the proposed herbicides, we rely not only on the toxicology data used by the EPA to certify the safety of pesticides, but also on risk assessments produced for the Forest Service independently by Syracuse Environmental Research Associates (SERA). These assessments consider data from scientific literature as well as that submitted to the EPA to support pesticide registration. Risks to human health from the herbicides we propose were assessed by SERA (Durkin 2001; 2004; 2011a; 2011b; 2011c). In the analysis of our proposal, we have reviewed and are incorporating, as appropriate, relevant information from the risk assessments, both to inform our decision-making as well as to disclose to the public potential environmental effects. The risk-analysis process quantitatively evaluates the probability that use of a given herbicide might harm humans or other species in the environment. Measures of risk were based on typical Forest Service uses of each herbicide.

Potential effects relate to direct contact with the herbicide, exposure to treated vegetation, or consumption of contaminated water, fish or vegetation. The possibility of the direct exposure of workers or the public to freshly treated vegetation is low, since workers would be aware and we would post notices warning the public. The greatest risk of exposure to herbicides would be for the workers mixing and applying them. Adherence to label directions would minimize the exposure of workers during application and apparatus cleanup.

We constructed the design criteria with Alternative 2 foremost in mind because it proposes synthetic herbicide use. Because adherence to all label instructions is required and expected, the design criteria reduce the risk of herbicide drift or the possibility of off-site movement into water or wetlands. If necessary, amendments can be added to the mixture to reduce drift. Herbicides may be hand-applied, ensuring limited environmental exposure to the chemicals, or applied with a boom-mounted powered sprayer on an all-terrain or utility vehicle, pickup truck, or tractor. When using a spraying apparatus, label directions place restrictions on applications at certain wind speeds.

Some chemical solutions have an odor that may persist at spray sites for several days. The proposed chemicals do not readily volatilize—vaporize into the air—with the exception of triclopyr. In order to protect the public and applicators, volatilization would be minimized by application of the herbicide according to label directions and under conditions that would minimize vaporization.

As we discuss in the Watershed Resources section (page 45), the proposed herbicides have relatively short half-times and would not build up in the environment. They have limited mobility, and only herbicides approved for aquatic use would be applied near water. None of our proposed application methods poses a risk to underground water. Based on the estimated levels of exposure and the criteria for chronic exposure developed by the EPA, there is no evidence that typical or accidental exposures would lead to dose-levels that exceed the level of concern. In other words, all of the anticipated exposures—most of which involve highly conservative assumptions—are at or below the reference dose. The use of the reference dose, which is designed to be protective from chronic or lifetime exposures, is itself a very conservative component of this risk characterization because the duration of any plausible and substantial exposures is far less than lifetime exposure (Durkin 2001; 2004; 2011a; 2011b; 2011c).

– Hazard Quotient as Indicator of Human Health and Safety –

The hazard quotient (HQ) is the measure of a level of concern. It is defined by the EPA as:

> …the ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible. The Hazard Quotient cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur (www.epa.gov/ ttnatw01/nata1999/gloss.html).

Clopyralid – The risk characterization for potential human health effects associated with the use of clopyralid is relatively unambiguous. The upper limits for hazard quotients are sufficiently far below a level of concern that the risk characterization is relatively unambiguous: based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that the general public will be at any substantial risk from longer-term exposure to clopyralid. At the upper range of exposures, the highest hazard quotient is 0.2, associated with the consumption of contaminated vegetation. Other hazard quotients are much lower, in the range of 0.000004 to 0.001. At the highest application rate, the upper range of the highest hazard quotient for chronic exposure would be 0.3 (Durkin 2004).

Glyphosate – Based on the HQ method, the concern for workers is minimal. At the highest labeled rate of 8 pounds active ingredient per acre, the highest HQ is 0.6. The highest HQ for any accidental exposure scenario is 0.003, the upper bound for a spill over the lower legs that is not mitigated for one hour. This is below the level of concern by a factor of 300. To reach a level of concern, an HQ of 1, would require the application of 300 pounds of glyphosate per acre, exposure duration of 300 hours, or about 12 days, none of which is credible.

For Forest visitors, the only non-accidental exposure of concern is for acute exposure involving consumption of contaminated vegetation shortly after the application of glyphosate. For the longer-term consumption of contaminated vegetation, a maximum application rate of 8 pounds active ingredient per acre would not exceed the level of concern (HQ=1). For aquatic applications, the highest HQ is 0.01, the upper bound of the HQ for a child who drinks surface water immediately after an aquatic application of glyphosate. This upper bound is below the level of concern by a factor of 100, thus there is no basis for asserting plausible risk.

Picloram – Typical human exposures to picloram do not lead to estimated doses that exceed a level of concern (HQ=1). The upper limits for hazard quotients are below a level of 1 for workers as well as Forest visitors. The only scenario in which the HQ exceeds 1 requires the long-term consumption of contaminated vegetation. Thus, based on the available information and under the foreseeable conditions of application, there is no route of exposure or scenario suggesting that workers or members of the general public will be at any substantial risk from exposure to picloram (Durkin 2011b).

Sethoxydim – None of the longer-term human-exposure scenarios exceed a level of concern. The upper limits for hazard indices are below a level of concern by factors of 25 (longer-term consumption of contaminated fruit) to 2000 (longer-term consumption of fish by the general population). The risk characterization is thus relatively unambiguous: based on the available information and under the foreseeable conditions of application, there is no route of exposure or exposure scenario suggesting that the general public will be at risk from longer-term exposure to sethoxydim.

The unlikely exposure scenario of drinking water immediately following an accidental spill results in a modest elevation above the reference dose at the upper limit of exposure—i.e., a hazard quotient of 1.3. This exposure scenario is extreme to the point of limited plausibility. This sort of scenario is routinely used in Forest Service risk assessments as an index of the measures that should be taken to limit exposure in the event of a relatively large spill into a relatively small body of water. For sethoxydim, this standard exposure scenario may have only very limited applicability because the amount spilled, about 15 lbs., is about four times more sethoxydim than the Forest Service used in all of 1999. The acute drinking-water scenario for water contamination of a small stream after a rainfall is much more plausible (although still highly conservative) and leads to very low hazard quotients—i.e., 0.008 to 0.04 (Durkin 2001).

Triclopyr – Under normal circumstances and in most types of applications, it is extremely unlikely that humans would consume substantial amounts of vegetation contaminated with triclopyr. Nonetheless, any number of accidental or incidental scenarios could be developed involving either spraying of crops, gardens, or edible wild vegetation. Again, in most instances and particularly for longer-term scenarios, treated vegetation would probably show signs of damage from exposure to triclopyr, thereby reducing the likelihood of consumption that might lead to significant levels of human exposure.

Besides these occurrences, unlikely scenarios involving the general public include: an accidental direct spray of triclopyr to the body of a child has an HQ in the range of .02-.07; accidental direct spray to the legs of a young woman has an HQ in the range of .05-1.4; all other accidental scenarios have an HQ equal to or less than .01. Contact by a woman with still-wet treated vegetation has an HQ in the range of .02-.04; all other scenarios have an HQ equal to or less than .05 (Durkin 2011).

– Consideration of Possible Human Endocrine System Disruption –

Clopyralid – In terms of effects with important public-health implications, effects on endocrine function can be expressed as diminished or abnormal reproductive performance.

> Clopyralid has not been tested for activity as an agonist or antagonist of the major hormone systems, nor have the levels of circulating hormones been measured following clopyralid exposures. Thus, all inferences concerning the potential effect of clopyralid on endocrine function must be based on inferences from standard toxicity studies. The available toxicity studies have not reported any histopathologic changes in endocrine tissues examined as part of the standard battery of tests (Durkin 2004).

Additionally, two oral studies on rabbits indicate that, "at doses that cause no signs of maternal toxicity, no reproductive effects are apparent. The available data suggest that clopyralid does not produce developmental effects at doses that do not produce maternal toxicity" (Durkin 2004).

Glyphosate – The EPA has developed screening assays for endocrine disruption under its Endocrine Disruptor Screening Program and is requiring the testing of glyphosate. No results of the screening assays have been posted to date on the EPA website. The Forest Service risk assessment of glyphosate includes several laboratory studies that indicate no remarkable results regarding endocrine disruption (Durkin 2011a). As is pointed out above, effects on endocrine function can be expressed as diminished or abnormal reproductive performance. No general conclusions could be drawn in the risk assessment from the several laboratory studies cited. The EPA-derived "chronic" reference dose for glyphosate is two milligrams per kilogram of body weight per day; the Forest Service adopts the same reference dose in its risk assessment. This reference dose represents a daily intake that would cause no adverse effects. It is based on laboratory reproductive studies of glyphosate that indicated no harmful effect.

Picloram – The EPA provides this assessment of the potential effects of picloram on endocrine function:

> An evaluation of the potential effects on the endocrine systems of mammals has not been determined; however, no evidence of such effects was reported in the chronic or reproductive toxicology studies… There is no evidence at this time that picloram causes endocrine effects (Durkin 2011b).

The EPA is requiring the testing of picloram under its Endocrine Disruptor Screening Program. No results of the screening assays have been posted to date on the EPA website.

Sethoxydim – As stated earlier, the effects on endocrine function can be expressed as diminished or abnormal reproductive performance. The Forest Service risk assessment reports:

> Sethoxydim has been tested for its ability to cause birth defects… as well as its ability to cause reproductive impairment. Two studies… were conducted on sethoxydim: one in rats and one in rabbits. In the rat study… no effects on fetuses were noted at the highest dose tested, 250 mg/kg/day. In the rabbit study, the highest dose tested (480 mg/kg/day) resulted in toxic effects to the dams (decreased weight gain) and fetuses (decreased number of viable fetuses and decreased fetal weight)… U.S. EPA/OPP (1998a) summarizes the results of a two-generation reproduction study in which rats were fed diets… (that) resulted in daily doses of approximately 0, 7.5, 30, and 150 mg/kg. No effects were observed in dams or offspring (Durkin 2001).

Triclopyr – This herbicide is not among the chemicals selected by EPA for testing under its Endocrine Disruptor Screening Program. As with other herbicides, the effects on endocrine function can be expressed as diminished or abnormal reproductive performance:

> …[E]xtensive data are available on the reproductive and developmental effects of triclopyr; moreover, the current reference dose for triclopyr is based on a 2-generation reproduction toxicity study in rats. Although fetal toxicity and abnormalities have been observed at higher doses, there is no indication in this or any other study that triclopyr caused any of the toxic effects through a mechanism involving endocrine disruption…At sufficiently high doses, triclopyr can cause adverse developmental effects including birth defects. A consistent pattern with triclopyr, however, is that the adverse developmental effects occur only at doses that are maternally toxic (Durkin 2011c).

The Endocrine Disruption Exchange, or TEDX, is a non-profit organization that compiles and disseminates scientific evidence on the health and environmental problems caused by low-dose exposure to chemicals that interfere with development and function, called endocrine disruptors. TEDX maintains a list of potential endocrine-disruptors (TEDX 2011). Each chemical on the list has at least one citation to published scientific research demonstrating effects on the endocrine system. Two of the chemicals we propose to use, glyphosate and picloram, and Roundup, can be found on the list, although the listing of each is supported by only one study indicating a potential for endocrine disruption.

The glyphosate study (Paganelli et al. 2010) was done in South America in response to concern over the ubiquitous use of glyphosate-based herbicides in agriculture there. The glyphosate formulations used in South America are unlike those used in the United States and no studies have been done of them in this country (Durkin 2011a). The study refers to cases of human deformity and spontaneous abortion in Paraguay and Argentina related to the direct exposure of pregnant women to glyphosate in villages surrounded by genetically-modified crops treated with glyphosate-based herbicides. The Roundup study (Richard et al. 2005) was done on human placental cells and aromatase. It found that Roundup has more deleterious effects on the cells over time than glyphosate alone.

The picloram study was done by Melvin Reuber, who, according to the 4th Circuit Court of Appeals, in Reuber v. Food Chemical News, "is no stranger to the scientific and political debates raging over the carcinogenicity of chemical pesticides." According to the court, in Senate hearings in the early 1970's, "Reuber established himself as a scientist who frequently found pesticides to be carcinogens." In 1981, in an independent study, he concluded that picloram is a carcinogen, after inducing cancer in mice and rats.

The EPA is currently requiring additional tests of glyphosate to assess its potential to cause endocrine effects. While we note the studies that led to the listing of the herbicides by TEDX, we refer to the limitations of our proposed use of glyphosate and picloram. Our application of glyphosate would be focused on targeted plants in discrete areas of a watershed, not applied to thousands of acres of crops: about 1200 pounds over 1300 widely dispersed acres. Our implementation of the project design criteria specified in Table 6 would ensure that Forest visitors would be made aware of treated areas and, so, prevent their exposure. Regarding picloram, our proposed use of the herbicide—in small quantities applied directly to kudzu stumps—offers no route of exposure that would permit adverse health effects.

– Consideration of Cancer Risk –

The SERA risk assessments and other scientific information on which we rely for our analysis do not establish a cancer risk or cumulative cancer-risk baseline for the herbicides that we propose for use. This is because none of the proposed herbicides are known to be carcinogens, so it is reasonable to conclude that there would be no increase in cancer risk from the use of any of them (Durkin 2001; 2004; 2011a; 2011b; 2011c).

Based on our review of the human health risk assessments of each of the herbicides we propose to use, we can reasonably state that there would be no significant, direct or indirect, adverse effects on human health and safety as a result of implementing the proposed action.

Also under Alternative 2, we propose to apply fire on 12,400 acres in and around the natural area treatment zones. However, as under Alternative 1, we would be able to burn only about 6,000 acres per year, with a planned increase to about 10,000 acres per year. The natural area treatment-zone acreage that could be burned would be included in the Forest's annual goal. With that in mind, we can reasonably expect that effects on human health and safety would be similar to those under Alternative 1. The amount of smoke effects from the increased acreage would not be noticeably different, since the additional amount of fire is expected to be applied over increased time and not in addition to the amount we have been applying. Our fires are well planned and result in minimal smoke-effects and fairly rapid dissipation (Huffman 2009, USDA FS 2009).

Alternative 3 – Direct and Indirect Effects

The effects on human health and safety under Alternative 3 would be similar to those described for mechanical methods employed under Alternative 2. Any difference is related to the additional mechanical methods proposed in Alternative 3. Mechanical methods of control of certain plants (e.g., multiflora rose and tree-of-heaven) could increase the risk of worker injury. For example, workers would more likely be scratched and cut by multiflora rose if they were grubbing out plants than if they were applying herbicides. Similarly, workers could be more likely to come in contact with tree-of-heaven sap if they chainsaw and grub out stumps, rather than apply a basal-bark application of herbicide. Adherence to the design criteria would protect applicators from natural herbicide applications, as well as manual and mechanical treatments.

Table 12. Human-Health Risk-Characterizations for Proposed Natural Herbicides in Alternative 3 (MSDS).
Acetic Acid (Vinegar): • Immediate pain; may cause eye irritation and possible damage; can cause injury to corneal membrane. • Effects may be delayed. May cause respiratory tract irritation. • May cause severe skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. • May cause gastrointestinal irritation with nausea, vomiting and diarrhea. • Not considered to be a carcinogen. • At the highest dose tested (1600 mg/kg/day) in the mouse, the rat and the rabbit, there were no effects on fertilization, or on maternal or fetal survival.
18% Clove Oil / 30% Citric Acid: • Contact with this product will result in eye irritation. • Breathing vapors will cause significant respiratory irritation. • Contact with this product will cause severe skin irritation. • Ingestion of this product could cause burns and destroy tissue in the mouth, throat and digestive tract. • Not considered to be a carcinogen. • Information about effects on human endocrinology and reproduction not available.

Another plant-killing tool included in Alternative 3 is the Waipuna® hot-foam system. It poses minimal threat to health and safety since no synthetic produced herbicides are used. However, because the foam is very hot, protective clothing and gloves are necessary when using the system. Alternative 3 also includes the use of prescribed fire to control invasive species and to the increased extent described under Alternative 2 and would have effects similar to those described under Alternatives 1 and 2.

All Alternatives – Cumulative Effects

The area under consideration is the project area within the Forest, the 11 counties in which the Forest lies. Although the amount of time required for a proposed herbicide (if any) to break down is relatively short, the temporal boundary of ten years was selected because that is the length of the expected life of the effects of invasive species management activities, as well as the extent to which these effects are measurable and meaningful. Five years past was chosen to consider these specific actions because their effects would not be discernible beyond a five-year timeframe. Past, present and reasonably foreseeable future actions within the analysis area are described at the beginning of Chapter 3.

Since the acres of prescribed fire proposed under the action alternatives would not be in addition to the acreage already burned annually on the forest, there would be no additional prescribed fire effects under these alternatives. Smoke production as a result of prescribed fire has the potential to affect human health and safety in the area; however, adherence to the design criteria and burn plan prescriptions will lessen the effects to a minimal level. Since we only apply prescribed fire under appropriate atmospheric and wind conditions, the smoke produced by a prescribed fire on the Forest would not contribute cumulatively to adverse smoke conditions produced by any ill-timed fire ignited elsewhere in the project area. Thus, our smoke production would have no measurable cumulative effect in the project area or adjacent properties because there would be minimally adverse, direct and indirect effects under all three alternatives.

Considering the effects of implementing either Alternative 2 or 3 with those of past, present and reasonably foreseeable future actions, the cumulative effects of the application of herbicides, natural or synthetic, would have no significant, adverse, direct or indirect effects on human health or safety. Considering the minimal effects on human health and safety of implementing either Alternative 2 or 3 with those of past, present and reasonably foreseeable future actions, and considering the minimal amounts of herbicide we propose to use—see Table 14 and Appendix B—in the context of the vast amounts applied for agriculture and other private use—the effects of which would occur with or without implementation of our proposal—the incremental effects on human and health and safety of implementing of either Alternative 2 or 3 would be immeasurable and inconsequential, and result in no significant cumulative effects.

Botanical Resources

In this section we discuss the anticipated effects of the alternatives on botanical resources; it is a summary of the Botanical working papers in the project record. We focused our analysis on the environmental effects of the alternatives on the significant and exceptional features for which natural areas were designated and on rare plant resources. Our proposed management of specified natural area management zones s is focused on the preservation and maintenance of these remnants of Illinois' pre-settlement landscape. Our cooperation with the state in advancing the sustainable natural areas vision demands our attention to the challenges facing the natural areas—invasives species, degradation and climate change (Glosser 2011).

The rare plant resources are grouped by specific habitats, and the natural areas associated with the specific habitats are identified. In Appendix A we detail our proposed invasive species management by watershed and further describe each of the natural areas and its significant and exceptional features, as well as provide a summary of effects on the rare plant species in each.

Natural Areas

Alternative 1 – Direct and Indirect Effects

Forested areas would continue their conversion toward shade-tolerant, late-successional forest-types. The understory would become increasingly shaded, preventing oaks and other sun-dependent species from germinating and growing. As dominant canopy trees die, they would be replaced by shade-tolerant trees that have grown into the midstory. The rare community-types, including barrens and seep-springs, would be directly and adversely impacted by the lack of prescribed fire and herbicide use.

The barrens communities consist of fire-adapted and fire-dependent species that rely on an open woodland and glade condition in order to compete and support their health and vigor. Without the use of herbicides in several of the barrens communities and around all the seep-spring areas, rare species would eventually wane, overcome by invasives. Monitoring indicates that past manual treatments have not been successful (IDNR 2011). Consequently, species that are significant and exceptional features of the natural areas face extirpation at these sites. Nepalese browntop (*Microstegium vimineum*) is the main culprit in the seep-springs, with Japanese honeysuckle and Amur honeysuckle encroaching into the barrens.

Under the no-action alternative, changes in forest-type due to succession and lack of fire would continue to cause an increase in shade-tolerant species at the expense of the oak-hickory community and associated understory species. Species that depend on open forest, natural openings or dry environments would likely decline due to the increase in canopy cover. A reduction in the diversity of vegetation would likely result from the absence of fire on the landscape, with the exception of those areas that are currently under a fire regime. Additionally, invasive species are likely to increase over time, except in administrative and recreational areas, where they are commonly controlled with herbicides.

Many vectors exist to bring invasive species into the project area and many activities could create favorable seedbeds. Without active management, the current spread of invasive species would be expected to continue. Invasive species can cause changes in fuel characteristics and moisture as well as the chemical composition of the soil through allelopathic compounds. These changes could have an adverse impact on sensitive plant species and their habitats.

Alternative 2 – Direct and Indirect Effects

Prescribed fire would kill many seedlings, saplings and vines, opening the understory and increasing sunlight to the forest floor. This would stimulate oak seedlings to sprout even if top-killed during the prescribed fire. Because subsequent prescribed fire may kill a higher proportion of shade-tolerant stems, the relative abundance of oak would likely increase (Brose et al. 2006). Prescribed fire would allow existing oak and hickory seedlings to compete when a new canopy gap is created through fire-induced mortality, windthrow, or other means. Young oak and hickory trees in heavily storm-damaged areas and areas that have been burned with prescribed fire—such as Teal Pond—have already been released from overhead competition. Prescribed fire in all the natural areas included in our proposal would give the species restricted to these fire-adapted and fire-dependent communities a better chance to germinate and grow into the canopy gaps. The use of herbicides to control or eradicate invasive plant species would be beneficial to the significant and exceptional plant species in these natural areas.

Through monitoring we have concluded there is minimal overspray onto native grasses when using a grass-specific herbicide on Nepalese browntop. In most cases, Nepalese browntop becomes a dense stand inhibiting the growth of native grasses and other vegetation, so spraying a patch does not cause direct or indirect death or damage to native vegetation at any level of concern. When glyphosate is applied to other invasive plant species, it occasionally kills some of the native species intertwined in the application zone. Only common species are adversely impacted and only for a short time; within the next year, seeds from adjacent areas easily re-populate a previously sprayed area. Herbicide spraying has not been done where rare plants exist; but, if it is done, these plants would be protected by the placement of a cover or barrier.

This alternative would have beneficial direct and indirect, short- and long-term environmental effects on the 23 natural areas—both from the use of prescribed fire to maintain and enhance the community-types and the use of herbicides to control invasive species. In addition, tree and shrub removal would also benefit the seep-springs and barrens areas, allowing the canopy to become more open and removing woody species that are encroaching and de-watering the seep-springs. Our experience with the application of herbicides at recreation and administrative sites indicates that direct and indirect adverse effects on native plant species as a result of herbicide application would be negligible. On a larger scale, we can expect the same negligible adverse effects on native plant species under Alternative 2 from the application of herbicides because the specified application methods would concentrate treatment on target plants, with minimal overspray or drift onto desirable native plants. When spraying in areas with known rare plant resources or uncommon species, a trained specialist would identify the rare or uncommon species, which we would then protect with barriers and/or covers to prevent damage to them.

See Appendix A for tables that detail each HUC6 watershed affected by this proposal, including targeted invasives, levels of proposed herbicide use, and the effects in the natural area treatment zones. See Table 4 for the treatments proposed.

Alternative 3 – Direct and Indirect Effects

Prescribed fire in Alternative 3 would have the same beneficial direct and indirect, short-term and long-term effects as Alternative 2; however, the rapidly spreading invasive species would have adverse long-term effects on all the natural areas, as well as adverse short-term effects on the natural areas with seep-springs. Prescribed fire alone would not prevent the Nepalese browntop from its swarming behavior in these delicate community-types and, in some situations, could stimulate this aggressive grass while controlling other invasives.

The edges of most of the 23 natural areas are already invaded by multiflora rose, autumn olive, Amur honeysuckle and other aggressive species that are moving into the interior of natural areas. Internally, Nepalese browntop and Chinese yam have invaded the streambanks. These invasives are moving in rapidly, displacing native species in sensitive natural areas. Our experience with the application of herbicides at recreation and administrative sites indicates that the direct and indirect effects on native plant species as a result of herbicide application would be negligible. The same negligible effects on native plant species can be expected under Alternative 3 from the application of herbicides to areas with invasive species infestations.

The use of a clove oil (eugenol)-vinegar (acetic acid) mixture for plant control in natural areas should kill annuals at the appropriate time of the growing season when they do not have the energy stored to resprout but may be ineffective on most perennials, since the effects are on aboveground parts of the plants. This natural herbicide does not get into the roots and repeat applications are most likely to be needed in order to kill or control the invasives. As when using synthetic herbicides, it would be necessary to cover or provide barriers to rare plants or uncommon species, since this substance can be damaging or detrimental to annual plants, although less so than synthetics.

The hot-foam method would be more difficult to control and would not likely be used in natural areas, since the mobility of the equipment is restricted to a short distance from roads and trails. It could be used on edges of natural areas where roadways exist. The hot-foam method is indiscriminate in its blanching of vegetation; it should only be used in areas where large blocks of invasives are a problem since it would be extremely difficult to protect adjacent desirable vegetation from potential damage or death. This method should be effective on annuals; however, it will be similar in effect to clove oil-vinegar, in that perennials may resprout and require further applications. Repetitive applications on the same plants (generally perennials) would limit the resources necessary to apply treatment to several areas on the Forest; therefore, covering less acreage and allowing invasives to seed and spread at a greater rate than Alternative 2.

Federally Listed Species

All Alternatives – All Effects

Mead's milkweed (*Asclepias meadii*) is listed as threatened, the only federally listed plant species known to occur on the Forest. None of the alternatives would have any effect on Mead's milkweed since none of the alternatives propose any management activities where this species occurs.

Regional Forester Sensitive Species (RFSS) and Species with Viability Evaluation (SVE)

RFSS and SVE occur on the Forest and are addressed in the plant biological evaluation. Field reconnaissance of the project area has been conducted for decades by naturalists, researchers, Forest employees and other professionals. The identified species are documented in records, literature, herbaria and databases. We have grouped the species into eight categories according to their general habitats and each is discussed below. More detailed discussion can be found in the biological evaluation in the Botanical Working Papers (project record). Some species may occur in more than one habitat-group, as is explained in the biological evaluation.

1. Swamps and Floodplain Forests
2. Seep-Springs
3. Streambanks and Streams
4. Mesic to Dry-Mesic Woodlands
5. Cliffs and Overhangs
6. Dry-Mesic Barrens and Glades
7. Open Barrens and Glades

See Appendix A for tables describing each HUC6 watershed affected by our proposal, including targeted invasives, levels of proposed herbicide use, and the effects in the natural area treatment zones. See Table 4 for the treatments proposed.

1. Swamps and Floodplain Forests – *LaRue-Pine Hills/Otter Pond Research Natural Area-Ecological Area:*

The plant group in this habitat-type includes RFSS in wet floodplain forests, wet woodlands, pin oak flatwoods, swamps, spring-fed ditches, or the sandy beaches of lakes. At LaRue-Pine Hills/Otter Pond Research Natural Area-Ecological Area the following species are known to occur: *Carex decomposita* (cypress-knee sedge), *Carex gigantea* (giant sedge), *Carex lupuliformis* (false hop sedge), *Carex socialis* (low woodland sedge), *Dichanthelium joorii* (variable panic grass), *Eleocharis wolfii* (Wolf's spikerush), *Glyceria arkansana* (Arkansas manna grass), *Heteranthera reniformis* (kidneyleaf mudplantain), *Hottonia inflata* (American featherfoil), *Hydrolea uniflora* (one-flowered false fiddleleaf), *Torreyocholoa pallida* (pale false manna grass) and *Vitis rupestris* (sand grape).

Other RFSS occur in this habitat-type outside of the research natural area: *Carex alata* (winged sedge), *Chelone obliqua* var. *speciosa* (red turtlehead), *Cynosciadium digitatum* (finger dogshade), *Platanthera flava* var. *flava (palegreen orchid)*, *Styrax americanus* (American snowbell) and *Urtica chamaedryoides* (nettle). *Schoenoplectus purshianus* (weakstalk bulrush) was delisted in 2011 because it had not been seen since 1977.

Alternative 1 – Direct and Indirect Effects

The majority of these species do not rely on prescribed fire for their existence, but fire would not get into swamps and wet floodplain forests with such intensity that it would affect them. Sand grape may experience indirect adverse effects from the continued encroachment of invasives in the long term (over the next 10 years). The other species do not currently require the use of herbicides or aggressive invasive species management in their habitat. Garlic mustard is encroaching into the drier portions of LaRue Swamp via the roadway and appears to survive the periodic flooding. Other species that may adversely impact these areas include Nepalese browntop, Amur honeysuckle, Japanese honeysuckle, multiflora rose, privet and beefsteakplant. The wetter areas are vulnerable to reed canarygrass, common reed, parrot feather watermilfoil and Eurasian watermilfoil.

Alternative 2 – Direct and Indirect Effects

This alternative would have no adverse effects on species found in swamps, floodplain forests and lake edges. The RFSS do not inhabit areas that a prescribed fire will generally burn through and, therefore, would experience no effects. The application of prescribed fire would enhance communities adjoining swamps and floodplain forests. Fires would help retard or kill several invasive species, while allowing the native species to compete better and with more vigor. This indirectly benefits the swamp and floodplain-forest species by being surrounded by more native vegetation and less likely to be influenced by aggressive invasive species.

Herbicide use would have indirect, short- and long-term, beneficial effects on the sand grape. Controlling the advancement of invasives and maintaining the native ecosystem of the swamps can be accomplished with little to no use of herbicides in the swamp areas; however, floodplain forests would benefit from the use of herbicides where encroaching invasives are moving into communities inhabited by RFSS and SVE.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same environmental effects on swamp and floodplain-forest species as Alternative 1 as it pertains to the lack of herbicide use, even though the use of a clove oil-vinegar or hot-foam application may be effective in the short-term on some perennial invasives and in the long-term on some of the annual invasives. Re-sprouting of the invasives will be a continuous control problem. This alternative would have the same environmental effects as Alternative 2 as it pertains to the application of prescribed fire.

2. Seep-Springs – *Cretaceous Hills Ecological Area, Dean Cemetery West Barrens Ecological Area, Kickasola Cemetery Ecological Area, Massac Tower Springs Ecological Area and Snow Springs Ecological Area:*

The plant group in these natural areas include the following RFSS in acid seep-springs and adjacent mesic barrens: *Bartonia paniculata* (twining screwstem), *Carex atlantica* (star sedge), *Carex bromoides* (sedge), *Isotria verticillata* (large whorled pogonia), *Platanthera clavellata* (small green wood orchid), *Rudbeckia fulgida* var. *sullivantii* (Sullivant's coneflower), *Sagittaria australis* (longbeak arrowhead) *Scirpus polyphyllus* (leafy bulrush), *Helianthus angustifolius* (swamp sunflower) and *Thelypteris noveboracensis* (New York fern).

Alternative 1 – Direct and Indirect Effects

These species would experience direct and indirect, adverse, short- and long-term effects from the lack of prescribed fire in the seep-springs areas and continued invasive species encroachment. The seep-springs are the most threatened community-type on the Forest and monitoring indicates that major portions of the seeps have been critically affected by encroaching woody native species, such as maples and poplars, and invasive species such as Nepalese browntop and Japanese honeysuckle (IDNR 2011). Maples are de-watering the seeps, while Nepalese browntop is taking over habitat crucial to these species. The seep-springs and their adjacent mesic barrens are vulnerable to plant-community extirpation if the damage is not reversed or controlled immediately. Past manual control methods have not been successful and we anticipate that, without human intervention, virtually none of these species can survive in the seeps.

Alternative 2 – Direct and Indirect Effects

The seep-springs species and the Sullivant's coneflower, which occurs in the adjacent mesic barrens of one of the springs, are found within fire-adapted communities. The application of prescribed fire would have beneficial, direct and indirect, short- and long-term effects on these species, as the fire helps restore the community-types surrounding them. Sullivant's coneflower was discovered following a prescribed burn and tree-girdling activities at the Kickasola seep during the spring of 1993. It was also found at Poco Cemetery North Ecological Area in moist pockets following the prescribed burn of 1995. With fire suppression and the canopy starting to close in, this species has not been seen in the last 15 years.

Native tree and shrub removal may also be necessary at some of the springs where woody encroachment is changing the hydrology to a drier one. The de-watering is also detrimental to this community-type; at one of the seeps it is suspected to have led to the disappearance of the longbeak arrowhead. Herbicide use to eradicate or control Nepalese browntop and Japanese honeysuckle is of upmost importance in the short term, resulting in both short-term and long-term beneficial effects. The infiltration of Nepalese browntop into the seep-springs will certainly extirpate species such as the small and delicate twining screwstem unless immediate action is taken.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effects on seep-spring species as Alternative 1 as it pertains to the continued encroachment of invasive species, and Alternative 2 as it pertains to prescribed burns. Some tree and shrub removal (or girdling) would also be implemented in this alternative, which would have beneficial, direct and indirect effects by relieving the seeps from de-watering by trees and partially opening the canopy for more sunlight to the forest floor.

Alternative 3 would also have some direct, short-term, beneficial effects from the use of clove oil-vinegar, which may be able to help control Nepalese browntop if applied at the appropriate time of the growing season. Re-sprouting of perennial plants is expected with the clove oil-vinegar solution as well as with the hot-foam method, although hot foam would likely not be used because of the distances of the seeps from trails and roads.

3. Streambanks and Streams – *Bell Smith Springs Ecological Area, Cretaceous Hills Ecological Area, Dean Cemetery West Ecological Area, Double Branch Hole Ecological Area, Fink Sandstone Barrens Ecological Area, Hayes Creek-Fox Den Ecological Area, Jackson Hole Ecological Area, LaRue-Pine Hills/Otter Pond Research Natural Area, Massac Tower Springs Ecological Area, Panther Hollow Research Natural Area and Snow Springs Ecological Area:*

The plant groups in these natural areas include RFSS in moist thickets, streambanks, sandy soil of mesic forests near streams, rich mesic woodlands, cool moist ravines, streams prone to flooding, springfed streambeds, and sandbars of creeks: *Amorpha nitens* (shining false indigo), *Dichanthelium yadkinense* (Yadkin's panicgrass), *Lilium superbum* (Turk's-cap lily), *Oxalis illinoensis* (Illinois wood sorrel), *Plantago cordata* (heartleaf plantain), *Rhynchospora glomerata* (clustered beaksedge), *Stenanthium gramineum* (eastern featherbells) and *Synandra hispidula* (Guyandotte beauty).

Alternative 1 – Direct and Indirect Effects

The majority of species along streambanks in the natural area treatment zones will not be affected in the short term; but, in the long term, over the next 10 years, most may experience adverse, indirect effects from the continued encroachment of invasive species. In many cases, the lack of prescribed fire in these areas would also have adverse, indirect, long-term effects on these species. Many are not in areas that a prescribed fire would reach; but the adjacent burned areas would have a beneficial influence on the habitat they occupy.

One species, Fraser's loosestrife, has already suffered adverse effects from the invasion of Chinese yam in its habitat. This invasive has infested the banks of Lusk Creek and threatens the native integrity of this high-gradient stream and its associated flora. Fraser's loosestrife has not been seen since 1999 at Lusk Creek; however, a seedbank may still be available if invasive species are eradicated or controlled. Yadkin's panicgrass is currently threatened by Nepalese browntop along the streams it inhabits. This species cannot compete with the dense matting of the Nepalese browntop.

Alternative 2 – Direct and Indirect Effects

Alternative 2 would have beneficial, direct and indirect, short- and long-term effects on Yadkin's panicgrass (Jackson Hole), Turk's-cap lily (Fink Sandstone Barrens) and clustered beaksedge (Bell Smith Springs) from the use of prescribed fire. With regard to herbicide use, Alternative 2 would have beneficial, direct and indirect, short- and long-term effects from the elimination or control of invasive species that compete for the same habitat as all of these species.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effects on RFSS that occur along streambanks as Alternative 1 as it pertains to the continued encroachment of invasive species, and Alternative 2 as it pertains to prescribed fire. Alternative 3 would also have direct, short-term, beneficial effects from the use of clove oil-vinegar, which may be able to help control the Nepalese browntop if applied at the appropriate time of the growing season; however, this substance would be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Re-sprouting of perennial plants is expected with the clove oil-vinegar, as well as with the hot-foam method, although hot foam would likely not be used because of the distances of streams from trails and roads.

4. Mesic to Dry-Mesic Woodlands – *Barker Bluff Research Natural Area, Bell Smith Springs Ecological Area, Cretaceous Hills Ecological Area, Dean Cemetery West Ecological Area, Double Branch Hole Ecological Area, Fink Sandstone Barrens, Hayes Creek-Fox Den Ecological Area, Jackson Hollow Ecological Area, Keeling Hill North and South Ecological Areas, LaRue-Pine Hills/Otter Pond Research Natural Area, Massac Tower Springs Ecological Area, Odum Tract Ecological Area, Panther Hollow Research Natural Area, Russell Cemetery Barrens Ecological Area and Snow Springs Ecological Area:*

The plant groups in these natural areas include RFSS in mesic woodlands, dry-mesic to mesic rocky upland woods, generally north-sloped woods, talus slopes, thickets, rich woods, rich woods with calcareous bluffs, springy ground, bottomlands and their floodplains: *Actaea rubifolia* (Appalachian bugbane), *Carex oxylepis* var. *pubescens* (sharpscale sedge), *Chamaelirium luteum* (fairywand), *Dryopteris goldiana* (Goldie's woodfern), *Euonymus americana* (strawberry bush), *Juglans cinerea* (butternut), *Panax quinquefolius* (American ginseng), *Poa alsodes* (autumn bluegrass), *Saxifraga virginiensis* (early saxifrage) and *Scleria oligantha* (littlehead nutrush).

Alternative 1 – Direct and Indirect Effects

The majority of the species that occur along the moister areas of mesic and dry-mesic woodlands would not be affected in the short term under Alternative 1; but, in the long term, over the next 10 years, most could experience adverse effects from the continued encroachment of invasive species. In particular, Nepalese browntop, garlic mustard, multiflora rose, autumn olive and Chinese yam threaten habitats for species such as the sharpscale sedge, Goldie's woodfern, butternut and autumn bluegrass. Many of these are not located in areas that would be reached by currently approved prescribed fire; but any adjacent burned areas would have a beneficial influence on their habitats.

Alternative 2 – Direct and Indirect Effects

Alternative 2 would have beneficial, direct and indirect, short- and long-term effects on many rare species and plant communities from the application of prescribed fire. Herbicide use would have beneficial, direct and indirect, short- and long-term effects from the elimination or control of invasive species that compete for the same habitat as all of these species.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effects on RFSS as Alternative 1 as it pertains to the continued encroachment of invasive species, and Alternative 2 as it pertains to prescribed burns. Alternative 3 would also have direct, short-term, beneficial effects from the use of clove oil-vinegar, which may be able to help control the Nepalese browntop if applied at the appropriate time of the growing season; however, this substance would be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Re-sprouting of perennial plants is expected with the clove oil-vinegar, as well as with the hot-foam method, although hot foam would likely not be used because of the distances of these areas from trails and roads.

5. Cliffs and Overhangs – *Ava Zoological Area, Bell Smith Springs Ecological Area, Bulge Hole Ecological Area, Double Branch Hole Ecological Area, Fink Sandstone Barrens Ecological Area, Hayes Creek-Fox Den Ecological Area, Jackson Hollow Ecological Area, LaRue-Pine Hills/Otter Pond Research Natural Area, Odum Tract Ecological Area and Panther Hollow Research Natural Area:*

The plant groups in these natural areas include RFSS in dry or moist-shaded or open sandstone or limestone cliffs and chert outcrops, driplines under sandstone cliffs, moist humid crevices of sandstone overhangs, dry to xeric upland bluff tops and sandstone ledges: *Asplenium bradleyi* (Bradley's spleenwort), *Asplenium resiliens* (black-stem spleenwort), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Dodecatheon frenchii* (French's shootingstar), *Hylotelephium telephioides* (Allegheny stonecrop), *Lonicera flava* (yellow honeysuckle) and *Trichomanes boschianum* (Appalachian bristle fern).

Alternative 1 – Direct and Indirect Effects

Under Alternative 1, these species would likely experience adverse, indirect, long-term effects from the continued encroachment of invasives over the next 10 years. Invasive species currently adversely affecting their habitats include Nepalese browntop, Amur honeysuckle, Japanese honeysuckle and multiflora rose. In addition, there is an overabundance of native poison ivy and Virginia creeper. These species do not rely on fire for their existence and currently planned prescribed fire is unlikely to reach the cliff faces and overhangs with such intensity that it would adversely affect them. Prescribed fire should be applied to the area surrounding the habitat of several of the species to enhance them and their vigor.

Alternative 2 – Direct and Indirect Effects

This alternative would have no adverse effects on the RFSS. There would be beneficial, indirect, short-term and long-term effects from the application of prescribed fire. Fire would enhance the communities adjoining cliffs and overhangs; although, being low in intensity, it would be incapable of passing up the nearly bare cliffs. Fires would help retard or kill several invasive species, while allowing the natives to compete better and with more vigor. This would indirectly benefit the cliff and overhang species by improving the native vegetation surrounding them and diminishing the influence of aggressive invasives.

Herbicide use would have beneficial, direct and indirect, short- and long-term effects on these rare species. The use of herbicides on aggressive invasives would mostly occur along the edges of cliffs and away from beneath overhangs. Controlling the movement of invasive species and maintaining the native ecosystem of the cliff communities and overhang species can be accomplished with little to no use of herbicides in the overhang areas and minimal herbicide use where encroaching invasives are moving into the cliff communities.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effects on the species as Alternative 1 as it pertains to the continued encroachment of invasive species, and Alternative 2 as it pertains to prescribed fire. Alternative 3 would also have direct, short-term, beneficial effects with the use of clove oil-vinegar, which may be able to help control annual invasives if applied at the appropriate time of the growing season; however, this substance would be virtually ineffective in the long-term on Japanese honeysuckle, Virginia creeper and other woody and perennial species. Re-sprouting of perennial plants is expected with the clove oil-vinegar, as well as with the hot-foam method, although hot foam would likely not be used because of the distances of these areas from trails and roads.

6. Dry-Mesic Barrens and Rich Uplands – *Barker Bluff Research Natural Area, Bell Smith Springs Ecological Area, Cretaceous Hills Ecological Area, Dean Cemetery East and West Ecological Areas, Double Branch Hole Ecological Area, Fink Sandstone Barrens, Hayes Creek-Fox Den Ecological Area, Jackson Hollow Ecological Area, Keeling Hill North and South Ecological Areas, Kickasola Cemetery Ecological Area, LaRue-Pine Hills/Otter Pond Research Natural Area, Massac Tower Springs Ecological Area, Odum Tract Ecological Area, Panther Hollow Research Natural Area, Poco Cemetery East and North Ecological Areas, Russell Cemetery Barrens Ecological Area and Snow Springs Ecological Area:*

The plant groups in these natural areas include RFSS in a combination of rich, north-facing wooded slopes; dry to moist or mesic, rich upland woods; and mesic and dry-mesic prairies and barrens: *Carex nigromarginata* (black-edge sedge), *Carex willdenowii* (Willdenow's sedge), *Matelea obliqua* (climbing milkvine), *Scleria pauciflora* (fewflower nutrush) and *Silene ovata* (Blue Ridge catchfly).

Alternative 1 – Direct and Indirect Effects

Alternative 1 would have adverse effects in the long term on species of fire-adapted and fire-dependent communities from being encroached upon by native maple trees and shrubs and invasives, since no fires are approved in these communities. These species respond well to fire and are able to compete better in their habitat when it is burned. Blue Ridge catchfly is not dependent on fire, but will not be impacted adversely if fire is applied to its habitat. All these species would experience adverse impacts in the long term from the continued encroachment of invasive species. Invasives currently adversely affecting their habitats include Nepalese browntop, Amur honeysuckle, Japanese honeysuckle, multiflora rose and an overabundance of poison ivy. With time, another 10 years, these rare species may be outcompeted by the aggressive invasives and become extirpated from their habitats.

Alternative 2 – Direct and Indirect Effects

Alternative 2 would have beneficial, short- and long-term effects on climbing milkvine and Blue Ridge catchfly in the areas that will be burned. The other RFSS, in the dry-mesic barrens and rich uplands, are not in areas planned for prescribed fire. Alternative 2 would also have beneficial, short- and long-term effects

from the use of herbicide. Controlling and/or eradicating aggressive invasives that threaten these species and their community-type would greatly enhance the ability of these rare species to compete and persist.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effect on these species as Alternative 1 as it pertains to encroachment of invasive species, and Alternative 2 as it pertains to prescribed burns. This alternative would also have direct, short-term, beneficial effects from the use of clove oil-vinegar, which may be able to help control the Nepalese browntop if applied at the appropriate time of the growing season; however, this substance would be virtually ineffective in the long-term on Japanese honeysuckle and other woody and perennial species. Re-sprouting of perennial plants is expected with the clove oil-vinegar, as well as with the hot-foam method, although hot foam would likely not be used because of the distances of these areas from trails and roads.

7. Open Barrens and Glades – *Barker Bluff Research Natural Area, Bell Smith Springs Ecological Area, Cretaceous Hills Ecological Area, Dean Cemetery East and West Ecological Areas, Double Branch Hole Ecological Area, Fink Sandstone Barrens Ecological Area, Jackson Hollow Ecological Area, Keeling Hill South Ecological Area, Kickasola Cemetery Ecological Area, LaRue-Pine Hills/Otter Pond Research Natural Area, Odum Tract Ecological Area, Panther Hollow Research Natural Area, Poco Cemetery East and North Ecological Areas and Russell Cemetery Barrens Ecological Area:*

The plant groups in these natural areas include RFSS and species with viability concern in open barrens and prairies, old native fields, dry rocky north-sloped woodlands and adjacent dry limestone cliffs and sandstone outcrops, bluff-top communities, rich north-facing wooded slopes, dry open woodlands on rocky ledges, limestone and sandstone glades, open roadsides and dry cherty limestone slopes in woodlands: *Buchnera americana* (American bluehearts), *Calamagrostis porteri* var. *insperata* (Porter's reedgrass), *Carex communis* (fibrous-root sedge), *Cirsium carolinianum* (soft thistle), *Dichanthelium ravenelii* (Ravenel's rosette grass), *Eupatorium hyssopifolium* var. *hyssopifolium* (hyssop leaf thoroughwort), *Festuca paradoxa* (clustered fescue), *Gentiana alba* (plain gentian), *Helianthus silphioides* (rosinweed sunflower), *Hexalectris spicata* (spiked crested coralroot), *Pinus echinata* (shortleaf pine), *Phemeranthus parviflorus* (sunbright), *Polygala incarnata* (procession flower), *Rhexia mariana* (Maryland meadowbeauty), *Rhododendron prinophyllum* (early azalea), *Silphium pinnatifidum* (tansy rosinweed) and *Spiranthes vernalis* (spring ladies' tresses).

Alternative 1 – Direct and Indirect Effects

Alternative 1 would have adverse effects on these species in the long term in the areas that will not be burned, in that no prescribed fires are approved in these communities. These species occur in fire-adapted and fire-dependent communities that are being encroached upon by native maple trees and shrubs and invasive species. They respond well to fire and are able to compete better in their habitat if it is burned. They would also experience adverse effects in the long term from continued encroachment of invasive species. Invasives currently impacting their habitat include Nepalese browntop, Amur honeysuckle, Japanese honeysuckle, multiflora rose and an overabundance of poison ivy. Prescribed fire is an important component for their continued existence and the community-types they inhabit.

Alternative 2 – Direct and Indirect Effects

Alternative 2 would have beneficial, short- and long-term effects on any of these species in areas that would be burned. Alternative 2 would also have beneficial, short- and long-term effects from the reduction in invasive species. Controlling and/or eradicating aggressive invasive species that threaten these species and their community-type will greatly enhance the ability of these rare species to compete and persist.

Alternative 3 – Direct and Indirect Effects

Alternative 3 would have the same effects on these species as Alternative 1 as it pertains to the continued encroachment of invasive species, and Alternative 2 as it pertains to prescribed fire. Alternative 3 would also have direct, short-term, beneficial effects from the use of clove oil-vinegar, which may be able to help

control the Nepalese browntop if applied at the appropriate time of the growing season; however, this substance would be virtually ineffective in the long-term on Japanese honeysuckle, multiflora rose, Amur honeysuckle and other woody and perennial species. The hot-foam method would likely not be used because of the distances of these areas from trails and roads.

Cumulative Effects

The geographic boundary for this cumulative effects analysis is the Forest boundary itself. This boundary was selected because Forest management actions, natural processes and other activities that occur on the Forest are confined to the Forest itself and the areas immediately adjacent. The temporal boundary for the cumulative effects analysis of botanical resources is from the past ten years to ten years in the future. The past boundary was selected because impacts from activities generally fade into the landscape in ten years. Ten years in the future is long enough to accurately gauge management effects and short enough that any unforeseeable deleterious effects could be addressed, reversed and/or mitigated.

Alternative 1 **–** Considering the effects of implementing this alternative with those of past, present and reasonably foreseeable future actions, the cumulative effects on botanical resources of taking no action would be generally adverse, since protection of the natural areas and rare plant communities would be hampered by the lack of prescribed fire and the restriction of invasive species control to manual and mechanical methods. The application of prescribed fire in already-approved actions would contribute minimally to the effort. Without the application of herbicides, the invasion of harmful species would continue from within and outside the Forest.

Alternative 2 **–** Considering the effects of implementing this alternative with those of past, present and reasonably foreseeable future actions, the cumulative effects on botanical resources would be generally beneficial. The affected natural areas and rare plant resources would be protected by the application of herbicides on and off the Forest, in spite of recreational activities on the Forest that aid in the spread of invasives. The application of prescribed fire, both on and off the Forest, would also contribute beneficially to the eradication or slowing of the spread of invasives onto and within the Forest.

Alternative 3 **–** Considering the effects of implementing this alternative with those of past, present and reasonably foreseeable future actions, the cumulative effects of implementing Alternative 3 would be generally similar to those of Alternative 1. The application of clove oil-vinegar or hot foam would be limited in scope and effectiveness and would contribute minimally to the control or eradication of invasive species.

Watershed Resources

Affected Environment

Soil – The soils in the project area consist mainly of silt loams, which have low rock content. Many of these soils developed in a layer of loess, silt-sized particles carried by the wind. In some places, this layer is thin and the soils developed in both the loess and the underlying sandstone or shale bedrock. Many of the bottomland and floodplain soils were developed in alluvial, water-transported, material. Some are upland soils and erosion ranges from slight at gentler slopes (less than 5 percent) to high at steeper slopes (above 18 percent). Some bottomland soils are classified as floodplain soils and others as hydric soils. Nearly all the soil-mapping units have a high potential for compaction; most have slight limitations for prescribed burning (NRCS ratings).

Soils-mapping units are also delineated according to pesticide leaching-potential and pesticide runoff-potential. Most in the project area have slight-to-moderate leaching potential and moderate-to-high pesticide runoff potential. We do not expect herbicide runoff on this project since they would be applied in specific areas according to the design criteria.

Water – Water-quality information is provided in tables in the working paper appendices (project record). Overall, the water quality of Forest streams is very good. A few are listed as impaired, but that is generally related to mining, agriculture, or other off-Forest impacts. Table 13 presents the acreage of National Forest System lands in the major watersheds of southern Illinois.

Air –In consulting the Illinois EPA air-quality report (IEPA 2009), we found that Massac County generally has the highest estimated levels of the five monitored pollutants—carbon monoxide, nitrogen oxides, particulate matter, sulfur dioxide and volatile organic matter—and Pope County the lowest. Atmospheric deposition in southern Illinois has been becoming less acidic over the past few decades. Sulfates have decreased over the long term while nitrate and ammonia levels have fluctuated. None of these changes are attributed to Forest management. Overall, air quality across the Forest is good. The air-quality data from monitoring stations in the airsheds in which the project area is located can be found in the working paper appendices (project record).

Table 13. HUC4 Watersheds of the Project Area

Name (Percentage Forest Service Ownership)	National Forest System Acres	Non-National Forest System Acres	Total Acres
Big Muddy River (3)	48,809	1,478,053	1,526,862
Cache River (6)	14,815	219,056	233,871
Lower Ohio River (2)	6,998	375,685	382,683
Lower Ohio River-Bay Creek (30)	117,771	265,186	382,957
Saline River (6)	45,659	707,549	753,208
Upper Mississippi River – Cape Girardeau (12)	51,607	384,545	436,152
TOTAL	**285,658**	**3,430,074**	**3,715,732**

The Illinois EPA developed a statewide Smoke Management Plan to address smoke from prescriptive fires used to achieve resource benefits. The goals of the plan are: coordination with land managers to develop a basic framework of procedures and requirements for managing smoke from prescribed fires, avoidance of significant deterioration of air quality and potential air-quality standards violations and mitigation of the nuisance and public-safety hazards posed by smoke intrusions into populated areas.

Prescribed fires on the Forest comply with this plan as well as the Forest Plan, following detailed burn plans and strict prescription standards. We evaluate prescribed fires using smoke-management models (FOFEM, V-Smoke and/or SASEM). Our monitoring of recent burns on the Forest—the Blowdown, One Horse Gap, Cedar Grove, Eagle Mountain and others—complied with the Forest Plan, followed burn plans and prescriptions, and resulted in no significant adverse effects on air quality (Huffman 2009, USDA FS 2009).

Ecosystem Services: Carbon Sequestration – Interest in terrestrial carbon sequestration has increased an effort to explore opportunities for climate change mitigation. Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by trees and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage and roots) and soils. The "sink" of carbon sequestration in forests and wood products helps to offset sources of carbon dioxide to the atmosphere, such as deforestation, forest fires and fossil fuel emissions.

Sustainable forestry practices can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning are some of the ways to increase forest carbon in the long run (Helzer 2011, Wiedinmyer and Neff 2007, Wilhelm 2009). Harvesting and regenerating forests can also result in net carbon sequestration in wood products and new forest growth (AFE 2009).

Herbicide Use – The use of herbicides is common in southern Illinois, as in most of the United States. The State of Illinois uses herbicides to maintain roadsides; electric companies use herbicides to maintain right-of-ways; farmers apply herbicides to protect their crops. In southern Illinois, the majority of watersheds with forested lands also contain cropland. The hydrologic unit code (HUC) 6 watersheds with National Forest System lands in the project area—each of which is about 50,000-150,000 acres—contain about 311,000 acres of cropland and pastureland (project record). Most of this land is treated with herbicides, fungicides and fertilizers on an annual basis.

Within these same watersheds, the Forest consists of about 287,000 acres, on 1,750 acres of which we are proposing to apply some amount of herbicides annually (see Appendix A), 0.61 percent. Compared to the non-Forest acreage on which herbicides are applied in the same watersheds, this annual maximum area of application is trivial, insignificant (see Table 13 and Appendix B). Additionally, our predominant methods of application would be with backpack sprayers and hand-held applicators. Some would be applied with small, boom-mounted equipment. These methods allow for a great deal of control as compared to other methods, such as large spray-rigs, herbicide cannons, or aerial application.

Alternative 1 – Direct and Indirect Effects

Current management activities would continue; therefore, land productivity would be unaffected. Soils would be impacted by the regular maintenance and use of roads, by planned and ongoing resource management activities, and by recreational activities such as hiking and horseback-riding. Current runoff and erosion patterns would be maintained, an upland erosion rate of less than one ton per acre per year on steep slopes. Soil organic matter is expected to increase, accompanied by an increase in microorganisms and fungi.

We would apply prescribed fire to about 6,000 acres Forest-wide, increasing to 10,000 acres over time, this acreage being the current limit we are able to burn annually. Accordingly, the effects of prescribed fire would be the same under any alternative, since prescribed fire is allowed under all. The effects of prescribed fire on soil erosion and nutrient loss are related to the severity of the burn. These effects are complex and depend on a variety of factors, but certain generalizations are relatively consistent.

Burning has the most pronounced effect on the forest floor, where carbon, nitrogen and sulfur are volatilized, and calcium, magnesium, potassium, phosphorus and other elements are left as ash. The ash is leached by rainfall into the mineral soil, which increases its base saturation and pH (Alban 1977). Increased nutrient availability at higher pH's may result in beneficial plant responses following fire (Van Lear and Kapeluck 1989). The beneficial response of plants leads to less soil erosion because plants hold the soil and slow the impact of rainfall. These findings coincide with results from a variety of other reviews and studies (DeBano et al. 1998, Liechty et al. 2004, and Neary et al. 2005).

We do not expect low-intensity prescribed fire to have an adverse effect on the quantity of water-flow, nutrient budgets, or soil quality over the long term. Prescribed fire can reduce organic-matter content and increase the loss of soil organisms through erosion. However, monitoring data from prescribed fires on the Forest show that an average of one to two centimeters of litter is consumed, with the majority unburned (project record: Soil and Water working paper). Repeated fires may be necessary to achieve multiple-use objectives: the control of invasive and mesophytic species to allow oak establishment. Forest burns are typically low-intensity–low-consumption burns. Burning that achieves variable consumption in mosaic patterns can provide substrate and habitat for microbial re-colonization following a fire. Monitoring shows this pattern in Forest burns (project record).

The typical fuel on the Forest consists of perennial and annual grasses and forbs and dried vegetative litter, the burning of which is unlikely to result in a net release of carbon (CO_2) into the atmosphere (Association for Fire Ecology 2009, Helzer 2011, USEPA 1996, Wiedinmyer 2007, Wilhelm 2004). As Gerould Wilhelm (of the Conservation Research Institute of Elmhurst, Illinois) explains in his paper, "The Realities of Carbon Dioxide: Seeing through the Smog of Rhetoric and Politics":

> Most of (the carbon) that is fixed above the ground in leaf and stem tissue is returned to the atmosphere during the… burn as water vapor, light, and CO_2—CO_2 that was fixed in our current era (post-glacial or Holocene), not the Paleolithic as is largely the case with fossil fuels. Given the fact that more carbon is fixed than burns or is decomposed after a growing season, there is a *net removal of CO_2 from the atmosphere every year* (emphasis added).
>
> The "smoke" is composed largely of CO_2 and water vapor. Generally, the more opaque the smoke, the greater the proportion of water vapor. The removal of atmospheric CO_2 is optimized in those grasslands that burn after each growing season, because the surface-area development of green leaves (photosynthetic surface) is maximized for the following year.
>
> The annual, one-time event of grassland combustion… is not only a clean burn but one that contributes positively to air quality by facilitating the grassland's removal of net amounts of CO_2 from the atmosphere.

Although Wilhelm (2004) and Helzer (2011) are addressing grassland burning, their conclusions apply to our burning of grasses and forbs, all of which fix CO_2 to some extent in the soil and release less CO_2 in their burning than the amount of which they have stored in the soil. Since trees, which have "stored" carbon mostly as cellulose within roots and trunk, are not consumed in our prescribed fires, the carbon they have stored is not released to the atmosphere.

Fireline construction associated with prescribed burning would be done under all alternatives. Erosion levels would vary depending on climatic conditions such as rainfall, freeze-thaw, slope, soil texture and other factors. Erosion-control measures would reduce these levels to the minimum. Ground-disturbing activities, particularly in wet-soil conditions, would have the potential to degrade soil structure, especially on soils with fragipans. The threat to these soils is from mechanical fireline-construction.

Some landscape-scale prescribed fires are ignited on the Forest by means of dropping "Ping-Pong" balls containing potassium permanganate—often used to treat water for drinking and as a disinfectant—injected with ethylene glycol (automotive antifreeze). These two substances react together in the sphere and begin an exothermic reaction, at which point they are dropped from a helicopter.

Potassium permanganate and ethylene glycol are highly reactive and ignite easily. In the unlikely event that the two do not ignite, potassium permanganate is a strong oxidizing agent that would react with organic matter without creating toxic byproducts. Ethylene glycol, on the other hand, is toxic if ingested. It is, however, readily biodegradable in the environment within 1 to 21 days, with the primary degradation occurring within three days. Because ethylene glycol is very soluble in water, biodegradation is the most important process that breaks it down. This suggests that bioaccumulation is not likely to occur. Since one substance reacts with organic matter without creating toxic byproducts and the other substance is biodegradable and not known to bio-accumulate, we expect no adverse effect on watershed resources from employing this ignition method.

There would be no direct or indirect effects on soil or water, surface or underground, from the proposed management activities. Soil quality and productivity would be increased in the long term as organic matter decomposes. Water quality would be maintained at current levels, considering anticipated future actions and assuming inputs from private land remain stable. Geologic erosion is expected to continue and some sediment is expected to enter streams. This alternative would likely result in less soil erosion, compaction, sediment load and percentage of bare ground than the other alternatives.

Alternative 1 – Cumulative Effects

Since there would be no project-related effects under this alternative, cumulative effects would be unchanged from the present. Invasive species would continue to spread in spite of the manual and/or mechanical control methods we employ.

Alternative 2 – Direct and Indirect Effects

Under this alternative, activities associated with invasive species management include prescribed burning, the application of herbicide, and mechanical and manual treatments. These activities have the potential to expose soil and cause some compaction. Exposed soil can erode at a faster rate than geologic rates. Soil particles can be loosened and transported in overland flow. Direct effects would be minimized through implementation of the project design criteria. Preventative measures described in the design criteria are based on Illinois Forestry Best Management Practice Guidelines and Forest Plan standards and guidelines.

The effects of prescribed fire would be the same as those described under Alternative 1.

– Synthetic Herbicide Application –

Our analysis indicates that use of the herbicides we propose would have minimal impact on soil and water resources, including underground water. In most cases, soil microorganism populations would increase briefly in the presence of these herbicides. Each herbicide has a "half-time" (formerly "half-life") that indicates the length of time required for half of the chemical to degrade.

Clopyralid – Clopyralid is a broadleaf-selective herbicide of very low toxicity to most animals, including soil invertebrates and microbes. It is degraded almost entirely by soil microbes. While clopyralid will leach under conditions that favor leaching—sandy soil, sparse microbial population, high rainfall—the potential for leaching or runoff is functionally reduced by its relatively rapid degradation in soil. Moderately persistent, it has a half-time in the environment of one to two months, but can range shorter or longer depending on soil-type, temperature and rates of application. A number of field lysimeter studies and a long-term field study by Rice et al. (1997) indicate that leaching is likely to be minimal and subsequent contamination of underground water unlikely (Durkin and Follansbee 2004). It is not susceptible to photo- or chemical degradation. Once in soil, the chemical rapidly dissociates and becomes extremely soluble in water. It is degraded almost entirely by microbial metabolism in soils and aquatic sediments (Tu et al. 2001, Extoxnet 1993). As proposed, clopyralid could be applied to broadleaf, leguminous and composite plants. We expect its direct effects to be limited to targeted plants, with minor, indirect effects in soil, described above.

Glyphosate – Glyphosate is a non-specific herbicide readily metabolized by soil bacteria, and many species of soil microorganisms use it as a sole source of carbon. Little information suggests that glyphosate would harm soil microorganisms under field conditions and a substantial body of information indicates glyphosate is likely to enhance or have no effect on soil microorganisms. Most field studies of microbial activity in soil after glyphosate exposure note an increase in microorganisms and/or activity. While the mechanism of this apparent enhancement is unclear, it is plausible that glyphosate causes an increase in pathogenic fungi in soil (sometimes noted in field studies) because it is used as a carbon source by the fungi and/or treatment results in increased nutrients for fungi. There is no indication that transient enhancement of populations of soil fungi or bacteria result in any substantial or lasting damage to soil ecology (Durkin 2011a, Extoxnet 1994). Its half-time averages two months in soil and it rapidly dissipates in water to settle in sediment, where its half-time can range from 12 days to 10 weeks (Tu et al. 2001).

Picloram – In heavy clay soil, picloram has a half-time of slightly over two months. However, when more organic material is present, this half-time nearly doubles (Durkin and Tollansbee 2011b). Breakdown by soil microorganisms occurs slowly, resulting in the formation of carbon dioxide and the release of a chloride ion. The compound is mobile and relatively persistent in soil and, therefore, if applied heavily, can be leached to underground water (Extoxnet 1993a), although no case of extensive off-site movement has been documented (Tu et al. 2001). We propose to use it only as a treatment on cut stumps: it would be

brushed onto the stump to prevent the growth of new sprouts at a time when rainfall is not forecast, so we expect no runoff to soil. The minimal amount applied would affect only the target plant and have no direct or indirect effects on watershed resources.

Sethoxydim – Sethoxydim targets grasses. It is moderately to slightly toxic to aquatic species, but has a low persistence in soil and underground water. Its average half-time in soils is four to five days, although it could range shorter or longer, to 25 days (Durkin 2001, Tu et al. 2001). It has a very low volatility and a weak tendency to adsorb to soil particles. In field tests, it did not leach below the top four inches of soil, and it did not persist. In soil, its photodegradation takes less than four hours. The disappearance of sethoxydim is primarily due to action by soil microbes. In water, photodegradation of sethoxydim takes less than one hour (Extoxnet 1993b). Because it is water-soluble and does not bind strongly with soils, it can be highly mobile. However, there are no reports of water contamination or off-site movement by sethoxydim. It is of relatively low toxicity to birds, mammals and aquatic animals and has little noticeable impact on soil microbe populations (Tu et al. 2001).

Considering the amount of this chemical that would be applied over ten years, direct effects would be limited to target grasses, with no measurable direct or indirect effect on soil, surface water, or underground water. Sethoxydim is used extensively in agriculture. Based on the most recent use-statistics in the literature, over one million pounds of sethoxydim are applied to crops annually, primarily to soybeans and cotton in the Midwest. By comparison, the uses of sethoxydim by the Forest Service are trivial - i.e., a total of 3.8 pounds in 1999 (Durkin 2001).

Triclopyr – Triclopyr is practically non-toxic to fish and aquatic invertebrates. In soil and aquatic environments, the chemical formulations rapidly convert to an acid that is neutralized to a salt. Triclopyr is not strongly adsorbed to soil particles, has the potential to be mobile and is fairly rapidly degraded by soil microorganisms. Its average half-time in soils is 30 days, but could range longer depending on the soil-type and environmental conditions. In water, its half-time is 10 hours (Tu et al. 2001, Extoxnet 1993c). The chemical readily breaks down in sunlight and rapidly degrades in soil. Used as proposed, triclopyr would have minimal direct effects other than on target plants. The amount of the herbicide applied in compliance with the design criteria and the characteristics of triclopyr indicate there will be no significant adverse effects. Based on recent Forest Service use reports, agency use of triclopyr constitutes about 1 percent of agricultural use (Durkin 2011).

– Mechanical Control Methods –

Pulling, digging, cutting, mowing, tilling and smothering would have minimal to no effects on soil or water. Hack-and-squirt and torching would have minimal impact on any watershed resources. Overall, these methods would have a minor impact on soil erosion, compaction, sediment load and the percentage of bare ground. These impacts would occur in individual, widely spread watersheds and should not impact soil productivity. Affected areas would be scattered across the landscape and minimal soil would actually be transported off-site.

Alternative 2 – Cumulative Effects

The cumulative effects of the activities proposed in Alternative 2, considered together with the effects of past, present and reasonably foreseeable future actions, would be imperceptible, non-measurable, and insignificant. In light of the vast quantities of herbicides and pesticides applied on thousands of acres of agricultural fields within the HUC6 watersheds and the larger HUC4 watersheds that contain the Forest—311,000 and 1,838,716 acres, respectively—the amount of herbicide use proposed by the Forest is trivial (see Table 14 and Appendix B): in terms of glyphosate alone, less than one-quarter of one percent of agricultural use in these watersheds.

The incremental effects on watershed resources from our proposed herbicide application would be short-term, non-measurable and insignificant. All currently observed effects from other herbicide and pesticide use in the watersheds will be realized under any alternative. Total proposed glyphosate application—

1218.049 pounds—is 0.2242 percent of agricultural use in the HUC6 watersheds of the project area. Total proposed clopyralid application by the Forest Service nationwide is about 2.2 percent of nationwide agricultural use (Durkin and Follansbee 2004), total sethoxydim application by the Forest Service has no published comparison, and total triclopyr application by the Forest Service nationwide is about 1 percent of nationwide agricultural use (Durkin 2011).

The proposed prescribed burning would have no measurable cumulative effects when considered together with the effects of past, present and reasonably foreseeable future actions on and off the Forest. Air-quality monitoring on the Forest has shown that any effects of fire on the Forest persist for only a very short time, with no cumulative effects, and our soils monitoring indicates that most of the duff on the ground before a burn remains after a burn (project record).

Table 14. Proposed Herbicide Active Ingredient (AI) Application (in Pounds) Forest-Wide vs. Agricultural Application

Herbicide	National Forest System Land		Agricultural Land	
		AI on 1,750 acres	HUC6 AI on 311,000A	HUC4 AI on 1,838,716 Acres
Clopyralid		117	Not available	Not available
Glyphosate		1218	544,156*	3,217,753*
Sethoxydim		30	Not available	Not available
Triclopyr		499	Not available	Not available
TOTAL all herbicides		**1864**	**544,156**	**3,217,753**
Total proposed glyphosate use is about 0.22% of agricultural glyphosate use in all treated HUC6 watersheds and about 0.038% of total agricultural use in the HUC4 watersheds containing the Forest.				

*We calculated the quantity of agricultural use of glyphosate in the herbicide Roundup using figures from the Center for Food Safety (CFS 2008) and comparing these to GIS land-use layers to conclude an average of 1.75 pounds of active ingredient per acre.

Alternative 3 – Direct and Indirect Effects

Prescribed Fire - The application of prescribed fire in this alternative would have the same direct and indirect effects as described under Alternative 1.

– Natural Herbicide Application –

Clove oil (eugenol) is expected to be short-lived and rapidly dissipated by volatilization and atmospheric deposition. Eugenol is broken down rapidly by soil microbes and would not have a lasting effect on earthworms, soil invertebrates or the breakdown of organic matter. One study found that *Pseudomonas fluorescens* bacteria (common soil bacteria) degraded eugenol. As eugenol volatilizes rapidly and is broken down rapidly in soils through microbial activity, it is not considered to be a potential underground water contaminant, and substantial surface-water runoff is not anticipated. When dissolved in water, eugenol volatilizes slowly in the air and can occur in wet soils as well, though microbial degradation may occur in soils first. Air transport of eugenol can occur after application by spray drift and over time by volatilization (Marin Municipal Water District 2008). The direct and indirect effects of the application of the clove oil-vinegar natural herbicide would be similar to the minimal effects of herbicide use in Alternative 2.

– Mechanical and Combination Control Methods –

The effects in this alternative of the mechanical and combination methods would be similar to the effects in Alternative 2: Pulling, digging, cutting, mowing, tilling and smothering would have minimal to no effects on soil or water. Hack-and-squirt and torching would have minimal impact on any watershed resources. Overall, these methods would have a minor impact on soil erosion, compaction, sediment load and the percentage of bare ground. These impacts would occur in individual, widely spread watersheds and should not impact overall soil productivity. Affected areas would be scattered across the landscape and minimal soil would actually be transported off-site.

Alternative 3 – Cumulative Effects

The cumulative effects of this alternative would be similar to those of Alternative 1 with regard to the application of prescribed fire and Alternative 2 with regard to the other proposed actions, the only difference being the use of natural herbicides instead of synthetic herbicides. Even though repeated treatments of natural herbicide might be required, the cumulative effects would be virtually the same as described under Alternative 2: non-measurable and insignificant (see Table 12).

Wildlife Resources

Affected Environment

In this section we discuss wildlife resources in the project area and the expected effects of the alternatives on these resources. Two federally listed species are known in the project area, the Indiana bat and the gray bat, and seven other federally listed or candidate species may have potentially suitable habitat in the Big Muddy River and/or some perennial streams on the Forest that are direct tributaries of the Mississippi and/or Ohio Rivers. Forty Regional Forester's Sensitive Species (RFSS), nine wildlife species with viability evaluation (SVE) and five management indicator species are known or suspected in the project area. This section is a summary of the wildlife working papers and biological evaluations prepared for this project. More detail can be found in those documents (project record).

Significant portions of the Forest, including natural areas, openlands and timber stands, have been surveyed many times by Forest Service wildlife biologists and botanists, IDNR heritage staff, numerous researchers from Southern Illinois University-Carbondale and Ball State University (Indiana) over the last 30 years, and especially since the early 1970's.

The geographic boundary of the analysis of effects on endangered and threatened species, RFSS and SVE will be different for each species based upon its distribution and/or habitat distribution in the project area. The temporal boundary for the effects analysis is the estimated 10-15 year life of the Forest Plan for present and future actions. Actions on non-federal land in the project area vicinity are anticipated to be similar to present actions on these areas during this timeframe. The temporal boundary for past actions is the last ten years. Any projects beyond ten years in the past are considered part of the baseline.

– Herbicide Application and Ecological Receptors –

Our analysis indicates that use of the herbicides we propose under Alternative 2 would have minimal to non-measurable adverse effects on wildlife. The SERA risk assessments of each of the proposed herbicides speak to the safety of each:

Clopyralid – Clopyralid is a broadleaf-selective herbicide of very low toxicity to most animals. Although it has not been tested on all animals, "the available data are sufficient to assert that adverse effects in terrestrial animals from the use of this compound in Forest Service programs do not appear to be likely" (Durkin and Follansbee 2004).

Glyphosate – The less toxic formulations of glyphosate do not appear to present any risks to terrestrial organisms other than terrestrial plants. Unlike the case with more toxic formulations, risks to amphibians and aquatic invertebrates appear to be insubstantial. Less toxic formulations of glyphosate pose no apparent risk to mammals. The risk to birds appears virtually non-existent and is "supported by several field studies indicating that aquatic applications of less-toxic formulations of glyphosate are beneficial to waterfowl due to the improvement of habitat conditions" (Durkin 2011a).

Based on the EPA's approach to risk assessment, the risk to terrestrial-phase amphibians from less-toxic glyphosate formulations would be characterized the same as risks to birds. Most field studies suggest that effects on terrestrial invertebrates would be minimal and secondary to changes in vegetation; those that don't utilize South American formulations of glyphosate, which are not available in the United States in any case (Durkin 2011a). Regarding amphibians, "there is no basis for asserting that adverse effects… would be apparent even at the upper bound estimates of exposure at the maximum application rate (and) as with

fish and amphibians, the risks associated with the less toxic formulations of glyphosate are minimal" (Durkin 2011a). A study of eastern red-backed salamanders showed that these terrestrial amphibians "are able to detect and avoid all three herbicide formulations at their full label application rates and to avoid the Roundup formulation at 10% the label concentration" (Gertzog et al. 2011).

Picloram – Picloram poses the greatest risk to targeted terrestrial plants. Exposures of terrestrial animals to contaminated water do not lead to apparent risks even in the case of an accidental spill (Durkin 2011b). We propose to use picloram only as a treatment on cut stumps: it would be brushed onto the stump to prevent the growth of new sprouts at a time when rainfall was not forecast. The minimal amount applied would affect only the target plant and have no direct or indirect effects on wildlife.

Sethoxydim – The simple interpretation of the quantitative risk characterization of sethoxydim for terrestrial animals is similar to that of the human health risk assessment: "the weight of evidence suggests that no adverse effects in terrestrial animals are plausible using typical or even very conservative worst-case exposure assumptions. As with the human health risk assessment, this characterization of risk must be qualified. Sethoxydim has been tested in only a limited number of species and under conditions that may not well represent populations of free-ranging non-target animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects can be anticipated in terrestrial animals from the use of this compound in Forest Service programs (Durkin 2001).

Triclopyr –The risk characterization for ecological receptors to triclopyr is parallel in many respects to the risk characterization for human health effects. HQs exceed the level of concern (HQ=1) for exposures involving the consumption of contaminated vegetation. With the exception of aquatic plants, risks associated with the contamination of surface water are low relative to risks associated with contaminated vegetation. "Based on the findings of field studies, triclopyr is not likely to cause frank adverse effects in small mammals and birds" (Durkin 2011c).

Management Indicator Species

Table 15 summarizes the expected effects on the five management indicator species under each alternative.

Table 15. Summary of Effects on Management Indicator Species

Common Name	No Action	Alternative 2	Alternative 3
Northern Bobwhite	Continued loss of habitat, downward trending population.	Improvement of habitat; decrease in invasives; increased native herbaceous groundcover, seed production, plant diversity; increase in oak-hickory forest-type and more early-successional forest and field habitats. Increase in populations.	Improvement of habitat, herbaceous groundcover, seed production, plant diversity; increase in oak-hickory forest-type and more early-successional forest and field habitats. Adverse effects expected from incomplete control of invasive plants.
Wood Thrush	Adverse effect on native overstory and understory plant species and thus on food and cover for most of upland and hardwood forest dependent species.	Beneficial effects: Improved native overstory and understory plants and/ or native prey that depend upon them are maintained or improved.	Improvement/maintenance of native habitats with food and cover, although not to extent of Alt 2. Adverse effects expected from incomplete control of invasive plants.
Yellow-Breasted Chat	Continued loss of habitat, downward trending of population.	Maintenance and improvement of native plant foods, nesting cover and insect prey. Net indirect effects expected to be an increase in species populations in short and long terms.	Improvement/maintenance of native habitats with food and cover, although not to extent of Alt 2. Adverse effects expected from incomplete control of invasive plants.

Table 15. Summary of Effects on Management Indicator Species			
Common Name	**No Action**	**Alternative 2**	**Alternative 3**
Scarlet Tanager	Adverse effects to nesting habitats, native plant foods and insect prey, resulting in population decline across Forest.	Maintenance and improvement of native plant foods, nesting cover and insect prey. Net indirect effects expected to be increase in population in short and long terms.	Beneficial effects from prescribed burning and maintaining oaks. Adverse effects expected from incomplete control of invasive plants.
Worm-Eating Warbler	Adverse effect on native overstory and understory plant species, food and cover for most upland hardwood forest-dependent species.	Improved native overstory and understory plants and/or native prey that depend upon them are maintained or improved.	Improvement/maintenance of native habitats with food and cover, although not to extent of Alt 2. Adverse effects expected from incomplete control of invasive plants.

Federally Listed Species

The project area contains habitat for the Indiana bat (*Myotis sodalis*) and the gray bat (*Myotis grisescens*). Indiana bats have been documented in the project area and in most counties in southern Illinois (Carter 2005; Herkert 1992). In early 2013 the presence of *geomyces destructans* was confirmed in the Forest. This fungus is the cause of white-nose syndrome, which affects many species of bats in the eastern and central United States, killing up to 99 percent of affected cave-dwelling bats. Since the fungus was only recently discovered in Illinois, our continued monitoring of the bats will tell what effect the disease is having on bats on the Forest. We continue to implement our Forest Plan in cooperation with the U.S. Fish and Wildlife Service and in compliance with the Service's 2005 Biological Opinion of the Forest Plan.

The other federally listed or candidate species are dependent upon open water: pink mucket pearly mussel (*Lampsilis abruptus*), orange-footed pearly mussel (*Plethobases cooperianus*), fat pocketbook pearly mussel (*Potamilus capax*), spectaclecase (*Cumberlandia monodota*), sheepnose (*Plethobasus cyphus*), least tern (*Sterna antillarum*) and pallid sturgeon (*Scaphirhynchus albus*) (see Table 16). All are known adjacent to the Forest in the Mississippi River and/or the Ohio Rivers. The fat pocketbook pearly mussel is also known in the Saline River on the Forest.

Indiana and Gray Bats

Alternative 1 – All Effects

Implementation of this alternative may affect, but is not likely to adversely affect, the Indiana bat or the gray bat. We anticipate that the effects of prescribed fire under this, or any other, alternative would be insignificant, discountable. Our determination is based on the fact that project burn plans consider all Forest Plan direction about burning in Indiana bat habitat. However, even should smoke enter a cave, fire burn an unknown roost tree, burning cause a temporary decrease in insect abundance, or lingering smoke temporarily displace bat individuals at foraging time, none of these conditions would have a lasting, measurable effect.

Alternative 1 would have no direct, indirect or cumulative effects on the Indiana bat or gray bat. Although adverse effects have been documented in various similar situations with regard to rare species and invasive plant infestations in other areas of the United States, it is unlikely that adverse cumulative effects would occur on these species as a result of Alternative 1 and minimally controlled invasive plant infestations.

Alternatives 2 and 3 – All Effects

The treatment of invasive plants is expected to be beneficial for the Indiana and gray bat because it would help maintain native habitats and the native insects (prey species) that have evolved with native plants. With the implementation of Forest Plan standards and guidelines and the project design criteria for Alternatives 2 and 3, both species would be protected from direct and indirect adverse effects.

As under Alternative 1, we anticipate that the effects of prescribed fire under these alternatives would be insignificant, discountable. Our determination is based on the fact that project burn plans consider all Forest Plan direction about burning in Indiana bat habitat. However, even should smoke enter a cave, fire burn an unknown roost tree, burning cause a temporary decrease in insect abundance, or lingering smoke temporarily displace bat individuals at foraging time, none of these conditions would have a lasting, measurable effect.

The treatment of terrestrial habitats under Alternatives 2 or 3 is expected to cause no adverse cumulative effects on the gray bat or the Indiana bat. Although there may be direct or indirect, short-term and localized effects, there would be no measurable incremental effect from implementing the proposed action when considered with the effects of other past, present and reasonably foreseeable future activities. We expect no direct, indirect or cumulative effects on water quality, caves, terrestrial and aquatic prey and roost trees because the scope of the proposed actions is extremely limited and scattered, and caves, mines and maternity roosts would be protected by implementation of Forest Plan standards and guidelines and/or project design criteria.

Table 16. Summary of Effects on Federally Listed Species

CLASS	SPECIES	COMMON NAME	STATUS	Alt. 1	Alt. 2	Alt. 3
Mollusk	*Lampsilis abrupta*	pink mucket mussel	Endangered	NE	NLAA	NLAA
Mollusk	*Plethobasus cooperianus*	orange-foot pimpleback mussel	Endangered	NE	NLAA	NLAA
Mollusk	*Potamilus capax*	fat pocketbook mussel	Endangered	NE	NLAA	NLAA
Mollusk	*Cumberlandia monodota*	spectaclecase mussel	Endangered	NE	NLAA	NLAA
Mollusk	*Plethobasus cyphus*	sheepnose mussel	Endangered	NE	NLAA	NLAA
Bird	*Sterna antillarum*	least tern	Endangered	NE	NLAA	NLAA
Mammal	*Myotis sodalis*	Indiana bat	Endangered	NE	NLAA	NLAA
Mammal	*Myotis grisescens*	gray bat	Endangered	NE	NLAA	NLAA
Fish	*Scaphirhynchus albus*	pallid sturgeon	Endangered	NE	NLAA	NLAA
Plant	*Asclepias meadii*	Mead's milkweed	Threatened	NE	NE	NE
NE = No Effect; NLAA = Not Likely to Adversely Affect						

We expect declines in bat populations in the future since white-nose syndrome has been discovered on the Forest. The disease will spread to bats that hibernate and/or roost in mines and caves in Illinois regardless of vegetation management. However, no declines associated with this disease have been documented to date in the project area vicinity (USDA-FS 2012).

Federally Listed or Candidate Avian and Aquatic Species

Alternative 1 – All Effects

This alternative would result in no direct adverse effects on aquatic threatened or endangered species or candidate birds, mussels, or fish. Of these species, only the fat pocketbook mussel is known to occur on the Forest, in the Saline River; however, we plan no actions near perennial streams that could directly affect this or any of the other species. No indirect adverse effects on habitats are expected because no measurable sedimentation or herbicide residue would occur in potential or known habitats for these species as a result of implementing this alternative. Prescribed burning as planned under this, or any other, alternative would have minimal adverse effects, if any, on water quality and sedimentation. Impacts on known or potential suitable habitats of aquatic threatened, endangered or candidate species would be minimal to immeasurable. Most of these species inhabit the large river systems, which would not be affected by proposed activities.

Although adverse effects have been documented in various similar situations with regard to rare species and invasive plant infestations in other areas of the United States, it is highly unlikely that adverse cumulative effects would occur on aquatic federal candidate species as a result of Alternative 1 and uncontrolled invasive plant infestations.

Alternatives 2 and 3 – All Effects

Prescribed burning under either alternative would have minimal adverse effects, if any, on water quality and sedimentation. Impacts on known or potential suitable habitats of aquatic threatened, endangered or candidate species would be minimal to immeasurable. Most of these species inhabit the large river systems, which would not be affected by proposed activities. No activities are proposed in or near the Saline River that could have any effect on the fat pocketbook pearly mussel.

Regional Forester Sensitive Species (RFSS) and Species with Viability Evaluations (SVE)

RFSS and SVE are grouped by affected habitats for this analysis:

1. Aquatic
2. Cave
3. Grassland/Oldfield
4. Cliff
5. Upland and Bottomland Hardwood Forest

1. Aquatic Habitats

Alternative 1 – All Effects

Alternative 1 would have no direct or indirect effects on aquatic RFSS. Prescribed burning under this, or any other, alternative would have minor adverse effects, if any, on water quality and sedimentation. No actions are planned near perennial streams that could directly affect the species. Because long-term impacts of uncontrolled invasive plant infestations on these species are not clearly understood, cumulative effects from the implementation of Alternative 1 are difficult to assess. Invasive plant infestations are dynamic, spread by humans and wildlife and continue to be documented: not all outbreaks have been discovered in their entirety. There is limited research regarding the impacts of invasive plants on wildlife.

Alternatives 2 and 3 – All Effects

Prescribed burning would have minor adverse effects, if any, on water quality and sedimentation. Potential effects on aquatic wildlife under Alternative 2 could include exposure as herbicides are applied to stream corridors and terrestrial areas adjacent to aquatic settings, although only herbicides approved for aquatic use would be applied. Indirect effects on the aquatic species would be minimal, non-measurable, given the formulations of aquatic herbicide we would apply near water, implementation of Forest Plan standards and guidelines and project design criteria, the limited scope of our proposal, scattered locations of treatments within a watershed and the relatively small individual sites being treated. Overall, while any adverse effects from Alternatives 2 and 3 would be minimal and temporary, beneficial effects from reducing or eliminating invasive plants from terrestrial habitats would be more wide-spread and long-term in plant and animal communities on the Forest.

Treatment of terrestrial habitats under either alternative could cumulatively contribute to minor, minimal sedimentation and herbicide/natural herbicide runoff when combined with past, present and reasonably foreseeable future activities. However, these effects would not contribute measurably to the existing effects on aquatic habitats and associated species.

2. Cave Habitats

Alternative 1 – All Effects

Cave-obligate species are dependent on subterranean environments in caves or mines to live all or a portion of their life cycle. Alternative 1 would have no direct or indirect effects on these species because none are known from the project areas and/or no actions are planned near perennial or intermittent streams and/or caves that could directly affect these species. This alternative would have no direct or indirect effects and, thus, no cumulative effects on cave-obligate species.

Alternatives 2 and 3 – All Effects

Because of our implementation of Forest Plan standards and guidelines for Indiana and gray bats and the design criteria for eastern small-footed bats, we expect minimal to no direct or indirect effects on any of these species from implementation of either alternative since no soil, water and/or auditory disturbances would occur near cave entrances that might harbor unknown populations.

Minimal sedimentation from prescribed burning and runoff from actions under either alternative may contribute incrementally, but would not add measurably, to the existing conditions in cave systems. The cumulative effects of either of these alternatives would be minimal to non-measurable on habitat for, and populations of, cave-obligate species.

3. Grassland/Oldfield Habitats

Alternative 1 – All Effects

Alternative 1 would have no direct effects on the Henslow's sparrow, loggerhead shrike, or northern bobwhite, since none of the proposed actions would be implemented. This alternative could have indirect adverse effects on the grassland/oldfield-associated birds as invasives invade and replace native grassland and openland plants throughout the project area, lacking more-aggressive invasive plant treatments.

Alternatives 2 and 3 – All Effects

Implementation of either alternative would have no direct effect on the grassland/oldfield-specific species, but would have beneficial, indirect effects on northern bobwhites from the burning of natural areas. Under Alternative 2, there would be beneficial, indirect effects on the species from herbicide treatments of the worst infestations of invasive species, reducing their spread and improving native vegetation. Considering the effects of past, present and reasonably foreseeable actions, the cumulative effects of either alternative on these species would be minimally beneficial, with improvements of native food and cover that would result in minor, overall improvements in species populations.

4. Cliff Habitats

Alternative 1 – All Effects

Alternative 1 would have no direct effects on any of the cliff-dependent species, as no actions beyond pulling and torching of invasives would occur. Indirect adverse effects could occur on all cliff-dependent species, since their habitats could change from the encroachment of invasive species not adequately controlled. Native vegetation would be overrun. Alternative 1 would result in adverse cumulative effects on populations of the carinate pillsnail, eastern woodrat and timber rattlesnake, as their habitat declines in diversity and quality. Alternative 1 would have no effect and, therefore, no cumulative effects on eastern small-footed bats.

Alternatives 2 and 3 – All Effects

Alternatives 2 and 3 could have some adverse, direct effects on all of the above species from burning and/or ingestion of herbicides in some areas. However, implementation of the design criteria would prevent most of these adverse effects by avoiding known habitats of the species. Indirect effects would be mostly beneficial under Alternatives 2 and 3 because invasive plants would be reduced or diminished in the vicinity of cliff habitats and provide additional or continued food and cover for all cliff-dependent species. Cumulative effects under Alternatives 2 and 3 would be beneficial, as known cliff habitats dominated by native plants are protected by controlling invasives and improving native plant diversity. Alternatives 2 and 3 would have no cumulative effects on the eastern small-footed bat with implementation of the design criteria protecting cliff areas from any direct, adverse effects of prescribed burning.

5. Upland and Bottomland Hardwood Forest Species

Alternative 1 – All Effects

Alternative 1 would have no direct effects, but could have adverse indirect and cumulative effects on most of the hardwood forest-dependent species. Declines in native plant communities, prey abundance and/or cover may result when invasive plants are not controlled. Cumulative effects on habitats and populations of hardwood-dependent species would be adverse and more pronounced in the long term (10-15 years) than in the short term (1-5 years).

Alternatives 2 and 3 – All Effects

Alternatives 2 and 3 would have no, or minor, adverse, direct or indirect effects on forest-dependent species. Some direct impacts could occur on the gray treefrog and American woodcock from herbicide and burning activities. These effects would be reduced or eliminated either because they are not present seasonally, not affected—as nests or roosts are protected by implementation of Forest Plan standards and guidelines and/or project design criteria—or are mobile and can move to avoid impacts. Both alternatives would have relatively major, beneficial, indirect effects on forest-dependent species, as native overstory and understory plants and/or native prey that depend on them are maintained or improved, with the most improvement and beneficial effects resulting from Alternative 2.

Wilderness Resources

Affected Environment

The proposed action would treat infestations in five of the Forest's seven wildernesses—Bald knob, Clear Springs, Garden of the Gods, Lusk Creek and Panther Den—to restore and maintain the natural character of wilderness: The introduction of invasive species is a result of human manipulation of the environment. Invasive species impact the natural condition and natural processes that wilderness was established to protect. In addition, the presence of invasive species compromises the "untrammeled" condition described in the Wilderness Act:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man…

Wilderness Indictors – We discuss the effects of the proposed action on wilderness resources in relation to two indicators of wilderness character (Landres et al. 2005):

- **Untrammeled Condition**: "Untrammeled" is defined as being unconfined or unhindered and is a measure of the control or manipulation that human activities exert over the components or processes of ecological systems inside wilderness. Invasive species are considered trammeling because they are introduced, in part, by human activities and damage the biological diversity and ecological integrity of wilderness. Invasive plants displace native plants and wildlife habitat and forage.
- **Natural Condition**: The natural condition of wilderness is a measure of the effect of human activity on the individual components of the natural community. This indicator examines the impairment of soil, water, wildlife, aquatic organisms and native and non-native plants. We recognize that, when natural conditions are manipulated for the purpose of restoring ecological systems, both anticipated and unforeseen impacts can occur (Landres et al. 2005).

Alternative 1 – Direct and Indirect Effects

Invasive species would continue to be treated using manual methods, which are not effective for the control and eradication of invasives. This alternative would have a direct and adverse effect on both the natural condition and the untrammeled character of wilderness. Invasive species populations would continue to expand and new populations would continue to become established.

Alternative 2 – Direct and Indirect Effects

Implementation of this alternative is likely to be successful in the control and reduction of spread of the four highly invasive species. Because of the increase in Forest personnel in the wilderness and the visible effects of killing unwanted vegetation, this alternative would have a minimal, adverse effect in the short term on the untrammeled character of wilderness. However, in the long term, the number of treatments and the size of treatment areas would decrease as infestations are controlled. The eventual reduction of invasive species would improve the untrammeled character of wilderness over time, a beneficial effect. This action would have a beneficial effect on the natural condition of wilderness, since native plants would return or be returned to the treated areas and reduce the encroachment of invasive species.

Alternative 3 – Direct and Indirect Effects

Under this alternative, invasives infestations in wilderness would be treated initially with manual methods. Natural weed-killers would be applied manually from a backpack sprayer. They would top-kill plants, much like torching does, but would not kill the roots. This treatment would top-kill perennial plants, but they would re-sprout the following year. Eradication of invasives infestations is not likely under this treatment regime.

This alternative would require frequent treatments of annual and biennial invasive species. These treatments may successfully eradicate Nepalese browntop and garlic mustard, but would be ineffective on perennial species, which would continue to spread, having a direct adverse effect on the untrammeled and natural conditions of wilderness.

All Alternatives – Cumulative Effects

The spatial boundary for this discussion includes the boundary of the Forest and Crab Orchard Wilderness, adjacent to Panther Den Wilderness. This boundary was selected because management actions, natural processes and recreational activities that occur on the Forest are confined to the Forest and areas immediately adjacent to it. The temporal boundary dates from the 1930's, when invasive species were commonly planted as soil stabilizers and as food for wildlife and domestic animals, to ten years into the future—long enough to gauge accurately the management effects.

When considered with the effects of past, present and reasonably foreseeable future actions, the actions proposed in this analysis would have a beneficial, cumulative effect on the untrammeled character and natural condition of wildernesses by slowing down the establishment and encroachment of invasive species that are transported by wind, water, humans and animals. These same beneficial effects are not expected from the implementation of Alternatives 1 or 3, both of which offer no effective method to manage invasive species. The result would be a failure to protect or enhance the untrammeled character and natural condition of wildernesses.

Heritage Resources

Affected Environment

Here we describe the heritage-resource concerns with the project area. The primary issue in this analysis is the preservation and protection of heritage resources and the assurance that significant heritage resources will not be affected by project implementation. Archaeological sites are located on and in the ground and are affected by any activity that disturbs the soil. Since project activities are confined to the proposed treatment areas and other heritage resources beyond the project boundary are protected by law, it is reasonable to limit the analysis to the treatment area boundaries.

The design criteria include methods developed decades ago with the passage of the National Historic Preservation Act (NHPA) of 1966 and its implementing regulations. According to Section 106 of the NHPA, "The agency official shall take the steps necessary to identify historic properties within the area of potential effects. The area of potential effect is defined as "….the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties… The

area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking" (36CFR 800.16[d]).

Much of the project area has been subjected previously to decades of traditional farming activities such as plowing and disking and, therefore, the top 4-8 inches of soil are already disturbed and the cultural deposits are mixed. This mixed layer of soil is called the plow zone. Invasive species management activities that further mix the soil within the plow zone will not adversely affect any cultural material that might be contained in the plow zone.

The area of potential effects may vary depending upon the level of disturbance and what earth-disturbing activities are planned. Invasive species management includes both non-earth–disturbing activities, as well as a variety of earth-disturbing activities, which also include variations in earth disturbance. Mowing, weed-whipping, smothering, spot-torching and herbicide treatments are not earth-disturbing activities and will have no effect on heritage resources. Hand-pulling and digging with a shovel, as in Alternative 2, are earth-disturbing activities, but are much less invasive than bulldozing, backhoeing and grubbing, as in Alternative 3. Because of this variation, the level of inventory and other archaeological investigations will vary within the area of potential effects.

Alternative 1 – All Effects

There would be no direct, indirect or cumulative effects on heritage resources from implementation of this alternative because no additional invasive species management projects would be implemented and, therefore, activities that might potentially damage archaeological sites and other historic properties would not occur. Treatment of invasive species with manual methods or torching would have no effect on subsurface or sub-plow zone heritage resources. Although some invasive vegetation can affect heritage sites, especially in non-forested areas, this would be comparable to natural vegetation encroachment. Prescribed-fire project areas are inventoried according to a programmatic agreement among the Forest, the Illinois State Historic Preservation Officer and the Advisory Council on Historic Preservation. Herbicide use in campgrounds has no effect on heritage resources.

Alternative 2 – All Effects

There would be no direct, indirect or cumulative effects on heritage resources from implementation of this alternative. A methodology is in place to protect heritage resources from earth-disturbing activities associated with prescribed fire under the programmatic agreement among the Forest, the Illinois State Historic Preservation Officer and the Advisory Council on Historic Preservation. The protocol and mitigation measures included in the programmatic agreement were designed to protect heritage resources that might be affected adversely during prescribed fire.

Of the remaining proposed activities, mowing, weed-whipping, smothering, spot-torching and herbicide treatments are not earth-disturbing activities and would have no effect on heritage resources. In general, herbicides do not have the resident time of pesticides and would not affect the chemical structure or character of surface or subsurface archaeological materials. However, hand-pulling and digging with a shovel are earth-disturbing activities.

The great majority of the project area is located on ridge tops that have already been disturbed by decades of plowing and other agriculture-related activities. Manual and mechanical-pulling and digging with a shovel to a depth of eight inches or less would not further affect heritage resources. Areas known to contain invasive species that have not been previously disturbed by agricultural activities will be reviewed and inventoried for heritage resources prior to project implementation.

Alternative 3 – All Effects

There would be no direct, indirect or cumulative effects on heritage resources from implementation of this alternative. This alternative is designed to control invasive plant species, but not eradicate them. Although much of the same methodology proposed for Alternative 3 is the same as Alternative 2, this alternative proposes more aggressive earth-disturbing activities, such as grubbing (repeatedly hacking at individual

plants) and excavating the invasive plant populations with bulldozers and/or backhoes. Areas in which these methods of eradication are proposed will be reviewed and inventoried for heritage resources prior to implementation. However, the level of earth-disturbance with these aggressive management activities is much higher and more likely to extend below the plow zone and adversely affect any archeological materials located there. Therefore, the level of heritage inventory will be greater under Alternative 3 than under either Alternatives 1 or 2.

Disclosures

Agencies Consulted	
Illinois Department of Natural Resources	Illinois Invasive Plant Species Council
Illinois Nature Preserves Commission	River-to-River Cooperative Weed Management Area

Clean Water Act – Activities identified in the alternatives comply with Section 319 of the Federal Clean Water Act. The Illinois Non-point Source Management Program, which recommends using Illinois Department of Natural Resources Best Management Practices, was developed to comply with Section 319 of the Federal Clean Water Act (IDNR et al. 2007 [revision]). These practices, as well as Forest Plan Standards and Guidelines and soil suitability and limitations, as determined by the Natural Resources Conservation Service, will be used to guide the action alternatives.

Air Quality – The air quality in the Forest meets EPA standards. Implementation of any of the alternatives would result in a few hundred hours of heavy equipment use over the next 1-3 years. The amount of exhaust generated from the level of activity expected would not have a measurable effect on air quality. There would be a short-term detrimental effect on air quality in the project area and in the watershed during periods of prescribed burning. This would result in long-term negligible direct and indirect effects and an insignificant addition to cumulative air quality in the Forest.

Migratory Bird Treaty Act – This proposal complies with the Migratory Bird Treaty Act and Executive Order 13186. See the Wildlife working paper for details.

National Historic Preservation Act – Following consultation, the State Historic Preservation Office has concurred with our determination of no-effect on heritage resources from implementation of our invasive species management proposal.

Floodplains – Site productivity and riparian function would be maintained in the project area in all alternatives; therefore, also on the floodplains in the project area.

Wetlands – None of the alternatives would have an adverse effect on the site productivity or function of the sites near the project area identified as having one or more wetland characteristics.

Irreversible or Irretrievable Commitment of Resources – None of the project alternatives would have an irreversible or irretrievable commitment in the project area or adjacent analysis area if design criteria and Forest Plan protections are adhered to. We anticipate no irreversible effects on soil and water resources from any alternative. Soil erosion above natural rates is an irretrievable effect. Alternatives 2 and 3 would result in a temporary, slight increase in erosion rates above natural geologic rates.

Roadless – The Secretary of Agriculture issued a memo reserving the authority for approval of road construction and timber harvest in 2001 inventoried roadless areas. Our invasive species management proposal includes the management (herbicide treatments and prescribed fire) of two designated natural areas in the 6200-acre Burke Branch Inventoried Roadless Area.

The Regional Forester reviewed our proposal and allowed us to continue our analysis. Proposed activities comply with condition 2 (B)(2)(c) of the Secretary's Memorandum of May 28, 2010, which recognizes the need "to improve threatened, endangered proposed, or sensitive species habitat" [and] "to maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects..." We have reviewed the roadless direction and have determined that the

activities planned are consistent with the 2001 roadless rule. The proposed actions would improve the roadless character by eliminating invasive species and improving the ecological condition of these areas.

Social and Economic Environment and Environmental Justice – Executive Order 12898 requires federal agencies to respond to the issue of environmental justice by "identifying and addressing disproportionately high and adverse human activities on minority and low income populations. Ethnic minorities are defined as African Americans, American Indian and Alaska Native, Asian, Hispanic or Latino, and Native Hawaiian and other Pacific Islanders. Low income persons are defined as people with incomes below the federal poverty level, which was defined in 2009 as $22,050.00 for a family of four.

According to "Social Assessment of the Shawnee National Forest" (Welch and Evans 2003), "Several key characteristics distinguish southern Illinois from the rest of the state. Perhaps the most striking is the level of poverty in the region… Southern Illinois, still recovering from job losses due to coal mine closings, had relatively high rates of unemployment in 2000; "… Jackson and Massac counties had the lowest rates in the region" (Welch and Evans 2003). The area is also characterized by low population density and declining population.

Although the area is marked by high unemployment, high poverty rates, and lower-than-average minority numbers, the action alternatives described in this environmental assessment are limited to Forest Service-managed lands, and potential effects resulting from these activities would not affect residents, including minority or low-income populations, bordering National Forest System lands. The project design criteria outlined in Chapter 2, including herbicide application procedures, short-term closures during herbicide applications and other mitigation measures, would ensure that the proposed activities would have no effect on neighboring private property or on the health and safety of forest visitors and, therefore, the health of minorities or low-income individuals will not be affected.

Minimum Requirements Decision Guide for Proposed Actions in Wilderness – The Minimum Requirements Decision Guide assists wilderness managers in making appropriate decisions regarding management actions in wilderness areas. The concept of Minimum Requirements comes from Section 4(c) of the Wilderness Act of 1964:

> Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and except as necessary to meet *minimum requirements* for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area. (Emphasis added.)

Applicable actions include, but are not limited to, scientific monitoring, research, recreational developments and, as proposed in this environmental assessment, invasive species treatment and control. We have prepared a Minimum Requirements Decision Guide to identify, analyze and select the minimum actions necessary for the treatment and control of invasive species in the wilderness areas on the Forest. Its findings are incorporated in the environmental assessment and it is included in the project record.

Forest Plan – All actions proposed under any alternative are consistent with the Forest Plan.

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APPENDIX A

Invasive Species Management by HUC6 Watershed

SUMMARY OF EFFECTS COMMON TO HUC6 WATERSHEDS

- Application of herbicides in any listed HUC6 watershed in the quantities specified and in accordance with label direction and the project design criteria (as detailed in the environmental assessment) is expected to result in the death/control of the plants to which the herbicides are applied. No rare plant or wildlife species would be adversely affected.
- Human health and safety hazard quotients (as described in the environmental assessment) related to the application of herbicides as specified in any listed watershed would be below the level of concern, which is 1.
- Application of herbicides in the quantities specified and in accordance with label direction and the project design criteria would result in minimal to no runoff of herbicides to the soil or to any waterbody. Herbicide persistence in the soils on the proposed sites would be minimal.
- Application of prescribed fire or other manual or mechanical methods of invasive species control in any listed watershed would result in the control, minimization, or extirpation of the targeted plants.
- Successful results from the application of herbicides and prescribed fire or other manual or mechanical methods of invasive species control would yield beneficial effects on the rare plant communities and natural areas in any listed watershed.
- Specific effects on rare plants in each natural area are detailed below.

INDEX OF NATURAL AREAS

Natural Area	HUC6 Watershed
Ava Zoological Area	Little Kinkaid Creek – Kinkaid Creek
Barker Bluff Research Natural Area – Ecological Area	Peters Creek – Ohio River
Bell Smith Springs Ecological Area	Little Bay Creek – Bay Creek
Bulge Hole Ecological Area	Little Cache Creek
Cretaceous Hills Ecological Area	Barren Creek
Dean Cemetery West Ecological Area	Barren Creek
Double Branch Hole Ecological Area	Hayes Creek
Fink Sandstone Barrens Ecological Area	Cedar Creek
Fountain Bluff Geological Area	Fountain Bluff – Mississippi River
Hayes Creek – Fox Den Ecological Area	Hayes Creek
Jackson Hole Ecological Area	Hayes Creek
Keeling Hill North Ecological Area	Peters Creek – Ohio River
Keeling Hill South Ecological Area	Peters Creek – Ohio River
Kickasola Cemetery Ecological Area	Sister Islands – Ohio River
LaRue-Pine Hills Research Natural Area – Ecological Area	Hutchins Creek
Massac Tower Springs Ecological Area	Sister Islands – Ohio River
Odum Tract Ecological Area	Little Cache Creek
Panther Hollow Research Natural Area – Ecological Area	Camp Creek – Ohio River
Poco Cemetery East Ecological Area	Sister Islands – Ohio River
Poco Cemetery North Ecological Area	Sister Islands – Ohio River
Reid's Chapel Ecological Area	Little Saline River
Russell Cemetery Ecological Area	Goose Creek – Big Creek
Snow Springs Ecological Area	Sister Islands – Ohio River

BARREN CREEK

Total Acreage	FS Ownership Acreage	Cropland Acreage
13,862	7656	2593

Priority Species outside Natural Area Treatment Zones

Amur Honeysuckle	Chinese Yam	Garlic Mustard	Kudzu
0	0	0	0.7 acre

Cretaceous Hills and Dean Cemetery West Ecological Areas

Cretaceous Hills and Dean Cemetery West Ecological Areas treatment zones comprise approximately 723 acres. They are located in proximity in Pope County at T15S, R6E.

Cretaceous Hills and Dean Cemetery West contain seep spring and barrens habitat, with rare and sensitive plants. The areas are about 50-percent forested, with young to mature second-growth, dry, dry-mesic, and mesic upland forest and young to mature second-growth wet floodplain forest along wooded stream valleys. Open areas include large successional fields and disturbed dry to dry-mesic barren remnants. The barrens communities represent the last remaining examples of this savanna-like habitat in Illinois. Management objectives in these areas include the protection of critical habitat for rare and sensitive plants, the preservation of significant seep springs, and the perpetuation of significant natural communities representative of the Cretaceous Hills section of the Coastal Plain division, including the use of prescribed fire and the control of invasive species.

Amur Honeysuckle	Chinese Yam	Garlic Mustard	Kudzu
0	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Common periwinkle 0.69 acre	Nepalese browntop 11.12 acres	Annual ragweed 0.12 acre Sericea lespedeza 0.01 acre	Autumn olive 2.53 acres Japanese honeysuckle 100.84 acres Multiflora rose .03 acre
Total: 0.69 acre	Total: 11.12	Total: 0.13 acre	Total: 103.4 acres

Herbicide Application (in pounds of active ingredient per acre/treatment)

Common periwinkle, Japanese honeysuckle: glyphosate 3% on 101.53A = 36.327 Nepalese browntop: sethoxydim 1.5% on 11.12A = 3.545 Autumn olive, multiflora rose: glyphosate 20% on 2.56A = 2.714	Annual ragweed, sericea lespedeza: triclopyr 3% on 0.13A = 0.146 Kudzu: triclopyr 2% on 0.7 acre = 1.313 Annual ragweed, kudzu, sericea lespedeza: clopyralid 3% on 0.83A = 1.015

Clopyralid = 1.015	Glyphosate = 39.041	Sethoxydim = 3.545	Triclopyr = 1.459

Soil Conditions

Cretaceous Hills: Area contains 23.8 acres of floodplain soils and 0.6 acre hydric soils. Hosmer soils in this area—when wet—have a moderate potential for leaching herbicides and moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).
Dean Cemetery West: The area contains 11.5 acres of floodplain soils and 7.1 acres of hydric soils. As at Cretaceous Hills, the Hosmer soils in this area—when wet—have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREAS

CRETACEOUS HILLS ECOLOGICAL AREA

Bartonia paniculata (twining screwstem), ***Buchnera americana*** (American bluehearts), ***Carex atlantica*** (prickly bog sedge), ***Carex bromoides*** (brome-like sedge), ***Polygala incarnata*** (procession flower), ***Rhexia mariana*** (Maryland meadowbeauty), ***Scirpus polyphyllus*** (leafy bulrush): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of species populations within seep springs on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasive plant species are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.
Chamaelirium luteum (fairywand): **Alt. 1**: Adverse, direct and indirect, short- and long-term effects from the lack of herbicide use. Nepalese browntop is invading sites where this species is currently known and will eventually outcompete it. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts resulting from use of herbicides. Selective spraying will help control encroaching invasive species that threaten the few locations this species inhabits. **Alt. 3**: Adverse, indirect, long-term impacts from lack of herbicides. Use of clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species such as this.
Isotria verticillata (large whorled pogonia): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese honeysuckle has encroached on one of the populations and threatens to choke it out; without use of herbicides, the invasive species will certainly out-compete it. Nepalese browntop poses a second threat to the majority of the populations. Without removal or spraying of this invasive, it will out-compete the orchid in its rare habitat. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment that may not only cause reduction in health and vigor of the species populations within seep springs on the Forest, but may lead to extirpation of the species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides; this orchid is readily identifiable and protected during herbicide use.

BARREN CREEK

Alt. 3: Adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short-term and long-term impacts from use of prescribed fire.

Sagittaria australis (longbeak arrowhead), ***Thelypteris noveboracensis*** (New York fern): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese honeysuckle has encroached on much of their habitats and, without use of herbicides, this invasive will certainly out-compete them. Nepalese browntop also poses a major threat to the populations. Without removal or spraying of this invasive, it will also out-compete these species in their habitats. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of the species populations on the Forest, but may lead to their extirpation in Illinois. Prescribed fire is also required for the community these species inhabit to help reduce encroaching woody species and stimulate vigor and health. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides. These species are readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short-term and long-term impacts from use of prescribed fire.

Spiranthes vernalis (spring ladies'-tresses): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese and Amur honeysuckle have encroached on much of its habitat. Without use of herbicides, these invasives species will out-compete it. Nepalese browntop also poses a major threat to the populations. Without removal or spraying of this invasive, it will out-compete the species in its rare habitat. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment, which cause a reduction in health and vigor of this species' populations on the Forest. Prescribed fire is also required for the community this species inhabits to help reduce encroaching woody species and stimulate vigor and health. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides. This species is readily identifiable and protected during herbicide use. Species is adapted to fire and will respond favorably. **Alt 3**: Some adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire.

DEAN CEMETERY WEST ECOLOGICAL AREA

Carex atlantica (prickly bog sedge), ***Rhexia mariana*** (Maryland meadowbeauty), ***Scirpus polyphyllus*** (leafy bulrush): See above.

Scleria pauciflora (fewflower nutrush): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns.

BAY CREEK DITCH

Total Acreage	FS Ownership Acreage	Cropland Acreage
11,588	4188	4852

Priority Species

Amur Honeysuckle	Chinese Yam	Garlic Mustard	Kudzu
0	16.18 acres	0	0

Herbicide Application (in pounds of active ingredient per acre/treatment)

Chinese yam: triclopyr 3% on 16.18A = 22.753

Triclopyr = 22.753

Soil Conditions

The Wellston-Berks soil complex of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).

BEAVER CREEK-SALINE RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
20,780	4267	9306	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	92.16 acres	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 92.16A = 129.6			
Triclopyr = 129.6			
Soil Conditions			
The Hosmer silt-loam—when wet—and the Wellston silt-loam of these sites have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

BIG CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
12,829	4731	2819	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.11 acre	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on .11A = 0.155			
Triclopyr = 0.155			
Soil Conditions			
The Zanesville silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

BIG GRAND PIERRE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
15,672	7562	3549	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	373.79 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 373.79A = 672.822			
Glyphosate = 672.822			
Soil Conditions			
The Grantsburg silt-loam—when wet—and the Wellston-Berks soil complex of these sites have a moderate and slight potential, respectively, for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

BLACK BRANCH-EAGLE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
22,172	6487	7712	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	1 acre	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 1A = 1.8			
Glyphosate = 1.8			
Soil Conditions			
The Wellston-Berks soil complex of these sites has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

CAMP CREEK-OHIO RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
31,064	4261	3891	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
8.7 acres	0	0	0
Panther Hollow Research Natural Area–Botanical Area			
Panther Hollow Research Natural Area treatment zone comprises approximately 522 acres. It is located in Hardin County at T11S, R10E.			
Panther Hollow contains the sandstone canyons of two tributaries of Cane Creek. One is narrow with steep overhanging cliffs, rock outcroppings, and a waterfall; the other is broader with gentler slopes and a wider floodplain. The upper reaches of the eastern area contain exposed sandstone bedrock forming a chute with intermittent stream flow. The southwestern and western blufftops of the hollows contain dry to xeric forest and sandstone glade communities. Shallow soils and exposed bedrock harbor species typical of drier communities. Management objectives for the area are protection of the critical habitat of rare plant species and the preservation of the sandstone cliff and glade, dry upland forest, and dry-mesic ravine forest communities representative of the Greater Shawnee Hills section of the Shawnee Hills division, including the use of prescribed fire and the control of invasive species.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Asiatic dayflower .16 acre Oriental lady's-thumb 0.08 acre	Canada bluegrass 1.17 acres Nepalese browntop 1.8 acres Tall fescue 2.8 acres	Sericea lespedeza 0.16 acre	Autumn olive 0.99 acre Japanese honeysuckle 8.54 acres Multiflora rose 2.72 acres
Total: 0.24 acre	Total: 5.77 acres	Total: 0.16 acre	Total: 12.25 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, Japanese honeysuckle, oriental lady's-thumb, tall fescue: glyphosate 3% on 20.12A = 8.2656 Canada bluegrass: sethoxydim 3% on 1.17A = 0.044		Nepalese browntop: sethoxydim 1.5% on 1.8A = 0.57375 Sericea lespedeza: clopyralid 3% on 0.16A = 0.086 Sericea lespedeza: triclopyr 3% on 0.16A = 0.180 Autumn olive, multiflora rose: glyphosate 20% on 3.71A = 3.9326	
Clopyralid = 0.086	**Glyphosate = 12.198**	**Sethoxydim = 0.618**	**Triclopyr = 0.18**
Soil Conditions			
The area contains 10.7 acres of floodplain soils and 4.2 acres of hydric soils. The Alford silt-loam in this area has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			
SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREA			
Carex nigromarginata (blackedge sedge), ***Carex oxylepis* var. *pubescens*** (sharpscale sedge): **Alt. 1**: Adverse, direct and indirect short- and long-term effects from lack of herbicide use. Nepalese browntop is invading trailsides on ridgetops where these species are known and will eventually out-compete these species. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides; species are readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, indirect, long-term impacts from the lack of herbicide use. The use of the clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species. ***Euonymus americana*** (strawberry bush): **Alt. 1**: Not adversely affected in the short-term; but, in the long-term, over the next 10 years, may experience adverse indirect effects from continued encroachment of invasives. In many cases, lack of prescribed fire will also have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from use of prescribed fire if fire reaches its habitat. Beneficial, direct and indirect short- and long-term effects from herbicide use resulting in elimination or control of invasives competing for same habitat. **Alt. 3**: Not adversely affected in the short-term; but, in the long-term, over the next 10 years, may experience adverse indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from use of prescribed fire if fire reaches its habitat. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of the growing season; however, this substance will be virtually ineffective in the long-term on Chinese yam, Japanese honeysuckle and other woody and perennial species. ***Saxifraga virginiensis*** (early saxifrage): **Alt. 1**: No adverse, direct or indirect, short-term impacts, although possible adverse, indirect impacts in the long-term without use of herbicide since areas surrounding habitat will continue to become encroached with woody vegetation and invasive species. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from integrated pest management; species are readily identifiable and easily avoided during use of herbicides. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. Also may be adverse, direct and indirect, long-term impacts from eventual invasives encroachment, which may cause reduction in health and vigor of populations within habitats. ***Scirpus polyphyllus*** (leafy bulrush): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of species populations on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed			

CAMP CREEK-OHIO RIVER
burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasive plant species are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats. ***Silene ovata*** (Blue Ridge catchfly): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat.

CEDAR CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
25,422	6687	10,650	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0
Fink Sandstone Barrens Ecological Area			
Fink Sandstone Barrens Ecological Area treatment zone comprises approximately 708 acres. It is located in Johnson County at T11.5S, R4E.			
Fink Sandstone Barrens is located adjacent to Jackson Hollow—one virtually an extension of the other, although located in two different watersheds and separated by a roadway. It has expansive, high-quality glades and sandstone cliffs with relict plant associations. Management objectives for the area include protection of the rare resources and plant associations representative of the Greater Shawnee Hills section of the Shawnee Hills division, including the use of prescribed fire and the control of invasive species such as the Japanese honeysuckle infestation.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Adam's needle 0.01 acre Asiatic dayflower 0.11 acre Japanese knotweed 0.07 acre Oriental lady's-thumb 0.08 acre Queen-Anne's lace 0.01 acre Sleepydick 0.01 acre	Bald brome 0.08 acre Canada bluegrass 0.08 acre Japanese bristlegrass 0.08 acre Kentucky bluegrass 0.08 acre Nepalese browntop 2.7 acres Orchardgrass 0.09 acre Reed canarygrass 0.08 acre Tall fescue 0.08 acre	Common mullein 0.01 acre Common plantain 0.01 acre Common yarrow 0.08 acre Field clover 0.08 acre Lesser burdock 0.08 acre Sericea lespedeza 0.19 acre Yellow sweetclover 0.02 acre	Autumn olive 0.09 acre Japanese honeysuckle 76.66 acres Multiflora rose 0.11 acre
Total: 0.29 acre	Total: 3.27 acres	Total: 0.47 acre	Total: 76.86 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, common mullein, common plantain, common yarrow, field clover, Japanese bristlegrass, Japanese honeysuckle, Japanese knotweed, lesser burdock, orchardgrass, oriental lady's-thumb, Queen Anne's lace, reed canarygrass, sleepydick, tall fescue, yellow sweetclover: glyphosate 3% on 77.45A = 28.218 Autumn olive, multiflora rose: glyphosate 20% on 0.2A = 0.212		Common mullein, field clover, Japanese knotweed, Queen Anne's lace, sericea lespedeza, yellow sweetclover: triclopyr 3% on 0.38A = 0.449 Bald brome, Canada bluegrass, Japanese bristlegrass, Kentucky bluegrass: sethoxydim 3% on 0.32A = 0.015 Nepalese browntop: sethoxydim 1.5% on 2.7A = 0.860 Sericea lespedeza: clopyralid 3% on 0.19A = 0.12	
Clopyralid = 0.108	**Glyphosate = 28.43**	**Sethoxydim = 0.875**	**Triclopyr = 0.449**
Soil Conditions			
The area contains 42.3 acres of floodplain soils, but no hydric soils. The Grantsburg soils in this area—when wet—have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

CEDAR CREEK
SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREA
Lilium superbum (Turk's-cap lily), ***Rhynchospora glomerata*** (clustered beaksedge): **Alt. 1**: Not adversely affected in the short term; but, in the long-term, over the next 10 years, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will also have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from herbicide use resulting in elimination or control of invasives competing for same habitat. **Alt. 3**: Not adversely affected in the short term; but, in the long term, over next 10 years, may experience adverse indirect effects from continued encroachment of invasives. Some direct, short-term, beneficial effects from the use of vinegar/clove oil, which may be able to control Nepalese browntop if applied at appropriate time of the growing season; however, this substance will be virtually ineffective in the long term on Chinese yam, Japanese honeysuckle and other woody and perennial species. ***Scleria pauciflora*** (fewflower nutrush): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns.

CEDAR LAKE-CEDAR CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
22,129	6052	7237	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	38.31 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Kudzu: clopyralid 3% on 38.31A = 58.719		Kudzu: triclopyr 2% on 38.31A = 71.831	
Clopyralid = 58.719		**Triclopyr = 71.831**	
Soil Conditions			
The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

COOPER CREEK-MILL CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
16,544	2623	8303	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0.26 acre
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Kudzu: clopyralid 3% on 0.26A = 0.351		Kudzu: triclopyr 2% on 0.26A = 0.488	
Clopyralid = 0.351		**Triclopyr = 0.488**	
Soil Conditions			
The Menfro-Clarksville soil complex of this site has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

DRURY CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
11,453	731		
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.81 acre	0	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle: glyphosate 3% on 0.81A = 0.292			
Glyphosate = 0.292			
Soil Conditions			
The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

DUTCH CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
25,642	3849	4792	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
1.73 acres	0	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle: glyphosate 3% on 1.73A = 0.623			
Glyphosate = 0.623			
Soil Conditions			
The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

DUTCHMAN CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
30,923	3849		
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle: glyphosate 3% on 0.01A = 0.0036			
Glyphosate = 0.0036			
Soil Conditions			
The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

EDMONDSON SLOUGH-SEXTON CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
21,603	6915	2921	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0.96 acre	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on0.96A = 1.728			
Glyphosate = 1.728			
Soil Conditions			
The Stookey-Clarksville soil complex of this site has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

FOUNTAIN BLUFF-MISSISSIPPI RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
27,842	3187	18,584	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
4.63 acres	0	9.38 acres	0
Fountain Bluff Geological Area			
Fountain Bluff Geological Area treatment zone comprises approximately 642 acres (divided approximately equally between Fountain Bluff-Mississippi River and Town Creek-Big Muddy watersheds). It is located in Jackson County at T10S, R4W.			
Fountain Bluff is an outstanding glacial diversion mound feature. The site is generally a dry-mesic forest.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	0.01 acre	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
None	None	None	None
Total: 0	Total: 0	Total: 0	Total: 0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard: glyphosate 3% on 14.03A = 18.554			
Glyphosate = 18.554			
Soil Conditions			
The area contains no floodplain or hydric soils. The Menfro-Wellston soils in this area have a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

GOOSE CREEK-BIG CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
14,046	6369	3516	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.2 acre	0.1 acre	0
Russell Cemetery Barrens Ecological Area			
Russell Cemetery Barrens Ecological Area treatment zone comprises approximately 366 acres (split 2/3-1/3 between Goose Creek-Big Creek [about 245 acres] and Little Eagle Creek [about 121] watersheds). It is located in Hardin County at T10.5S, R8E.			
Russell Cemetery Barrens contains a relatively undisturbed sandstone glade. Management objectives include preservation of the high-quality sandstone glade community and the adjoining dry upland forest that is representative of the Lesser Shawnee Hills section of the Shawnee Hills division, including the use of prescribed fire and the control of invasive species.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
None	Johnsongrass 0.02 acre Nepalese browntop 0.32 acre Orchardgrass 0.01 acre	Common mullein 0.08 acre Sericea lespedeza 0.04 acre	Autumn olive 0.02 acre Japanese honeysuckle 0.92 acre Multiflora rose 0.18 acre Tree-of-heaven 0.04 acre
Total: 0	Total: 0.35 acre	Total: 0.12 acre	Total: 1.16 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam, sericea lespedeza: triclopyr 3% on 0.24A = 0.326 Common mullein, garlic mustard, Japanese honeysuckle, Johnsongrass, orchardgrass: glyphosate 3% on 1.13A = 0.595 Nepalese browntop: sethoxydim 1.5% on 0.32A = 0.06		Sericea lespedeza: clopyralid 3% on 0.04A = 0.022 Autumn olive, multiflora rose, tree-of-heaven: glyphosate 20% on 0.24A = 0.2544	
Clopyralid = 0.022	**Glyphosate = 0.849**	**Sethoxydim = 0.06**	**Triclopyr = 0.326**
Soil Conditions			
The area contains 1.5 acres of floodplain soils, but no hydric soils. The Hosmer soils in this area—when wet—have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

GRASSY CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
18,924	1528	6197	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	9.41 acres (2.98 acres in Panther Den Wilderness)	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 9.41A = 13.233			
Triclopyr = 13.233			
Soil Conditions			
The Hosmer silt-loam—when wet—and Zanesville-Westmore soil complex of this site have a moderate and slight potential, respectively, for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

HAYES CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
15,326	7297	5945	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0
Double Branch Hole, Hayes Creek-Fox Den and Jackson Hole Ecological Areas			
Double Branch Hole, Hayes Creek-Fox Den and Jackson Hole Ecological Areas treatment zones comprise approximately 1558 acres. They are located in proximity in Pope County at T11.5S, R5.5E.			
Hayes Creek-Fox Den, Double Branch Hole and Jackson Hole are within the Hayes Creek watershed on sandstone cliff formations of the Hayes Creek Canyon and its tributaries. The cliffs are sheer and provide a diversity of habitats due to their varying exposure. The ecological areas contain rare plant populations beneath the cliffs, on the cliff faces, and in the adjacent mesic forests. Management objectives include protection of the rare plant habitats, including the use of prescribed fire and the control of invasive species.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.2 acre	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Asiatic dayflower 0.09 acre Creeping Jenny 0.01 acre Curly dock 0.01 acre Oriental lady's-thumb 0.65 acre	Bald brome 0.08 acre Canada bluegrass 0.01 acre Nepalese browntop 12.85 acres Tall fescue 1.48 acres	Common yarrow 0.16 acre Field clover 0.08 acre Oxeye daisy 0.08 acre Sericea lespedeza 0.52 acre Yellow sweetclover 0.41 acre	Autumn olive 0.18 acre Black locust 0.08 acre Japanese honeysuckle 52.37 acres Multiflora rose 2.19 acres
Total: 0.76 acre	Total: 14.42 acres	Total: 1.25 acres	Total: 54.82 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam, field clover, oxeye daisy, sericea lespedeza, yellow sweetclover: triclopyr 3% on 1.29A =2.802 Common yarrow, creeping Jenny, field clover, Japanese honeysuckle, oriental lady's-thumb, tall fescue, yellow sweetclover: glyphosate 3% on 55.16A = 21.006 Curly dock: triclopyr 5% on 0.01A = 0.0047		Nepalese browntop: sethoxydim 1.5% on 12.85A = 4.096 Bald brome, Canada bluegrass: sethoxydim 3% on 0.09A = 0.0034 Oxeye daisy, sericea lespedeza: clopyralid 3% on 0.6A = 0.298 Autumn olive, multiflora rose: glyphosate 20% on 2.37A = 2.512 Black locust: triclopyr 50% on .08A = 0.012	
Clopyralid = 0.298	**Glyphosate = 23.518**	**Sethoxydim = 4.099**	**Triclopyr = 2.819**
Soil Conditions			
Double Branch Hole: The area contains 7.1 acres of floodplain soils, but no hydric soils. The Grantsburg-Wellston soils in this area—when wet—have a slight to moderate potential of leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9). **Hayes Creek-Fox Den:** The area contains no hydric or floodplain soils. The Grantsburg-Wellston soils in this area—when wet—have a slight to moderate potential of leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9). **Jackson Hole:** The area contains no hydric or floodplain soils. The Grantsburg-Wellston soils in this area—when wet—have a slight to moderate potential of leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Plan Table F-9).			

HAYES CREEK

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREAS

DOUBLE BRANCH HOLE ECOLOGICAL AREA

Carex willdenownii (Willdenow's sedge): **Alt. 1**: Adverse, direct and indirect, short- and long-term effects with lack of herbicide use. Nepalese browntop is invading trailsides on ridgetops where this species is currently known and will eventually out-compete it. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides; species is readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, indirect, long-term impacts from the lack of herbicide use. The use of the clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species.

Dennstaedtia punctilobula (eastern hay-scented fern), ***Huperzia porophila*** (rock clubmoss): **Alt. 1**: No direct and indirect, short-term impacts, although some adverse, indirect impacts in the long-term without use of herbicide. Areas adjacent to the species' habitat will continue to become encroached with woody vegetation and invasives, causing a reduction in health and vigor of population. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts through integrated pest management; species is readily identifiable and easily avoided during application of herbicides. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. May also be adverse, direct and indirect, long-term impacts from invasive species encroachment that causes a reduction in health and vigor of species' populations in their habitats.

Dichanthelium yadkinense (Yadkin's panicgrass), ***Dodacatheon frenchii*** (French's shooting-star): **Alt. 1**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Beneficial, direct and indirect, short- and long-term effects from elimination or control of invasives that compete for same habitat. **Alt. 3**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of growing season; however, this substance will be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Resprouting of perennial plants is expected with the vinegar/clove oil as well as with the hot foam method.

Vaccinium stamineum (deerberry): **Alt. 1**: Adverse, indirect, long-term impacts without use of herbicides or prescribed fire. Not fire-dependent, but adapted to fire and would respond well to prescribe burns. Plant communities this species inhabits are being encroached by maple trees, shrubs and invasives. Adverse long-term impacts from woody and invasive species encroachment. Over long term, this rare species may be outcompeted by the aggressive invasives and become extirpated from its known location. **Alt. 2**: Beneficial impacts from use of herbicides to control invasive plants and application of prescribed fire. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. May be adverse, direct and indirect, long-term impacts due to eventual invasives encroachment, which may cause reduction in health and vigor of populations in their habitats. Beneficial impacts from application of prescribed fire.

HAYES CREEK-FOX DEN ECOLOGICAL AREA

Scleria pauciflora (fewflower nutrush): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns.

HAYES CREEK-FOX DEN ECOLOGICAL AREA

Carex willdenownii (Willdenow's sedge), ***Dichanthelium yadkinense*** (Yadkin's panicgrass), ***Dodacatheon frenchii*** (French's shooting-star): See Double Branch Hole, above.

HUTCHINS CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
13,080	9909	2491	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	1.58 acres	0.69 acre (0.66 acre in Bald Knob Wilderness)	0
LaRue-Pine Hills / Otter Pond Research Natural Area / Ecological Area (~320 acres)			
LaRue-Pine Hills-Otter Pond Research Natural Area treatment zone comprises approximately 3226 acres (mostly located in Running Lake Ditch watershed, details below). It is located in Union County at T11S, R3W.			
See description at Running Lake Ditch watershed, below.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.31 acre	0.01 acre	0.01 acre	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Queen-Anne's lace 0.01 acre	Nepalese browntop 0.01 acre Orchardgrass 0.06 acre Tall fescue 0.8 acre	Yellow sweetclover 0.03 acre	Black locust 0.01 acre Japanese honeysuckle 0.06 acre Multiflora rose 0.28 acre
Total broadleaf: 0.01 acre	Total grassy: 0.87 acre	Total leguminous: 0.03 acre	Total woody: 0.35 acre
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard, Japanese honeysuckle, orchardgrass, Queen Anne's lace, tall fescue, yellow sweetclover: glyphosate 3% on 1.67A = 2.029 Nepalese browntop: sethoxydim 1.5% on 0.01A = 0.0032	Chinese yam, Queen Anne's lace, yellow sweetclover: triclopyr 3% on 1.63A = 2.312 Multiflora rose: glyphosate 20% on 0.28A = 0.297 Black locust: triclopyr 50% on 0.01A = 0.006		
Glyphosate = 2.326	**Sethoxydim = 0.0032**	**Triclopyr = 2.318**	
Soil Conditions			
See Running Lake Ditch watershed details below.			
SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREA			
See Running Lake Ditch watershed details below.			

KINKAID LAKE-KINKAID CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
25,699	8462	9364	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
176.76 acres	0	17.62 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard: glyphosate 3% on 194.38A = 95.35			
Glyphosate = 95.35			
Soil Conditions			
The Menfro silt loam soil of the garlic mustard sites and the Hickory-Menfro soil complex of the honeysuckle sites have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LAKE OF EGYPT			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
21,766	2233	8645	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	2.02 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 2.02A = 3.636			
Glyphosate = 3.636			
Soil Conditions			
The Wellston-Berks soil complex of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LITTLE BAY CREEK-BAY CREEK		
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**
27,172	13,756	6849

Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	6.49 acres	0

Bell Smith Springs Ecological Area

Bell Smith Springs Ecological Area treatment zone comprises approximately 1267 acres. It is located in Pope County at T11.5S, R5E.

Bell Smith Springs contains deeply dissected stream valleys cut into sandstone, with steep bluffs, sheer cliffs, canyons, rockfalls, a natural bridge and small waterfalls. Its sandstone bluffs, canyons, forests, glades and streams offer diverse habitats. Sandstone cliff faces exhibit rich bryophyte and lichen cover; bluff tops have well-developed sandstone glades. Most of the forested acreage is dry-mesic upland forest with white, post and red oaks, and hickories; major canyons contain high-quality, mesic upland forest with beech, sugar maple and oak. Management objectives include preservation of the outstanding sandstone cliff, forest, glade and stream natural communities representative of the Greater Shawnee Hills section of the Shawnee Hills division, protection of the relict plant communities associated with cliff and canyon features, and protection of rare-plant habitat, including the use of prescribed fire and control of invasive species.

Amur Honeysuckle	Chinese Yam	Garlic Mustard	Kudzu
0	0.37 acre	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Asiatic dayflower 0.31 acre Common dandelion 0.01 acres Common St. Johnswort 0.08 acre Curly dock 0.08 acre Oriental lady's-thumb 0.62 acre Queen-Anne's lace 0.28 acre	Canada bluegrass 0.08 acre Kentucky bluegrass 0.08 acre Nepalese browntop 4.82 acres Orchardgrass 0.08 acre Tall fescue 1.55 acres	Bristly oxtongue 0.08 acre Bull thistle 0.08 acre Common mullein 0.08 acre Common yarrow 0.09 acre Oxeye daisy 0.08 acre Red clover 0.16 acre Sericea lespedeza 0.49 acre Yellow sweetclover 1.26 acres	Autumn olive 0.25 acre Japanese honeysuckle 4.95 acres Multiflora rose 0.97 acre
Total: 1.38 acres	Total: 6.61 acres	Total: 2.32 acres	Total: 6.17 acres

Herbicide Application (in pounds of active ingredient per acre/treatment)

Chinese yam, common dandelion, common mullein, Queen Anne's lace, red clover, sericea lespedeza, yellow sweetclover: triclopyr 3% on 2.65A = 4.176 Curly dock: triclopyr 5% on 0.08A = 0.075 Canada bluegrass, Kentucky bluegrass: sethoxydim 3% on 0.16A = 0.012 Nepalese browntop: sethoxydim 1.5% on 4.82A = 1.536	Bristly oxtongue, bull thistle, common mullein, common St. Johnswort, common yarrow, garlic mustard, Japanese honeysuckle, orchardgrass, oriental lady's-thumb, Queen Anne's lace, red clover, tall fescue, yellow sweetclover: glyphosate 3% on 15.8A = 16.891 Oxeye daisy, sericea lespedeza: clopyralid 3% on 0.57A = 0.267 Autumn olive, multiflora rose: glyphosate 20% on 1.22A = 1.293

Clopyralid = 0.267	Glyphosate = 18.184	Sethoxydim = 1.548	Triclopyr = 4.251

Soil Conditions

The area contains 70.3 acres of floodplain, but no hydric soils. The Grantsburg-Wellston soils in this area—when wet—have a slight to moderate potential of leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Plan Table F-9).

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREA

Calamagrostis porteri ssp. ***Insperata*** (Porter's reedgrass): **Alt. 1**: Adverse, indirect, long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of the species populations on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.

Carex communis (fibrous-root sedge): **Alt. 1**: Adverse, indirect, long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of the species populations on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management. **Alt. 3**: Adverse, indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.

Carex willdenownii (Willdenow's sedge): **Alt. 1**: Adverse, direct and indirect, short- and long-term effects with lack of herbicide use. Nepalese browntop is invading trailsides on ridgetops where this species is currently known and will eventually out-compete it. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides; species is readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, indirect, long-term impacts from the lack of herbicide use. The use

LITTLE BAY CREEK-BAY CREEK
of the clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species. ***Dennstaedtia punctilobula*** (eastern hay-scented fern): **Alt. 1**: No direct and indirect, short-term impacts, although some adverse, indirect impacts in the long-term without use of herbicide. Areas adjacent to the species' habitat will continue to become encroached with woody vegetation and invasives, causing a reduction in health and vigor of population. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts through integrated pest management; species is readily identifiable and easily avoided during application of herbicides. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasives are not controlled by use of herbicides when non-chemical means are unsuccessful. May also be adverse, direct and indirect, long-term impacts from invasive species encroachment that causes a reduction in health and vigor of species' populations in their habitats. ***Dodacatheon frenchii*** (French's shooting-star): **Alt. 1**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Beneficial, direct and indirect, short- and long-term effects from elimination or control of invasives that compete for same habitat. **Alt. 3**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of growing season; however, this substance will be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Resprouting of perennial plants is expected with the vinegar/clove oil as well as with the hot foam method. ***Lilium superbum*** (Turk's-cap lily), ***Rhynchospora glomerata*** (clustered beaksedge), ***Stenanthium gramineum*** (eastern featherbells): **Alt. 1**: Not adversely affected in the short term; but, in the long-term, over the next 10 years, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will also have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from herbicide use resulting in elimination or control of invasives competing for same habitat. **Alt. 3**: Not adversely affected in the short term; but, in the long term, over the next 10 years, may experience adverse indirect effects from continued encroachment of invasives. Some direct, short-term, beneficial effects from the use of vinegar/clove oil, which may be able to control Nepalese browntop if applied at appropriate time of the growing season; however, this substance will be virtually ineffective in the long term on Chinese yam, Japanese honeysuckle and other woody and perennial species.

LITTLE CACHE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
23,699	2527	12,750	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.57 acre	0	0.6 acre	0
Bulge Hole and Odum Tract Ecological Areas			
Bulge Hole and Odom Tract Ecological Areas treatment zones comprise approximately 358 acres. They are located in proximity in Johnson County at T12S, R3E.			
Bulge Hole contains a significant sandstone-overhang community and Odum Tract high-quality sandstone glades, which occupy the xeric blufftops, with old, gnarled redcedars and blackjack oaks. Management objective is preservation of the high-quality sandstone overhang and glade communities representative of the Greater Shawnee Hills section of the Shawnee Hills division.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.37 acre	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Asiatic dayflower 0.16 acre Cultivated garlic 0.16 acre Garden yellowrocket 0.08 acre Oriental lady's-thumb 0.39 acre Queen-Anne's lace 0.1 acre Wild garlic 0.08 acre	Canada bluegrass 0.08 acre Nepalese browntop 37.71 acres Smooth brome 0.08 acre Tall fescue 0.45 acre	Bull thistle 0.01 acre Common mullein 0.29 acre Common yarrow 0.08 acre Crownvetch 0.29 acre Field clover 0.08 acre Korean clover 0.08 acre Red clover 0.09 acre Sericea lespedeza 1.12 acres Shrub lespedeza 0.48 acre	Autumn olive 0.21 acre Japanese honeysuckle 40.48 acres Multiflora rose 1.08 acres
Total: 0.97 acre	Total: 38.32 acres	Total: 2.52 acres	Total: 41.77 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, bull thistle, common mullein, common yarrow, cultivated garlic, field clover, garden yellowrocket, garlic mustard, Japanese honeysuckle, Korean clover, Oriental lady's-thumb, Queen Anne's lace, red clover, Tall fescue, wild garlic: glyphosate 3% on 43.37A = 9.678 Canada bluegrass, smooth brome: sethoxydim 3% on 0.16A = 0.012		Common mullein, crownvetch, field clover, garden yellowrocket, Korean clover, red clover, Queen Anne's lace, sericea lespedeza: triclopyr 3% on 2.13A = 4.026 Nepalese browntop: sethoxydim 1.5% on 37.71A = 12.02 Crownvetch, sericea lespedeza, shrub lespedeza: clopyralid 3% on 1.89A = 1.608 Autumn olive, multiflora rose: glyphosate 20% on 1.29A = 1.367	
Clopyralid = 1.608	**Glyphosate = 11.045**	**Sethoxydim = 12.032**	**Triclopyr = 4.026**
Soil Conditions			
Bulge Hole: The area contains 16.5 acres of floodplain soils, but no hydric soils. The Hosmer silt-loam of this area—when wet—has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Table F-9) **Odum Tract:** The area contains no hydric or floodplain soils. The Hosmer silt-loam of this area—when wet—has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			
SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREAS			
Dodacatheon frenchii (French's shooting-star): **Alt. 1**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Beneficial, direct and indirect, short- and long-term effects from elimination or control of invasives that compete for same habitat. **Alt. 3**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of growing season; however, this substance will be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Resprouting of perennial plants is expected with the vinegar/clove oil as well as with the hot foam method. ***Lilium superbum*** (Turk's-cap lily), ***Rhynchospora glomerata*** (clustered beaksedge), ***Stenanthium gramineum*** (eastern featherbells): **Alt. 1**: Not adversely affected in short term; but, in long term, over next 10 years, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will also have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from herbicide use resulting in elimination or control of invasives competing for same habitat. **Alt. 3**: Not adversely affected in short term; but, in long term, over next 10 years, may experience adverse indirect effects from continued encroachment of invasives. Some direct, short-term, beneficial effects from the use of vinegar/clove oil, which may be able to control Nepalese browntop if applied at appropriate time of the growing season; however, this substance will be virtually ineffective in the long term on Chinese yam, Japanese honeysuckle and other woody and perennial species.			

LITTLE EAGLE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
14,481	6969	3896	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.01 acre	1.78 acres	0
Russell Cemetery Barrens Ecological Area			
Russell Cemetery Barrens Ecological Area treatment zone comprises approximately 366 acres (split 2/3-1/3 between Goose Creek-Big Creek [about 245 acres] and Little Eagle Creek [about 121] watersheds). It is located in Hardin County at T10.5S, R8E.			
Russell Cemetery Barrens contains a relatively undisturbed sandstone glade. Management objectives include preservation of the high-quality sandstone glade community and the adjoining dry upland forest that is representative of the Lesser Shawnee Hills section of the Shawnee Hills division, including the use of prescribed fire and the control of invasive species.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
None	None	None	Japanese honeysuckle 1.49 acres Multiflora rose 0.01 acre
Total: 0	Total: 0	Total: 0	Total: 1.5 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard, Japanese honeysuckle: glyphosate 3% on 3.27A = 3.74		Chinese yam: triclopyr 3% on 0.01A = 0.014 Multiflora rose: glyphosate 20% on 0.01A = 0.011	
Glyphosate = 3.751		**Triclopyr=0.014**	
Soil Conditions			
The area contains 1.5 acres of floodplain soils, but no hydric soils. The Hosmer silt-loam of this area—when wet—has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LITTLE GRAND PIERRE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
13,361	5095	3656	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.2 acre	0.13 acre	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 0.2A = 0.281		Garlic mustard: glyphosate 3% on 0.13A = 0.234	
Glyphosate = 0.234		**Triclopyr = 0.281**	
Soil Conditions			
The Wellston-Berks soil complex of these sites has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LITTLE KINKAID CREEK-KINKAID CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
15,527	2577	9036	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
181.51 acres	0.2 acre	3.12 acres	0
Ava Zoological Area			
Ava Zoological Area treatment zone comprises approximately 651 acres. It is located in Jackson County at T7.5S, R4W.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
35.26 acres	0.01 acre	10.69 acres	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
None	None	None	Autumn olive 4.77 acres Japanese honeysuckle 14.1 acres Multiflora rose 42.31 acres
Total: 0	Total: 0	Total: 0	Total: 61.21 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard, Japanese honeysuckle: glyphosate 3% on 244.68A = 107.971		Autumn olive, multiflora rose: glyphosate 20% on 47.08A = 49.905 Chinese yam: triclopyr 3% on 0.21A = 0.295	
Glyphosate = 157.876		**Triclopyr = 0.295**	
Soil Conditions			
The area contains 53.8 acres floodplain soils and 40.9 acres of hydric soils. The Menfro silt-loam and Menfro-Wellston silt-loams of these sites have a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LITTLE LUSK CREEK-LUSK CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
31,812	18,044	5957	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	112.78 acres (55.32 acres in Lusk Creek Wilderness)	2.58 acres (1.81 acres in Lusk Creek Wilderness)	1.57 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 112.78A = 158.597 Garlic mustard: glyphosate 3% on 2.58A = 3.096		Kudzu: clopyralid 3% on 1.57A = 2.12 Kudzu: triclopyr 2% on 1.57A = 2.944	
Clopyralid = 2.12	**Glyphosate = 3.096**	**Triclopyr = 161.541**	
Soil Conditions			
The Wellston-Berks soil complex, Wellston silt-loam and Zanesville silt loam soils of these sites have a slight potential for leaching herbicides, and the Grantsburg silt-loam soil has a moderate potential for leaching; all have a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LITTLE SALINE RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
20,928	8019	5851	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0	14.46 acres
Reid's Chapel Ecological Area			
Reid's Chapel Ecological Area treatment zone comprises approximately 176 acres. It is located in Saline County at T10S, R5E.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Oriental lady's-thumb 0.08 acre Queen-Anne's lace 0.1 acre	Nepalese browntop 0.03 acre Tall fescue 0.94 acre	Red clover 0.19 acre Yellow sweetclover 0.08 acre	Autumn olive 0.1 acre Black locust 0.08 acre Japanese honeysuckle 2.86 acres Multiflora rose 0.14 acre Princesstree 0.1 acre
Total: 0.18 acre	Total: 0.97 acre	Total: 0.27 acre	Total: 3.28 acres
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Japanese honeysuckle, oriental lady's-thumb, Queen Anne's lace, tall fescue, yellow sweetclover: glyphosate 3% on 4.06A = 1.886 Kudzu, Queen Anne's lace, red clover, yellow sweetclover: triclopyr 3% on 14.83A = 27.428		Nepalese browntop: sethoxydim 1.5% on 0.03A = 0.0096 Kudzu: clopyralid 3% on 14.46A= 19.521 Autumn olive, multiflora rose: glyphosate 20% on 0.24A = 0.254 Black locust, princesstree: triclopyr 50% on 0.18A = 0.012	
Clopyralid = 19.521	**Glyphosate = 2.14**	**Sethoxydim = 0.0096**	**Triclopyr = 27.428**
Soil Conditions			
The area contains 0.1 acre of floodplain soils, but no hydric soils. The Grantsburg silt-loam of this area—when wet—has a moderate potential for leaching herbicides and the Wellston-Berks soil complex of this area has a slight potential for leaching herbicides; both have a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

LUSK CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
24,610	5553	8151	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	6.68 acres	1.51 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 6.68A = 9.394		Garlic mustard: glyphosate 3% on 1.51A = 2.718	
Glyphosate = 2.718		**Triclopyr = 9.394**	
Soil Conditions			
The Wellston-Berks soil complex and Zanesville silt-loam of these sites have a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

MILL CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
17,573	2129	10,180	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	2.04 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 2.04A = 3.672			
Glyphosate = 3.672			
Soil Conditions			
The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

PETERS CREEK-OHIO RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
31,158	2401	9329	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	4.16 acres	0

Barker Bluff Research Natural Area, Keeling Hill North and Keeling Hill South Ecological Areas			
Barker Bluff, Keeling Hill North and Keeling Hill South Ecological Areas treatment zones comprise approximately 257 acres. They are located in proximity in Hardin County at T12S, R8E.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.02 acre	0	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Common sheep sorrel 1.17 acres Oriental lady's-thumb 0.23 acre	Canada bluegrass 0.16 acre Nepalese browntop 0.31 acre Tall fescue 0.1 acre	Common mullein 0.08 acre	Autumn olive 0.2 acre Japanese honeysuckle 20.43 acres Multiflora rose 2.28 acres Tree-of-heaven 0.1 acre Wintercreeper 0.01 acre
Total: 1.4 acres	Total: 0.57 acre	Total: 0.08 acre	Total: 23.02 acres

Herbicide Application (in pounds of active ingredient per acre/treatment)		
Common mullein, common sheep sorrel, garlic mustard, Japanese honeysuckle, Oriental lady's-thumb, tall fescue: glyphosate 3% on 26.17A = 15.264 Chinese yam, common mullein, common sheep sorrel, wintercreeper: triclopyr 3% on 1.17A = 0.548	Nepalese browntop: sethoxydim 1.5% on 0.31A = 0.099 Autumn olive, multiflora rose: glyphosate 20% on 2.48A = 5.952 Tree-of-heaven: glyphosate 50% on 0.1A = 0.106 Canada bluegrass: sethoxydim 3% on 0.16A = 0.006	
Glyphosate = 21.322	**Sethoxydim = 0.105**	**Triclopyr = 0.548**

Soil Conditions

Barker Bluff: The area contains no floodplain or hydric soils. The Alford soils of this area have a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).
Keeling Hill North: The area contains no hydric or floodplain soils. The Hosmer silt-loam of this area—when wet—has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Plan Table F-9).
Keeling Hill South: Area contains 0.6 acre of floodplain soils, no hydric soils. Hosmer silt-loam of area—when wet—has moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREAS

BARKER BLUFF RESEARCH NATURAL AREA-ECOLOGICAL AREA

Scleria oligantha (littlehead nutrush): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns.
Silene ovata (Blue Ridge catchfly): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat.
Silphium trifoliatum (whorled rosinweed): **Alt. 1**: Adverse, indirect, long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of populations within the prairie/barrens areas on the Forest, but may lead to the extirpation of the species in Illinois. In particular, Japanese honeysuckle may become detrimental to this species, as well as excessive shading from trees in the overstory and saplings and shrubs in the understory. Many of the

barrens communities have already become invaded by invasive species and these rare community types will be lost from the Forest forever if intensive management is not implemented. Open, sunny barrens benefit the species and cannot be achieved without prescribed fire and will be more beneficial if herbicide use could be implemented. This species is fire-dependent and does not do well in the absence of fire disturbance. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management. This species is readily identifiable and avoided during application of herbicides. The effects of fire are known to have beneficial effects on this species and its habitat. **Alt. 3**: Adverse, indirect, long-term impacts if aggressive invasive species are not controlled with the use of herbicides when non-chemical means are unsuccessful. This is due to eventual invasive species encroachment that may cause further reduction in health and vigor of the species populations in their habitats. Prescribed fire will contribute to beneficial, direct and indirect, short- and long-term impacts to populations by stimulating native species and helping reduce the competition of invasives. It will also stimulate this species as it is dependent on fire-disturbance. The use of the clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species.

KEELING HILL ECOLOGICAL AREA

Scleria pauciflora (fewflower nutrush): **Alt. 1**: Adverse, indirect, long-term impacts in areas not treated with herbicides. This species is adapted to fire and responds well to prescribed burns. Plant communities inhabited by this species are being encroached by maple trees, shrubs and invasive species. Adverse, long-term impacts from woody and invasive species encroachment. Within the next 15 years, possibly less, this rare species may be out-competed by aggressive invasives and become extirpated from previously known locations. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of herbicide to control aggressive invasives that threaten this species and its community-type; invasives control enhances ability of this rare species to compete and persist. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns. **Alt. 3**: Beneficial, direct, short-term impacts from use of vinegar/clove oil, which may be able to help control Nepalese browntop; however, this will be virtually ineffective in the long-term to Japanese honeysuckle and other woody and perennial species. So, adverse, long-term impacts from woody and invasive species encroachment. Prescribed burning will benefit the species and its habitat; population numbers are known to respond well and increase following prescribed burns.

PINHOOK CREEK-BIG GRAND PIERRE CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
23,292	7314	6715	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.2 acre	4.21 acres (2.38 acres in Garden of the Gods Wilderness)	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 5% on 0.2A = 0.4		Garlic mustard: glyphosate 3% on 4.21A = 7.578	
Glyphosate = 7.578		**Triclopyr = 0.4**	
Soil Conditions			
The Wellston-Berks soil complex of these sites has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

ROCK CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
17,093	4267	4868	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	10.72 acres	0	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Chinese yam: triclopyr 3% on 10.72A = 21.44			
Triclopyr = 21.44			
Soil Conditions			
The Wellston-Berks soil complex of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

RUNNING LAKE DITCH		
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**
23,003	4172	16,153

Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.09 acre	0.01 acre	1 acre	0

LaRue-Pine Hills/Otter Pond Research Natural Area / Ecological Area

LaRue-Pine Hills-Otter Pond Research Natural Area treatment zone comprises approximately 3226 acres (a small portion of which is located in Hutchins Creek watershed, details above). It is located in Union County at T11S, R3W.

LaRue Pine Hills-Otter Pond contains a vast assemblage of plants and animals within a diversity of habitats ranging from swamps to high xeric bluffs. Within this area is the northern limit of many southern species of plants and animals and the Ozarkian oak-pine forest in Illinois—one of only two locations of native short-leaf pine in the state. Management objectives include preservation of the xeric upland sites with shortleaf pine-oak forest communities of the southern section of the Ozark Division, protection of significant forest glade and cliff communities of the southern section of the Ozark Division, protection of notable lowland forests' and wetland communities' biologically significant features, and protection of critical habitat for rare species of plants and animals, including the use of prescribed fire and the control of invasive species.

Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.83 acres	0.61 acre	1.8 acres	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Beefsteakplant 0.8 acre Common periwinkle 0.26 acre Creeping Jenny 0.07 acre Daffodil 0.01 acre Queen-Anne's lace 0.16 acre	Johnsongrass 0.22 acres Nepalese browntop 6.4 acres Orchardgrass 0.35 acre Tall fescue 0.77 acre	Crownvetch 0.01 acre Yellow sweetclover 0.15 acre	Autumn olive 0.01 acre Black locust 0.18 acres Burningbush 0.02 acre Japanese honeysuckle 1.95 acres Multiflora rose 1.91 acres Wintercreeper 0.12 acre
Total: 1.3 acres	Total: 7.74 acres	Total: 0.16 acre	Total: 4.19 acres

Herbicide Application (in pounds of active ingredient per acre/treatment)

Amur honeysuckle, beefsteakplant, burningbush, common periwinkle, creeping Jenny, garlic mustard, Japanese honeysuckle, Johnsongrass, orchardgrass, Queen Anne's lace, tall fescue, yellow sweetclover: glyphosate 3% on 7.64A = 7.861 Black locust: triclopyr 50% on 0.18A = 1.627	Beefsteakplant, Chinese yam, Queen Anne's lace, wintercreeper: triclopyr 3% on 1.7A = 1.209 Nepalese browntop: sethoxydim 1.5% on 6.4A = 2.04 Autumn olive, burningbush, multiflora rose: glyphosate 20% on 1.94A = 2.056

Glyphosate = 9.917	**Sethoxydim = 2.04**	**Triclopyr = 2.836**

Soil Conditions

The area contains 1,480.5 acres of riparian and wetland soils. The Alford soils of this area have a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREA

Carex decomposita (cypress-knee sedge), ***C. gigantea*** (giant sedge), ***C. lupuliformis*** (false-hop sedge), ***C. socialis*** (low woodland sedge), ***Chelone obliqua* var. *speciosa*** (red turtlehead), ***Eleocharis wolfii*** (Wolf's spikerush), ***Glyceria arkansana*** (Arkansas manna-grass), ***Heteranthera reniformis*** (kidneyleaf mudplantain), ***Hottonia inflata*** (American featherfoil), ***Hydrolea uniflora*** (one-flowered false fiddleleaf), ***Torreyochloa pallida*** (pale false manna-grass), ***Vitis rupestris*** (sand grape): **Alt. 1**: Adverse, indirect, long-term impacts on these species from aggressive native and invasive species encroachment that may cause a reduction in health and vigor of their populations, if not controlled manually. **Alt. 2**: Not expected to have direct impacts in swamp habitat; however, with prescribed burning and integrated pest management on adjacent land, they would be beneficial, indirect, short- and long-term. These species are readily identifiable and avoided during application of herbicides. (Invasives affecting *Heteranthera* must be removed manually.) Prescribed fire on adjacent land would contribute to beneficial, indirect, short- and long-term impacts by stimulating surrounding native species and helping reduce the competition of invasive species. **Alt. 3**: Adverse, indirect, long-term impacts if aggressive invasive species are not controlled by the use of herbicides when non-chemical means are unsuccessful. As under Alternative 2, prescribed fire on adjacent land would contribute to beneficial, indirect, short- and long-term impacts by stimulating surrounding native species and helping reduce the competition of invasive species.

Juglans cinerea (butternut): **Alt. 1**: Adverse, direct and indirect, short- and long-term effects from lack of herbicide use. Japanese honeysuckle, autumn olive and other woody species are invading the sites where this species is currently known and could eventually out-compete this species. **Alt. 2**: Beneficial direct and indirect, short- and long-term impacts from the use of herbicides. Selective spraying will help control encroaching invasives that threaten the few locations this species inhabits. Although can be susceptible to fire damage, habitat is adjacent to and within fire-dependent communities and is known to persist following wildfires. **Alt. 3**: Adverse, indirect, long-term impacts from the lack of herbicide use. Use of the clove oil/vinegar will mostly kill or damage annuals, but may be futile in the effort to kill perennial invasive species. The effects of fire same as under Alternative 2.

SANDY CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
19,027	8508	6843	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0.62 acre	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 0.62A = 1.116			
Glyphosate = 1.116			
Soil Conditions			
The Hosmer soils of this site—when wet—have a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

SEMINARY FORK-CLEAR CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
20,094	5004	6279	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.09 acre (in Bald Knob Wilderness)	0	1.06 acres (0.92 acre in Bald Knob Wilderness)	0.14 acre (in Bald Knob Wilderness)
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard: glyphosate 3% on 1.15A = 1.304		Kudzu: clopyralid 3% on 0.14A = 0.158 Kudzu: triclopyr 2% on 0.14A=0.263	
Clopyralid = 0.158	**Glyphosate = 1.304**	**Triclopyr = 0.263**	
Soil Conditions			
The Menfro-Clarksville soil complex of these sites has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

SISTER ISLANDS-OHIO RIVER		
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**
34,000	3680	5537

Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0.01 acre	10.7 acres

Kickasola Cemetery, Massac Tower Springs, Poco Cemetery East, Poco Cemetery North and Snow Springs Ecological Areas			
Kickasola Cemetery, Massac Tower Springs, Poco Cemetery East, Poco Cemetery North and Snow Springs Ecological Areas treatment zones comprise approximately 763 acres. They are located in proximity in Pope County at T15S, R6.5E.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0.2 acre	0.11 acre	9.56 acres
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Annual ragweed 0.36 acre Common periwinkle 0.1 acre Queen-Anne's lace 0.02 acre	Nepalese browntop 16.55 acres	Common yarrow 0.02 acre Sericea lespedeza 1.04 acres Yellow sweetclover 0.01 acre	Autumn olive 2.68 acres Black locust 0.01 acre Japanese honeysuckle 24.64 acres Japanese meadowsweet 0.01 acre Mock orange 0.01 acre Multiflora rose 0.08 acre
Total: 0.48 acre	Total: 16.55 acres	Total: 1.07 acres	Total: 27.43 acres

Herbicide Application (in pounds of active ingredient per acre/treatment)			
Kudzu: clopyralid 3% on 20.26A = 30.39 Common periwinkle, common yarrow, garlic mustard, Japanese honeysuckle, Queen Anne's lace: glyphosate 3% on 24.9A = 9.112 Annual ragweed, kudzu, Queen Anne's lace, sericea lespedeza: triclopyr 3% on 21.68A = 39.649 Nepalese browntop: sethoxydim 1.5% on 16.55A = 5.275		Chinese yam: triclopyr 5% on 0.2A = 0.47 Annual ragweed, sericea lespedeza: clopyralid 3% on 1.4A = 0.84 Autumn olive, Japanese meadowsweet, mock orange, multiflora rose: glyphosate 20% on 2.78A = 2.947 Black locust: triclopyr 50% on 0.01A=0.09	
Clopyralid = 31.23	**Glyphosate = 12.059**	**Sethoxydim = 5.275**	**Triclopyr = 40.209**

Soil Conditions

Kickasola Cemetery: The area contains 15.3 acres of floodplain soils and 12.1 acres of hydric soils. The Alford silt-loam of this area has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Plan Table F-9).
Massac Tower Springs: The area contains 1.6 acres of hydric and floodplain soils. The Zanesville silt-loam of this area has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).
Poco Cemetery East: The area contains 4.5 acres of hydric soils and 5.3 acres of floodplain soils. The Wellston silt-loam of this area has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Table F-9).
Poco Cemetery North: The area contains 3 acres of hydric soils and 3 acres of floodplain soils. The Wellston silt-loam of this area has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Table F-9).
Snow Springs: The area contains 0.2 acre of floodplain soils, but no hydric soils. The Alford silt-loam of this area has a slight potential for leaching herbicides and a severe potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).

SUMMARY OF SPECIFIC EFFECTS IN THE NATURAL AREAS

KICKASOLA CEMETERY ECOLOGICAL AREA

Bartonia paniculata (twining screwstem), ***Carex atlantica*** (prickly bog sedge), ***Rhexia mariana*** (Maryland meadowbeauty): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of species populations within seep springs on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasive plant species are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.
Platanthera clavellata (small green wood-orchid), ***Rudbeckia fulgida* var. *sullivantii*** (Sullivant's sunflower): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese honeysuckle has encroached on much of their habitats and, without use of herbicide, this invasive will certainly out-compete it. Nepalese browntop also poses a major threat to these populations. Without removal or spraying of this invasive, it will also out-compete these species in their habitats. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of the species populations on the Forest, but may lead to their extirpation in Illinois. Prescribed fire is also required for the community these species inhabit to help reduce encroaching woody species and stimulate vigor and health. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides. These species are readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short-term and long-term impacts from use of prescribed fire.

SISTER ISLANDS-OHIO RIVER

MASSAC TOWER SPRINGS ECOLOGICAL AREA

Bartonia paniculata (twining screwstem), ***Carex atlantica*** (prickly bog sedge), ***Platanthera clavellata*** (small green wood-orchid): See Kickasola Cemetery, above.

Carex bromoides (brome-like sedge): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of species populations within seep springs on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasive plant species are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.

Chamaelirium luteum (fairywand): **Alt. 1**: Adverse, direct and indirect, short- and long-term effects from the lack of herbicide use. Nepalese browntop is invading sites where this species is currently known and will eventually outcompete it. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts resulting from use of herbicides. Selective spraying will help control encroaching invasive species that threaten the few locations this species inhabits. **Alt. 3**: Adverse, indirect, long-term impacts from lack of herbicides. Use of clove oil/vinegar will mostly kill or damage annuals but may be futile in the effort to kill perennial invasive species such as this.

Isotria verticillata (large whorled pogonia): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese honeysuckle has encroached on one of the populations and threatens to choke it out; without use of herbicides, the invasive species will certainly out-compete it. Nepalese browntop poses a second threat to the majority of the populations. Without removal or spraying of this invasive, it will out-compete the orchid in its rare habitat. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment that may not only cause reduction in health and vigor of the species populations within seep springs on the Forest, but may lead to extirpation of the species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides; this orchid is readily identifiable and protected during herbicide use. **Alt. 3**: Adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short-term and long-term impacts from use of prescribed fire.

Scirpus polyphyllus (leafy bulrush): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts from aggressive native and invasive species encroachment that may not only cause a reduction in health and vigor of species populations on the Forest, but lead to extirpation of these species in Illinois. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from prescribed burning and integrated pest management; species are readily identifiable and easily avoided during use of herbicides. The application of prescribed fire is known to have positive effects on these species and their habitats on the Forest. **Alt. 3**: Adverse, direct and indirect, long-term impacts if aggressive invasive plant species are not controlled by use of herbicides when non-chemical means are unsuccessful. Eventual invasive species encroachment may cause reduction in health and vigor of species populations within their habitats.

POCO CEMETERY NORTH ECOLOGICAL AREA

Bartonia paniculata (twining screwstem): See Kickasola Cemetery, above.

Euonymus americana (strawberry bush): **Alt. 1**: Not adversely affected in the short-term; but, in the long-term, over the next 10 years, may experience adverse indirect effects from continued encroachment of invasives. In many cases, lack of prescribed fire will also have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from use of prescribed fire if fire reaches its habitat. Beneficial, direct and indirect short- and long-term effects from herbicide use resulting in elimination or control of invasives competing for same habitat. **Alt. 3**: Not adversely affected in the short-term; but, in the long-term, over the next 10 years, may experience adverse indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from use of prescribed fire if fire reaches its habitat. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of the growing season; however, this substance will be virtually ineffective in the long-term on Chinese yam, Japanese honeysuckle and other woody and perennial species.

SNOW SPRINGS ECOLOGICAL AREA

Bartonia paniculata (twining screwstem): See Kickasola Cemetery, above.

Dichanthelium yadkinense (Yadkin's panicgrass): **Alt. 1**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Lack of prescribed fire will have adverse, indirect, long-term effects. **Alt. 2**: Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Beneficial, direct and indirect, short- and long-term effects from elimination or control of invasives that compete for same habitat. **Alt. 3**: Not affected in the short term, but in the long term, over the next 10 years, without herbicide use, may experience adverse, indirect effects from continued encroachment of invasives. Beneficial, direct and indirect, short- and long-term effects from prescribed fire. Some direct, short-term, beneficial effects from use of vinegar/clove oil, which may be able to help control Nepalese browntop if applied at appropriate time of growing season; however, this substance will be virtually ineffective in the long term on Japanese honeysuckle and other woody and perennial species. Resprouting of perennial plants is expected with the vinegar/clove oil as well as with the hot foam method.

SISTER ISLANDS-OHIO RIVER
Scirpus polyphyllus (leafy bulrush): See Massac Tower Springs, above. ***Spiranthes vernalis*** (spring ladies'-tresses): **Alt. 1**: Adverse, direct and indirect, short- and long-term impacts. Japanese and Amur honeysuckle have encroached on much of its habitat. Without use of herbicides, these invasives species will out-compete it. Nepalese browntop also poses a major threat to populations. Without removal or control of this invasive, it will out-compete the species in its rare habitat. These impacts may come from the eventual woody species and aggressive native and invasive species encroachment, which cause a reduction in health and vigor of this species' populations on the Forest. Prescribed fire is also required for the community this species inhabits to help reduce encroaching woody species and stimulate vigor and health. **Alt. 2**: Beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire and herbicides. This species is readily identifiable and protected during herbicide use. Species is adapted to fire and will respond favorably. **Alt 3**: Some adverse, direct and indirect, short- and long-term impacts without use of herbicides; but beneficial, direct and indirect, short- and long-term impacts from use of prescribed fire.

SPRING VALLEY CREEK-SOUTH FORK SALINE RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
21,085	4520	9417	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	0.17 acre	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 2% on 0.17A = 0.306			
Glyphosate = 0.306			
Soil Conditions			
The Wellston-Berks soil complex of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

SUGAR CREEK			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
13,464	6862	5144	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	5.57 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 2% on 5.57A = 10.026			
Glyphosate = 10.026			
Soil Conditions			
The Grantsburg silt-loam of this site—when wet—has a moderate potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

TOWN CREEK-BIG MUDDY RIVER			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
36,231	18,560	14,835	
Priority Species outside Natural Area Treatment Zones			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	11.88 acres (2.19 acres in Clear Springs Wilderness)	1 acre
Fountain Bluff Geological Area			
Fountain Bluff Geological Area treatment zone comprises approximately 642 acres (divided approximately equally between Fountain Bluff-Mississippi River and Town Creek-Big Muddy River watersheds). It is located in Jackson County at T10S, R4W.			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0.01 acre	0	0.05 acre	0
Broadleaf	**Grassy**	**Leguminous/Composite**	**Woody**
Queen-Anne's lace 0.01 acre	Johnsongrass 0.01 acre Tall fescue 0.1 acre	None	Multiflora rose 0.03 acre
Total: 0.01 acre	Total: 0.11 acre	Total: 0	Total: 0.03 acre
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Amur honeysuckle, garlic mustard, Johnsongrass, Queen Anne's lace, tall fescue: glyphosate 3% on 12.07A = 21.589		Kudzu, Queen Anne's lace: triclopyr 3% on 1.01A = 3.257 Kudzu: clopyralid 3% on 1 acre = 1.35 Multiflora rose: glyphosate 20% on 0.03A = 0.072	
Clopyralid = 1.35	**Glyphosate = 21.661**	**Triclopyr = 3.257**	
Soil Conditions			
The area contains no floodplain or hydric soils. 2 acres have slight potential for soil erosion and 1.2 acres have severe erosion potential. The Menfro silt-loam of this site has a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

WORTHEN BAYOU			
Total Acreage	**FS Ownership Acreage**	**Cropland Acreage**	
10,321	1356	8087	
Priority Species			
Amur Honeysuckle	**Chinese Yam**	**Garlic Mustard**	**Kudzu**
0	0	3.38 acres	0
Herbicide Application (in pounds of active ingredient per acre/treatment)			
Garlic mustard: glyphosate 3% on 3.4A = 6.12			
Glyphosate = 6.12			
Soil Conditions			
The Menfro-Wellston silt-loams of this site have a slight potential for leaching herbicides and a moderate potential for herbicide runoff during heavy rainfall (Forest Plan Table F-9).			

Total Area of Invasive Plants	
Amur honeysuckle: 411.73 acres (36.8 in in natural area treatment zones) at 20 locations (7 in treatment zones)	Garlic mustard: 467.54 acres (12.67 in natural area treatment zones) at 31 locations (6 in treatment zones)
Chinese yam: 252.86 acres (1.42 in natural area treatment zones) at 22 locations (7 in treatment zones)	Kudzu: 76.7 acres (9.56 in a natural area treatment zone) at 9 locations (1 in a natural area treatment zone)
Other broadleaf plants: 7.71 acres	Other leguminous/composite plants: 8.58 acres
Grassy plants: 106.67 acres	Other woody plants: 417.44 acres

Total Herbicides	
Clopyralid: 116.915 pounds on 102.96 acres	*Glyphosate: 1218.049 pounds on 1315.64 acres*
Sethoxydim: 30.21 pounds on 96.68 acres	*Triclopyr: 499.041 pounds on 339.48 acres*
Total herbicide: 2084.648 pounds	

Natural area treatment zones = 11,217 acres (12,378.4 fire)

Treated acres:

600.85 acres in natural area treatment zones

1148.38 acres outside natural area treatment zones

TOTAL: 1749.23

APPENDIX B

Herbicide Application by HUC6 Watershed

Watershed	Herbicide (Pounds of Active Ingredient)					Agricultural Application	
	Acres Treated						
Total Acres/FS Acres and Percent Ownership	Clopyralid	Glyphosate	Sethoxydim	Triclopyr		Acreage	Glyphosate Use
Barren Creek 13,862 / 7656: 55	1.023	39.041	3.545	1.459		2593	4537
	0.83	104.1	11.12	0.13			
Proposed glyphosate application in this watershed is 0.86% of total agricultural use.							
Bay Creek Ditch 11,588 / 4188: 36	0	0	0	22.753		4852.6	8492
				16.18			
Beaver Creek-Saline River 20,780 / 4267: 21	0	0	0	129.6		9306.6	16,286
				92.16			
Big Creek 12,829 / 4731: 37	0	0	0	0.155		2819.1	4933
				0.11			
Big Grand Pierre Creek 15,672 / 7562: 48	0	672.822	0	0		3546.9	6207
		373.79					
Proposed glyphosate application in this watershed is 10.839% of total agricultural use.							
Black Branch-Eagle Creek 22,172 / 6487: 29	0	1.8	0	0		7712.5	13,496
		1					
Proposed glyphosate application in this watershed is 0.0133% of total agricultural use.							
Camp Creek-Ohio River 31,064 / 4261: 14	0.086	12.198	0.618	0.18		3891.3	6809
	0.16	23.29	2.97	0.16			
Proposed glyphosate application in this watershed is 0.1791% of total agricultural use.							
Cedar Creek 25,422 / 6687: 26	0.19	28.43	0.875	0.449		10,649.9	18,637
	0.108	77.65	3.02	0.38			
Proposed glyphosate application in this watershed is 0.1525% of total agricultural use.							
Cedar Lake-Cedar Creek 22,129 / 6052: 27	58.719	0	0	71.831		7236.8	12,664
	38.31			38.31			
Cooper Creek-Mill Creek 16,544 / 2623: 16	0.351	0	0	0.488		8303.3	14,530
	0.26			0.26			
Drury Creek 11.454 / 731: 6	0	0.292	0	0		4792.1	8386
		0.81					
Proposed glyphosate application in this watershed is 0.00348 % of total agricultural use.							

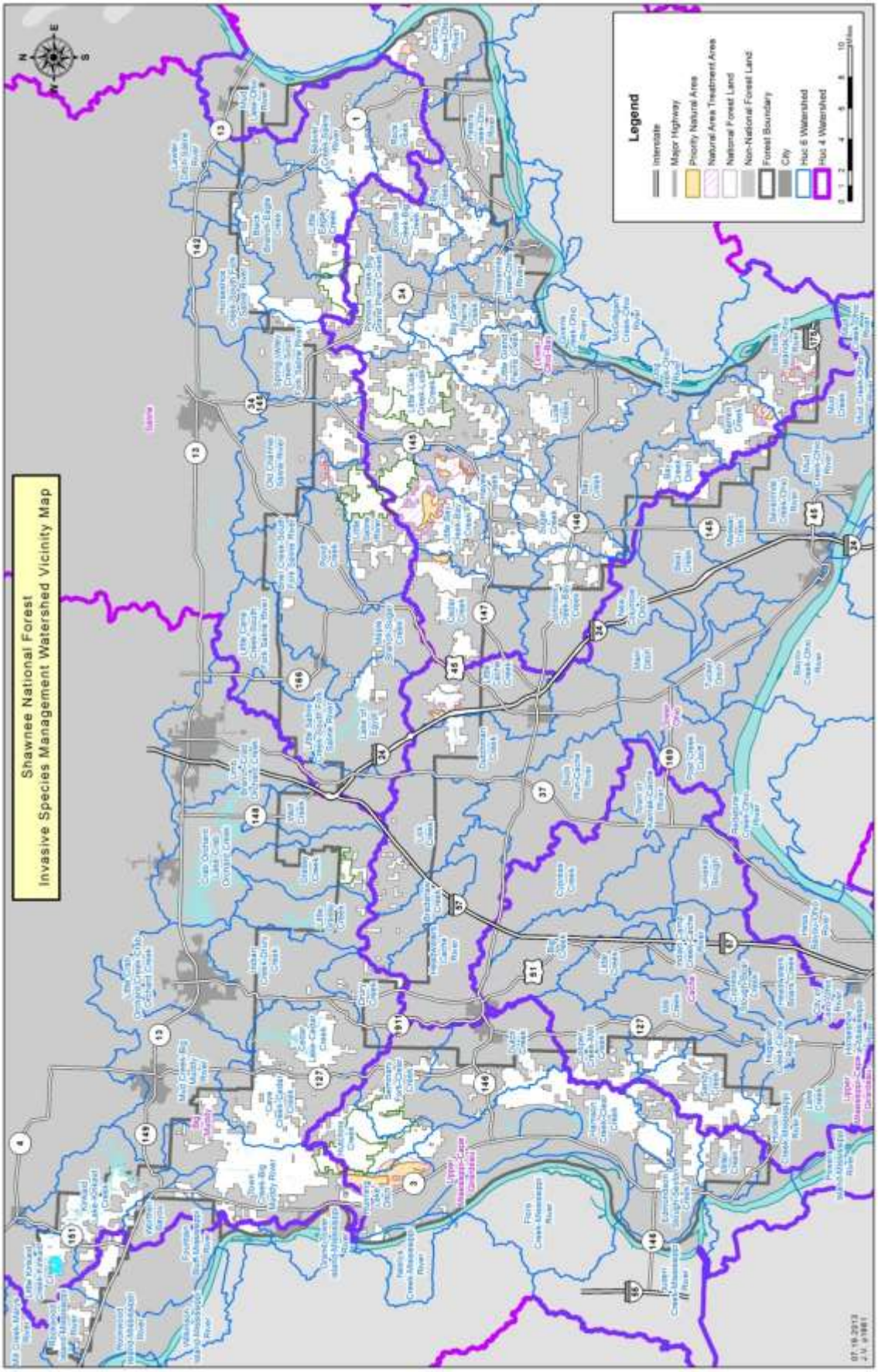
Watershed	Herbicide (Pounds of Active Ingredient) Acres Treated					Agricultural Application	
Total Acres/FS Acres and Percent Ownership	Clopyralid	Glyphosate	Sethoxydim	Triclopyr		Acreage	Glyphosate Use
Dutch Creek 25,647 / 3849: 15		0.623 1.73				11,707.9	20,488
Proposed glyphosate application in this watershed is 0.00304% of total agricultural use.							
Dutchman Creek 30,923 / 1523: 5	0	0.0036 0.01	0	0		16342.4	28,599
Proposed glyphosate application in this watershed is 0.00001258 % of total agricultural use.							
Edmondson Slough-Sexton Ck 21,603 / 6915: 32	0	1.728 0.96	0	0		2920.9	5111
Proposed glyphosate application in this watershed is 0.0338% of total agricultural use.							
Fountain Bluff-Mississippi River 27,842 / 3187: 11	0	18.554 14.03	0	0		18,584.1	32,522
Proposed glyphosate application in this watershed is 0.05705% of total agricultural use.							
Goose Creek-Big Creek 14,046 / 6369: 45	0.022 0.04	0.849 1.37	0.06 0.32	0.326 0.24		3516.1	6153
Proposed glyphosate application in this watershed is 0.0138% of total agricultural use.							
Grassy Creek 18,924 / 1528: 8	0	0	0	13.233 9.41		6196.7	10,844
Hayes Creek 15,326 / 7297: 48	0.298 0.6	23.518 57.53	4.099 12.94	2.819 1.38		5945.5	10,404
Proposed glyphosate application in this watershed is 0.226% of total agricultural use.							
Hutchins Creek 13,080 / 9909: 76	0	2.326 1.95	00032 0.01	2.318 1.64		2491	4359
Proposed glyphosate application in this watershed is 0.05335% of total agricultural use.							
Kinkaid Lake-Kinkaid Creek 25,699 / 8462: 33	0	95.35 194.38	0	0		9364.5	16,387
Proposed glyphosate application in this watershed is 0.58183% of total agricultural use.							
Lake of Egypt 21,766 / 2233: 10	0	3.636 2.02	0	0		8645.9	15,130
Proposed glyphosate application in this watershed is 0.024% of total agricultural use.							
Little Bay Creek-Bay Creek 27,172 / 13,756: 65	0.267 0.57	18.184 17.02	1.548 4.98	4.251 2.73		6849.6	11,9868
Proposed glyphosate application in this watershed is 0.1517% of total agricultural use.							

Watershed	Herbicide (Pounds of Active Ingredient) Acres Treated					Agricultural Application	
Total Acres/FS Acres and Percent Ownership	Clopyralid	Glyphosate	Sethoxydim	Triclopyr		Acreage	Glyphosate Use
Little Cache Creek 23,699 / 2527: 11	1.608	11.045	12.032	4.026		12,749.7	22,311
	1.89	44.66	38.03	1.56			
Proposed glyphosate application in this watershed is 0.0495% of total agricultural use.							
Little Eagle Creek 14,481 / 6969: 48	0	3.751	0	0.014		3895.9	6817
		3.28		0.01			
Proposed glyphosate application in this watershed is 0.055% of total agricultural use.							
Little Grand Pierre Creek 13,361 / 5095: 38	0	0.234	0	0.281		3656.6	6399
		0.13		0.2			
Proposed glyphosate application in this watershed is 0.00366% of total agricultural use.							
Little Kinkaid Creek-Kinkaid Ck 15,527 / 2577: 17	0	157.876	0	0.295		9036	15,813
		291.76		0.21			
Proposed glyphosate application in this watershed is 0.9984% of total agricultural use.							
Little Lusk Creek-Lusk Creek 31,812 / 18,044: 58	2.12	3.096	0	161.541		5956.8	10,424
	1.57	2.58		114.35			
Proposed glyphosate application in this watershed is 0.0297% of total agricultural use.							
Little Saline River 20,928 / 8019: 38	19.575	2.14	0.0096	27.428		5850.9	10,239
	14.5	4.3	0.03	15.01			
Proposed glyphosate application in this watershed is 0.0209% of total agricultural use.							
Lusk Creek 24,610 / 5553: 23	0	2.718	0	9.394		8151.6	14,265
		1.51		6.68			
Proposed glyphosate application in this watershed is 0.01906% of total agricultural use.							
Mill Creek 17,573 / 2129: 12	0	3.672	0	0		10,180.4	17,815
		2.04					
Proposed glyphosate application in this watershed is 0.02061% of total agricultural use.							
Peters Creek-Ohio River 31,158 / 2401: 0.08	0	21.322	0.105	0.548		9328.9	16,325
		28.75	0.47	1.17			
Proposed glyphosate application in this watershed is 0.1306% of total agricultural use.							
Pinhook Ck-Big Grand Pierre Ck 23,292 / 7314: 31	0	7.578	0	0.4		6715.2	11,751
		4.21		0.2			
Proposed glyphosate application in this watershed is 0.064484% of total agricultural use.							
Rock Creek 17,093 / 4267: 25	0	0	0	21.44		4868.6	8520
				10.72			

Watershed	Herbicide (Pounds of Active Ingredient) Acres Treated					Agricultural Application	
Total Acres/FS Acres and Percent Ownership	Clopyralid	Glyphosate	Sethoxydim	Triclopyr		Acreage	Glyphosate Use
Running Lake Ditch 23,003 / 4172: 18	0	9.917	2.04	2.836		16,153.2	28,268
		9.58	6.4	1.88			
Proposed glyphosate application in this watershed is 0.03508% of total agricultural use.							
Sandy Creek 19,027 / 8508: 45	0	1.116	0	0		6842.9	11,975
		0.62					
Proposed glyphosate application in this watershed is 0.009319% of total agricultural use.							
Seminary Fork-Clear Creek 20,094 / 5004: 25	0.158	1.304	0	0.263		6279.5	10,989
	0.14	1.15		0.14			
Proposed glyphosate application in this watershed is 0.01187% of total agricultural use.							
Sister Islands-Ohio River 34,000 / 3680: 11	30.39	12.059	5.275	40.209		5537.1	9689
	21.66	27.68	16.55	1.27			
Proposed glyphosate application in this watershed is 0.1245% of total agricultural use.							
Spring Valley Ck-S Fork Saline R 21,085 / 4520: 21	0	0.306	0	0		9417.7	16,480
		0.17					
Proposed glyphosate application in this watershed is 0.001856% of total agricultural use.							
Sugar Creek 13,464 / 6862: 51	0	10.026	0	0		5144.4	9002
		5.57					
Proposed glyphosate application in this watershed is 0.1114% of total agricultural use.							
Town Creek-Big Muddy River 36,231 / 18,560: 51	1.35	21.661	0	3.257		14,835.9	25,962
	1	12.1		1.01			
Proposed glyphosate application in this watershed is 0.083431% of total agricultural use.							
Worthen Bayou 10,321 / 1356: 13	0	6.12	0	0		8087.3	14,152
		3.4					
Proposed glyphosate application in this watershed is 0.043242% of total agricultural use.							

TOTAL HERBICIDE APPLICATION	116.075	1218.049	30.21	499.041		544,156 (glyphosate)
TOTAL ACREAGE TREATED	81.098	1221.44	96.84	317.5		310,957.3

Note that total clopyralid application by the Forest Service nationwide is about 2.2 percent of nationwide agricultural use (Durkin and Follansbee 2004), total glyphosate application under this proposal—1218.049 pounds—is 0.2242 percent of agricultural use in the HUC6 watersheds affected by our proposal, total sethoxydim application by the Forest Service has no published comparison, and total triclopyr application by the Forest Service nationwide is about 1 percent of nationwide agricultural use (Durkin 2011).


Shawnee National Forest
Invasive Species Management Watershed Vicinity Map
Legend
Interstate
Major Highway
Priority Natural Area
Natural Area Treatment Area
National Forest Land
Non-National Forest Land
Forest Boundary
City
Huc 6 Watershed
Huc 4 Watershed
0 1 2 4 6 8 10 Miles
N
E
S
W