Biological Evaluation
Invasive Species Management Project
Federal Threatened and Endangered Species
Shawnee National Forest, Illinois
Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Saline and Union Counties
August 2012

Note: References used in the completion of this document can be found in the Invasive Species Management project file located in the Supervisor's Office of the Shawnee National Forest, 50 Highway 145 South, Harrisburg, Illinois. This biological evaluation includes effects determinations for federally listed animal and plant species, and these site-specific effects are determined, in part, using information from the Programmatic Biological Opinion for the Shawnee National Forest Plan (BO) signed by the U.S. Fish and Wildlife Service (FWS) on December 13, 2005; the Shawnee National Forest Programmatic Biological Assessment for the Forest Plan Revision (BA) dated September 6, 2005; and Chapter 3 of the Final Environmental Impact Statement (FEIS) for the 2006 Forest Plan.

Introduction

The purpose of this biological evaluation is to identify the likely effects of the proposed actions and alternatives in the Invasive Species Management Project on nine federally listed or candidate animals and one federally listed plant. The evaluation is completed to ensure that Forest Service actions (1) do not contribute to a loss of viability or trend toward federal listing of any species, (2) comply with the requirements of the Endangered Species Act that actions of Federal agencies not jeopardize or adversely modify critical habitat of federally listed or proposed species, (3) provide a process and standard that ensures threatened, endangered and proposed species receive full consideration in the decision-making process, and (4) comply with the Reasonable and Prudent Measures (RPM's) and associated Terms and Conditions (TC's) of the BO. There is no critical habitat designated on the Shawnee National Forest (Forest) for any of the listed species that occur on or may be affected by Forest management. Site-specific effects determinations for each species are summarized in Appendix F.

Purpose of and Need for Action

The purpose of this project is to protect and restore naturally-functioning native ecosystems on the Forest by controlling or eliminating populations of non-native invasive plant species. Forest-wide action is needed at this time because:

- invasive species are increasingly degrading native plant communities and jeopardizing the survival of some local native plant communities;
- established invasive species populations serve as a seed source for spreading infestations,
- taking action now averts creation of a more widespread and costly future problem
- existing invasive species populations have the potential to spread to adjacent lands and facilitate the spread of invasive species in Illinois
- Past control efforts, (focused on small areas using mostly manual methods) were only marginally successful in arresting the establishment of invasive species populations;
- invasive species populations persist and continue to spread, evidencing a need for a comprehensive and integrated approach to treatment
- preventing new infestations from becoming established is more effective than trying to control and eradicate entrenched infestations.

Action is needed to effectuate guidance in the 2006 Land and Resource Management Plan (Plan):

> *Risk and damage from existing non-native invasive species should be reduced through integrated pest management. Invasion prevention measures should be implemented to maintain native ecosystems. Existing populations of non-native invasive species should be eradicated, controlled and/or reduced.*

Effects of management activities on the invasion and spread of non-native 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 non-native invasive species (page 47).

Proposed Action

The Forest Service proposes to take 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 all known sites of the four highly invasive species: Amur honeysuckle, Chinese yam, garlic mustard and kudzu.
2. Management of 23 natural areas and their 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. This work would be accomplished over the next ten years, with periodic reviews of the assumptions, data and analysis on which the responsible official will base his decision

Existing Condition

The Invasive Plant Species Management Project addresses specific occurrences of invasive plant infestations across the Forest. Many of these infestations are at roadsides, recreation sites, food plots, riparian areas, in newly acquired or exchanged lands, and in some natural areas. Field survey and inventory of invasive species has been occurring in natural areas on the Forest for over 20 years and locations of invasive species plants on the Forest have been recorded for decades. Over 1500 sites of invasive species infestation involving 80 different species have been identified. Database management is an ongoing job and for this analysis of existing inventory information, as of January 20, 2009 was used.

The ecological settings on the Forest are described in detail in Chapter 3 of the FEIS (USDA Forest Service 2006a). The Forest encompasses about 286,000 acres, with National Forest System land about one-third of the ownership within the Forest proclamation boundary. Most of the Forest is within three physiographic provinces, the Ozark Plateau, Interior Low Plateaus, and Gulf Coastal Plain. These regions contain extraordinary geological, hydrological and ecological diversity. The Forest is bound by the Mississippi River on the west and the Ohio River on the east and south. Signature features include broad floodplains of the large rivers, large cuestas of the Greater Shawnee Hills, karst areas of the Lesser Shawnee Hills, Ozark Hills, and Cretaceous Hills, and some of the highest quality streams in Illinois. The Forest is predominantly upland hardwood dominated by oak-hickory, with bottomland hardwood forests in floodplains and very small areas of grasslands and barrens.

Description of Alternatives

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 Forest Service 2003) and the Forest is implementing prevention measures currently, including the washing of equipment before and after entry onto Forest lands, 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 participation in the River-to-River Cooperative Weed Management Area (CWMA) partnership: Twelve 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 plants 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 our current strategies of management: Pulling and torching 100 to 150 acres of invasive species annually, inventorying and mapping infestations, and burning about 6,000 acres per year to set back invasives, including in some natural areas. We will 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, 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. We would continue to use public information and education to increase awareness of invasive species issues. We would treat specified Forest lands given available time and resources. With post-treatment monitoring, we would evaluate effectiveness and success, which we would disclose in our annual monitoring reports. We propose a dual approach to treating invasive species:

1. Treatment Forest-wide 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: Amur honeysuckle *(Lonicera maackii*), infesting about 70 acres at 5 sites in natural area treatment zones and 630 acres at 11 sites outside the treatment zones, Chinese yam *(Dioscorea oppositifolia*), infesting about 2 acres at 5 sites in natural area treatment zones and 340 acres at 19 sites outside the natural area treatment zones, garlic mustard (*Alliaria petiolata*), infesting about 75 acres at 6 sites in natural area treatment zones and 500 acres at 23 sites outside natural area treatment zones, and kudzu (*Pueraria montana*), on about 4 acres at 1 site in a natural area treatment zone and 20 acres at 6 sites outside natural area treatment zones. For the most part, these species were chosen because of their high degree of invasiveness and/or their ability to suppress or extirpate native vegetation and wildlife by their aggressive growth characteristics. Published science, monitoring, and field study indicate that active management of these species can greatly reduce both their current and potential adverse effects on native plants and animals with minimal impact on the surrounding environment. An integrated treatment approach using manual and mechanical methods and, where appropriate, herbicide is proposed to control and eliminate the four highly invasive species where they occur.

2. Management of 23 designated natural areas and their treatment zones:
The interdisciplinary team reviewed the information on invasives 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 areas for 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 areas. As detailed in Table 3 and Appendix A, we would target all invasives in the natural areas and their treatment zones, following the published guidance of the Illinois Nature Preserves Commission.

Management would include the application of prescribed fire in the natural areas and their treatment zones, about 11,220 acres. 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, using leaf-blowers that cause no earth-disturbance, and 6 miles mechanically, which would be earth-disturbing. These lines would be restored promptly in accordance with the Forest Plan guidelines in Appendix F and Illinois Forestry Best Management Practices.

The treatment zones would be burned at intervals of 1-3 years, depending on fuel availability and the monitoring and assessment of effects to determine the need for additional fire. 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.

Table 1. High-Priority Natural Areas.*		
Ava Zoological Area	Barker Bluff Ecological Area/Research Natural Area	Bell Smith Springs Ecological Area
Bulge Hole Ecological Area	Cretaceous Hills Ecological Area	Dean Cemetery West Ecological Area
Double Branch Hole Ecological Area	Fink Sandstone Barrens Ecological Area	Fountain Bluff Geological Area
Hayes Creek-Fox Den Ecological Area	Jackson Hole Ecological Area	Keeling Hill North Ecological Area
Keeling Hill South Ecological Area	Kickasola Cemetery Ecological Area	LaRue-Pine Hills–Otter Pond Ecological Area / Research Natural Area
Massac Tower Springs Ecological Area	Odum Tract Ecological Area	Panther Hollow Botanical Area / Research Natural Area
Poco Cemetery East Ecological Area	Poco Cemetery North Ecological Area	Reid's Chapel Ecological Area
Russell Cemetery Barrens Ecological Area	Snow Springs Ecological Area	

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

The proposal includes "thin-line application" and basal-bark treatment (i.e., "hack-and-squirt": cutting into a tree's cambium and applying herbicide), as well as the cutting and stump-spraying and/or girdling of 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 that traditionally have sparse vegetation. With 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 the trees and shrubs that are encroaching on seep-spring areas and de-watering their rare plant communities.

Herbicide Treatments

We have analyzed the treatment of about 3,000 acres of invasive species infestation across the Forest annually. We would limit our chemical treatment of invasive species to five herbicides: triclopyr, clopyralid, glyphosate, sethoxydim and/or picloram (Table 2). Following the published guidance of the Illinois Nature Preserves Commission and The Nature Conservancy, we have selected these commonly used, generally low-impact herbicides that should provide effective treatment. Additionally, we propose to use the most controllable application methods that would have the least residual impact:

1) a hand-held applicator, hack-and-squirt, sprayer, or wick applicator,
2) backpack sprayer, or
3) boom-mounted spray rig (on an all-terrain or utility vehicle, pickup truck, or tractor).
4)

We do not propose aerial applications.

Table 2. Proposed Chemical Controls 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	SERA 2004a
Glyphosate	Accord® Roundup Pro® Roundup®	Woody and broadleaf plants: stump treatment, 10-20% solution; foliar spray; non-selective	Amur honeysuckle, autumn olive, Japanese honeysuckle, garlic mustard, multiflora rose	SERA 2003a
Glyphosate (aquatic)	Aquamaster® Rodeo®	Foliar treatment, invasives near open water, non-selective	purple loosestrife, any species near open water	SERA 2003a
Sethoxydim	Poast® Vantage®	Foliar spray; narrowleaf selective (grasses)	Nepalese browntop, Canada bluegrass, bald brome	SERA 2001
Picloram	Tordon K Tordon 22k; Grazon	Stump and/or basal-bark treatment	Kudzu, autumn olive, tree-of-heaven, black locust	SERA 2003c
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	SERA 2003b
(http://www.fs.fed.us/foresthealth/pesticide/risk.shtml)				

We would apply herbicides at or below label-recommended rates, using only those registered by the Environmental Protection Agency for the specific type of site and use we propose. We would follow all applicable state and federal laws. We would apply herbicides according to label directions and in accordance with the guidance published by the Illinois Nature Preserves Commission and The Nature Conservancy and monitor our use in compliance with 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 any 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. If a first application of an herbicide should not be as effective as expected, we would re-treat with one of the proposed herbicides 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 invasive species 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 details in Table 3). 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 3. Invasive Species and Treatments: Treatments in Natural Areas Based on Recommendations of the Illinois Nature Preserves Commission for Natural Area Protection.	
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	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 at a 3%** solution on dormant or early-germinating bulbils in early spring through April.
Common sheep sorrel Beefsteakplant	Apply **triclopyr at 3-5%** solution before bloom or seedset in areas where broadleaf-selective herbicide is preferable; alternatively, **glyphosate may be applied at 2-3%** solution where non-selective herbicide is acceptable.
Creeping jenny (bindweed)	Apply **glyphosate at 2-3%** solution 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 at 3-5%** solution to young, growing plants, ideally before seeding.
Garlic mustard	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 at 2%** solution 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.
Oriental lady's-thumb	Apply **glyphosate at 3%** solution when plant is actively growing.
Periwinkle	Cut plants, then apply **glyphosate at 3%** solution to new growth.
Queen Anne's lace Garden yellowrocket	Apply **glyphosate at 3%** solution to rosettes; apply **triclopyr at 3%** solution to rosettes the following year if necessary. Plants are biennial; goal is to treat before seeding.
Sleepydick	Apply **glyphosate at 2%** solution.
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 at 3%** solution to new growth.
Japanese bristlegrass	Do not burn. Apply **glyphosate at 2%** solution or **sethoxydim at 3%** solution 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 at 2%** solution 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 at 1.5%** solution 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 at 2%** solution when plants are actively growing and not stressed.
Reed canarygrass	Apply fire in late spring; apply **glyphosate at 2%** solution in June and September to ensure control.
Leguminous / Composite Plants	
Bristly oxtongue	Remove by digging if possible. If large infestation, apply **glyphosate at 2%** solution.
Bull thistle	Apply fire in late spring, if possible, to increase exposure of rosettes to herbicide application. Apply **glyphosate in 2.5%** solution 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 at 2%** solution 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 at 2%** solution to rosette when plant is actively growing.
Crownvetch	Apply **triclopyr at 2%** solution before seed maturity; **clopyralid may be applied at 2%** solution if a more legume-specific herbicide is desired. (MDC)

Table 3. Invasive Species and Treatments: Treatments in Natural Areas Based on Recommendations of the Illinois Nature Preserves Commission for Natural Area Protection.	
Field clover Yellow sweetclover Red clover Korean clover	Apply **glyphosate at 2%** solution or **triclopyr at 3%** solution 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	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 (3%)** 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 44% **triclopyr at a 2%** solution. 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 at a 2.5%** solution during June to mid-July when plants are still vegetative and during early flowering. An herbicide containing at least 40% **clopyralid (3%)**could also be used at the rate 21 ounces to the gallon.
Lesser burdock	Apply **glyphosate at 2%** solution to actively growing plant rosettes.
Oxeye daisy	Apply an herbicide containing at least 40% (21 ounces to the gallon) **clopyralid at 3%** to actively growing plants.
Woody Plants	
Amur / bush honeysuckle	Apply prescribed fire If sufficient fuel is present to sustain fire; treat resprouting with **glyphosate at 4%** solution. In heavy infestations of honeysuckle, spray foliage with glyphosate at 4% solution 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 at 10-20%** solution 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.
Burning bush Japanese meadowsweet Mock orange	Apply prescribed fire If sufficient fuel is present to sustain fire; treat resprouting with **glyphosate at 4%** solution. 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 at 1.5-2%** solution. 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 in 2%** solution to cut surfaces.

Alternative 3 –Treatment Action without Synthetic Herbicides

Under this alternative, no synthetic herbicides would be used to control invasive species. The methods we propose 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. This alternative was developed in response to public concerns about the unintended consequences of 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. Forest-wide treatment of four highly invasive species:

Under this alternative we would concentrate on the same four highly invasive species as under the proposed action, but would use manual and mechanical methods as a first line of treatment. Kudzu sites would be treated initially with prescribed fire, with a backhoe or bulldozer used to remove individual plants, concentrating on the root crowns. Amur honeysuckle and garlic mustard sites would be removed by concentrating on individual plants. Amur honeysuckle would be pulled or grubbed out. Garlic mustard would be hand-pulled or torched. Chinese yam would be treated initially by continual mowing, clipping or torching. For all four species, natural herbicides could be applied after initial work has reduced the vigor of populations.

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 than water) is applied to the targeted vegetation at a high temperature (200°F) and low pressure; the foam traps the steam, giving it time to "cook," or "blanch," the vegetation. This causes a cellular collapse of the treated aboveground 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 specified natural areas (Table 1) would be treated using non-chemical methods. Management would include the application of prescribed fire in the natural areas and the treatment zones, about 11,200 acres. 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.

The treatment zones would be burned at intervals of 1-3 years, depending on fuel availability and the assessment of effects to determine the need for additional fire. The fire would help restore native vegetation and set back the development 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.

Key Issues and Indicators

Issues are points of debate, disagreement, or dispute about the environmental effects of a proposed action. Following our 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 establishment and growth of invasive species may affect natural areas and ecosystems, including plants and wildlife.
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of acres of invasive species reduced and native species restored.
    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat (density and diversity of understory vegetation) on ground nesting birds.
- The application of prescribed fire may affect natural areas and ecosystems, including soil, water, plants and wildlife.
    - Soil & Water Quality Indicator: The amount of soil erosion (tons/acre/year).
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of changes in the number and frequency of invasive and native plant species.
    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat (density of undisturbed leaf litter, coarse woody debris and density and diversity of understory vegetation) of ground nesting birds.
- The application of herbicides may affect natural areas and ecosystems, including soil, water, plants and wildlife.
    - Soil & Water Quality Indicator: Pounds of active ingredient of herbicide used.
    - Plant Community Indicator: The response of the plant community to the proposed action will be discussed in terms of the effect on the natural area's significant and exceptional features for which they were designated.
    - Wildlife Community Indicator: The response of the wildlife community to the proposed action will be discussed in terms of potential changes in the habitat of management indicator species.
- The application of herbicides may affect humans.
    - Human Health Indicator: The response of general populace to the proposed action will be discussed in terms of the effect that the properly approved and applied chemical eradication measures will have on public health and employees/applicators.

Forest Plan Standards and Guidelines

The Invasive Species Management Project incorporates the standards and guidelines of the Forest Plan consistent with the BO. Forest-Wide standards and guidelines can be found in Chapters 2 and Appendix H of the Forest Plan and were incorporated into this project during proposal development.

Design Criteria Action Alternatives

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 5 and 6). 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 4. Design Criteria for Invasive Species Management.		
Resource Area	**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 seriously 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 weed establishment.	
	All treatment locations will be marked 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	Ensure that rare plant resources, including state-listed threatened and endangered species, are protected from mechanical or chemical treatments.	Rare plant resources will be protected and habitat enhanced. Known locations of state-listed plant species will be protected by request of the Illinois Department of Natural Resources.
Wildlife	Retain all standing dead trees unless necessary to cut for human safety or to accomplish project objectives.	These design criteria are required "terms and conditions" or "reasonable and prudent measures" in US Fish and Wildlife Service 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 in the project area. No firelines would be constructed in or immediately adjacent to cave habitat.	This species require additional RFSS protection identified in the Forest Plan (USDA 2006).
	High-intensity prescribed fire should not be applied to known locations of the carinate pill snail in LaRue-Pine Hills Research Natural Area.	This is protection suggested in the conservation assessment for the carinate pill snail (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 NNIS 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.

Table 4. Design Criteria for Invasive Species Management.		
Resource Area	**Design Criteria**	**Rationale / Effectiveness**
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 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 intense burns that remove forest-floor litter and expose excessive bare soil.	
	Maintain soil-stabilization practices until the site is fully revegetated and stabilized.	
	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 pesticides, herbicides; use only pesticides 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.	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.	

Consultation History

Informal consultation on the 2006 Forest Plan began in 2002. The Fish and Wildlife Service (Service) provided a list of federally listed threatened and endangered species and information on preparation of a biological assessment. A draft version of the BA was provided to the Service for review on May 12, 2004. The Service met with Forest staff on May 27, 2004, to discuss comments on the draft BA. In June, 2005, the Service provided comments to the Forest Service regarding the Draft EIS and proposed revision of the Forest Plan. The Forest submitted a Programmatic BA and requested initiation of formal consultation on July 19, 2005. The Service agreed and requested additional information on August 17, 2005. The additional information was provided in a revised Programmatic BA dated September 2005. In the BA, the Forest made the following determinations:

- There is no designated critical habitat for any of the federally listed species within the Forest (USFS 2005). A number of these species are not currently known to occur on the Forest: least tern; pallid sturgeon; fanshell, fat pocktbook, pink mucket, orange-footed, sheepnose, and spectaclecase mussels. All are present in large river systems adjacent to the Forest and may be indirectly affect by activities occurring on the Forest.
- The Forest Plan and projects predicated upon it are NOT LIKELY TO ADVERSELY AFFECT the fanshell, fat pocketbook, pink mucket pearly, and orange-footed pearly mussels and pallid sturgeon since

these species are not known on the Forest and there would be no measurable indirect effects on downstream habitats for the species in the Mississippi or Ohio Rivers from Forest actions due to the relatively, small amounts of additional sediment above natural levels contributed by Forest activities, primarily road and trail uses and management. It also identified that implementation of the Revised Forest Plan IS NOT LIKELY TO ADVERSELY AFFECT the least tern since the species is not known to nest on the Forest, there is very little potential habitat for the species on the Forest, and our planned actions would maintain these potential habitats and result in no overall impacts to the species or its populations in southern Illinois.

- Continued implementation of the Forest Plan and projects predicated upon it have a MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT determination on habitat and populations of gray bats. The Service agreed with determinations made in the BA.

The Forest received a programmatic BO on 12/13/2005, with the Service's opinion that "the 2006 Forest Plan for the Forest, as proposed, is not likely to jeopardize the continued existence of the Mead's milkweed. No critical habitat has been designated for this species; therefore, none will be affected" (page 43).

The opinion on the Indiana bat is that the proposed revised Plan is not likely to jeopardize the continued existence of the Indiana bat. Critical habitat for this species has been designated at several major hibernacula; however, this action does not affect that area and no destruction or adverse modification of critical habitat is expected. Implementation of the Plan is likely to result in some adverse fitness consequences for individuals occurring within the action area. These adverse consequences are most likely to be either injury or death of individual Indiana bats from direct exposure to management actions. We do not expect these individual consequences will elicit population or species-level effects. On the contrary, we anticipate the overall beneficial effects of the proposed action will maintain and improve roosting and foraging habitat and, hence, the fitness of Indiana bats within the action area. Thus, overall impact on the conservation status of the populations in which these individuals belong and on the species range-wide is positive. So, we conclude that the proposed action is not expected to directly or indirectly reduce the likelihood of both the survival and recovery of this species by reducing their reproduction, numbers, or distribution. In the BO, the Service identified incidental take of habitat and individuals for Indiana bats related to timber harvest/management, minerals management, timber stand improvement, wetland management, monitoring, and research. Up to two Indiana bats may be killed during the project period as a result of monitoring and research activities.

Since the BO, the Forest has continued to manage bat habitats and monitor bats across the Forest. Recent surveys have identified gray bats foraging in one stream on the Forest and one individual gray bat hibernating in a cave within the Forest boundary very near National Forest system land. The least tern has also nested next to National Forest System land in leveed areas of the Mississippi River floodplain in recent high water year (2008) when riverine nesting habitat was not available. This recent information on the occurrence of both species would not change the determinations made for both. The BO for the Forest Plan is not based on site-specific projects but on actions resulting from the implementation of the Forest Plan as a whole over a ten year period.

Table 5. Annual Estimated management activities causing removal of Indiana bat habitat on the Forest.

Activity	First 10 Years	Second 10 Years	Total
Timber harvest/management and minerals management	11,565 acres	21,255 acres	32,820 acres
Timber stand improvement and wetland management	5,630 acres	13,289 acres	18,919 acres
Total	**17,195 acres**	**34,544 acres**	**51,739 acres**

Critical Habitat

There is no critical habitat for any federally listed species on the Forest.

Species Considered, Documented In Project Area, and Associated Information

The most recent email from FWS identifying federally listed species likely to occur on the Forest is 7/17/2009 (see project record). These are the same species addressed in the BA, with the exception of the bald eagle and fanshell mussel, which are not listed for counties that include the Forest, and the additions of two candidate, mussel species for Massac County. In this BE, animals are considered and discussed first and plants follow.

Many of the federally listed species identified for the Forest use unique habitats such as caves, abandoned mines, and large rivers during all or a portion of their life cycle. In this effects analysis, species will be grouped based on habitat associations. These include purely aquatic species and/or those associated with large river systems (least tern, pallid sturgeon, fat pocketbook mussel, pink mucket pearlymussel, orange-footed pearlymussel, sheepnose mussel, and spectaclecase mussel; terrestrial species closely associated with caves, riparian habitats, and floodplain forests (gray bat and Indiana bat), and those associated with glades and barrens (Mead's milkweed).

Four databases were reviewed for rare species occurrences. The Illinois Department of Natural Resources Natural Heritage Database, the Service's T&E species list by County, and National Forest Fauna and TES Plants databases for the Forest. Queries of these databases in 2009 showed all ten federally listed species are known or likely to occur in the counties affected in this proposal.

In partnership with the Forest and others, the Illinois Department of Natural Resources (IDNR) has been very aggressive in conducting species surveys and maintaining data on both listed and common species. The IDNR Natural Heritage Database includes specific locations of plant and animal species in Illinois by county. This database provides an excellent source of information on occurrences of threatened, endangered, and candidate species.

The species below are evaluated for the proposed project based on habitat associations and documented distribution. We give a brief description on distribution and habitat, documented occurrences, and threats or limiting factors. This information will not be repeated throughout the document. The NatureServe website (http://www.natureserve.org) contains detailed information on each of these species. In addition, the FEIS includes information on effects of pest management on the Forest, including invasive species management on Federal species, and it can be accessed at www.fs.fed.us/r9/forests/shawnee/projects/forest_plan/docs/FEIS.pdf.

I. Aquatic/River Species

BIRDS

The least tern is a federally listed endangered species considered a fairly common summer resident and local migrant in southern Illinois, particularly in Alexander and Jackson Counties along the Mississippi River and Pope County along the Ohio River. Nesting habitat is bare alluvial, dredge, or spoil islands and sand/gravel bars in or adjacent to large rivers and streams in the Mississippi and Ohio Rivers valleys. The species forages in shallow water along large rivers and streams and in backwater areas such as side channels and sloughs. Foraging habitat must be in close proximity to nesting habitat.

The species is not known to nest or forage on the Forest. There is no designated critical habitat for the species on the Forest or in southern Illinois. The relative population trend for the least tern in Illinois including southern Illinois is down (IFWIS 2004).

Breeding Habitat

The least tern breeds in Illinois in early June-late July (Hardy 1957). Nests are a shallow depression in sand or gravel generally on islands. Sandbars are preferred nesting habitats (IFWIS 2004). Breeding season is reported to last approximately 90 days including egg laying, incubation, and fledging (Hardy 1957). Species is a colonial nester, nesting in well-scattered groups. Requirements for a location of a ternery are 1) presence of sandbars, 2) existence of favorable water levels, and 3) availability of food (Hardy 1957).

There are no permanent or ephemeral islands on the Forest along the Mississippi, Ohio or Big Muddy Rivers. There are small acreages of National Forest System land along the western bank of the Ohio River, along the eastern bank of the Mississippi River and larger acreages on both banks of the Big Muddy River in southwestern Jackson County. These are marginal nesting habitats for least terns. The species has not been observed to date nesting on banks along the Big Muddy River on the Forest.

Potential foraging habitats on the Forest include the Big Muddy River and its floodplain including a number of swamps, sloughs, and bayous and managed perennial wetlands in the Mississippi River floodplain in Jackson, Union and Alexander Counties and along one backwater slough in south Pope County near the confluence of Bay Creek and the Ohio River.

Likely Effects on the least tern and habitat

No direct effects on the least tern or its nesting or foraging habitats would occur as a result of this project. There could be some indirect effects on its fish food source from reduced water quality and/or aquatic invertebrates resulting from off-site sedimentation or herbicides indirectly affecting the Mississippi or Ohio Rivers. The applied standards and guidelines from the Forest Plan and/or from project design criteria would greatly reduce or eliminate the chances of these indirect effects on the least tern's food supply, resulting in no effects or at most immeasurable, indirect effects on the species from planned project actions.

Status of the least tern in the project area

The species is not known to nest in the project area but is known as an uncommon, feeding species in or adjacent to only two of the project locations that are adjacent to the Mississippi and Big Muddy Rivers and their floodplains, LaRue-Pine Hills and Fountain Bluff.

Factors affecting the least tern within the project area

Prescribed burning and herbicide use could have indirect effects on small amounts of food supplies for the species. However, implementation of Forest Plan standards and guidelines and project design criteria would eliminate or greatly reduce those effects on the species.

MUSSELS

Locations for the orange-footed pearly mussel, pink mucket pearly mussel, sheepnose mussel, and spectaclecase mussel are identified as the Ohio River and other rivers. Although there is National Forest System land in Massac County, there is no system land along the Ohio River in Massac County. Some mussel surveys (Stinson and Welker 2000-2005) have also been done in Forest streams adjacent to the both the Ohio and Mississippi Rivers. No fat pocketbook mussels, pink mucket pearly mussels, nor orange-footed pearly mussels have been found in these surveys on or adjacent to the Forest to date.

The fat pocketbook mussel is described by Cummings and Mayer (1992) as a medium to large-sized mussel with a rounded to somewhat elongated and greatly inflated shell. It is tan or light brown in color, rayless and shiny. Its shell reaches lengths up to 5 inches. The hinge is S-shaped and pseudocardinal teeth are thin, compressed, and elevated. Its nacre is white sometimes tinged with pink or salmon. The mussel is found in the Ohio, Wabash and Little Wabash Rivers within several Illinois counties. The species utilizes sand and gravel substrates and may be found individually or in beds with other species. Cummings and Mayer (1992) describe its habitat as large rivers in slow-flowing water in mud and sand.

The pink mucket pearly mussel is described by Cummings and Mayer (1992) as a medium-sized mussel with a rounded to somewhat elongated, thick, and inflated shell. It is yellowish brown in color, smooth, and rayless or with faint green rays. Its shell reaches lengths up to 5 inches in males. The pseudocardinal teeth are triangular, thick, and divergent. Its nacre is pink or white iridescent posteriorly. This mussel is a unique long-term breeder in which male pink muckets release sperm in late summer or fall that fertilizes larvae in females which is incubated until the following spring. The mussel occurs in the Ohio River in Massac County and may potentially occur in other Illinois counties bordering the Ohio River. This species inhabits gravel and sand substrates in moderate to fast-flowing water. The pink mucket pearly mussel inhabits shallow riffles or

shoals in areas of gravel, rubble, or sand substrates that have been swept free of silt by the current. (Silt clogs the siphons in which mussels use to strain water for nutrients.)

The orange-footed pearly mussel is described by Cummings and Mayer (1992) as a medium mussel with a round shell with pustules on the posterior three-fourths. It is light brown to chestnut and dark brown in color, smooth on the anterior and with numerous pustules on the posterior. Its shell reaches lengths up to 4 inches. The pseudocardinal teeth are well-developed, with two in the left valve and one in the right valve. Its nacre is white usually with pink or salmon near the beak cavity, iridescent posteriorly. The mussel occurs in the Ohio River in Massac and Pulaski Counties and may potentially occur in other Illinois counties bordering the Ohio River. The species inhabits gravel or mixed sand and gravel substrates.

Spectaclecase (*Cumberlandia monodota*) mussel was listed as a candidate species on May 4, 2004. The range of this species has been drastically reduced and continues to decline. The distribution of this species is largely reduced to a relatively few disjunct sites in the Upper Mississippi, lower Missouri, and lower Ohio Rivers (Cummings and Meyer 1992), some of which may not be capable of reproduction either through loss of fish hosts or adverse environmental conditions. According to the NatureServe website, this species occurs in substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with slow to swift current (Buchanan, 1980; Parmalee and Bogan, 1998; Baird, 2000). According to Stansbery (1967), spectaclecase is usually found in firm mud between large rocks in quiet water very near the interface with swift currents. Specimens have also been reported in tree stumps, root masses, and in beds of rooted vegetation (Stansbery, 1967; Oesch, 1995). Threats are well documented and include impoundments, channelization, chemical contaminants, mining, and sedimentation. In or adjacent to Illinois, this species has been identified from the Ohio River in Massac County, Illinois.

Sheepnose mussel (*Plethobasus cyphus*) was listed as a candidate species on May 4, 2004. The species is known from the Mississippi, Ohio, and lower Missouri River systems and many of their main tributaries (*In* Nature Serve 2009 http://www.natureserve.org/explorer/servlet). Although it does inhabit medium-sized rivers, this mussel generally has been considered a large-river species. It may be associated with riffles and gravel/cobble substrates but has generally been reported from deep water (>2 m) with slight to swift currents and mud, sand, or gravel bottoms (Gordon and Layzer, 1989 *In* NatureServe, 2009). It also appears capable of surviving in reservoirs (Ahlstedt, 1989 *In* NatureServe, 2009). Fish hosts include central stoneroller and sauger (Furniss 2007). It is sensitive to pollution, siltation, habitat perturbation, inundation, and loss of glochidial hosts. It is identified from the Ohio River in Massac County, Illinois.

Mussels like the five species above spend most of their lives buried at least partially in the substrate (Cummings and Mayer 1992). Movement is accomplished by contractions of the foot, a muscle that can extend outside of the shell. Freshwater mussels are filter- feeding animals. Fine organic detritus and plankton are acquired by taking in water through the branchial siphon, passing it across an extensive gill system, and releasing the water back out through the anal siphon into the water column (Pennak 1989). Respiration is accomplished in the same manner.

Dispersal of mussels occurs when glochidia (the larval form of a mussel) attach to fish hosts. Once developed, the mussel detaches from its fish host and has extremely limited mobility. In one study, 96% of bass species, known to be used by the pink mucket, were found to stay within 300 feet of the original point of capture (Lewis and Flickinger, 1967). Therefore, glochidial movements appear to be minimal, and movements of mature mussels are even less. Downstream movements of adults occur primarily with major flood events.

Likely Effects on Mussel Species and Habitat

Range-wide, the distribution and reproductive capacities of these species have been impacted by impoundments, navigation projects, pollution, and habitat alterations such as dredging for sand and gravel mining (USDI Fish and Wildlife Service 1991, Lauritsen and Watters 1986). Impoundments and navigation projects historically have been the most serious threat to riverine mussels (Lauritsen and Watters 1986).

These structures alter the morphology of the natural river, changing the flow, oxygen levels and substrates. They can also impede passage of fish hosts.

Mussels are susceptible to pollution from various sources: runoff from coal mines; runoff containing pesticides, fertilizers, animal waste and heavy metals; and discharges of water with temperature extremes (Lauritsen and Watters 1986, USDI 1990). Siltation from mining, dredging, road construction, farming and logging can bury shells and impact feeding and respiration (Lauritsen and Watters 1986). They can also be indirectly affected by runoff from herbicides. Other potential threats to riverine mussel species include reduction of water flows, runoff from oil and gas exploration, toxic spills, water development projects, and collectors in the rivers where mussels remain (USDI 1990). A relatively new threat to this species is the zebra mussel *(Dreissena polymorpha*), an exotic species that has extended its range to the Ohio River basin. Berg *et al.* (1993) found that zebra mussels encrust native unionids and affect their fitness.

Natural predators include raccoons, otter, mink, muskrats, turtles and some birds (Simpson, 1899; Boepple and Coker, 1912; Evermann and Clark, 1918; Coker *et al*., 1921; Parmalee, 1967; Snyder and Snyder, 1969). Domestic animals such as hogs can root mussel beds to pieces (Meek and Clark, 1912). Fishes, particularly catfish, *Ictalurus* spp. and *Amieurus* spp., and freshwater drum, *Aplodinotus grunniens*, also consume large numbers of unionids. See the General Freshwater Mussel ESA.

No direct effects on any of the above species would occur as none of the above mussel species are known from project locations on the Forest. There could be some indirect effects on the species through effects on water quality of direct Mississippi and Ohio River tributaries and any subsequent sedimentation effects or residual herbicide effects downstream in these rivers.

Status of fat pocketbook mussel, pink mucket pearly mussel, orange-footed pearly mussel, sheepnose mussel and spectaclecase mussel within the project area

None of the above five species of mussels are known from the Forest. All are known from the Ohio and Mississippi Rivers that are adjacent to and border the Forest on its eastern and western boundaries. All are listed as endangered in Illinois (Illinois Department of Natural Resources 2004). There is no historical habitat for any of the above species on the Forest. There is some potential habitat in the lower reaches of the Big Muddy River and Barren, Bay, Big, Clear/Hutchins, Lusk, and Grand Pierre Creeks on the Forest.

Factors affecting the fat pocketbook mussel, pink mucket pearly mussel, orange-footed pearly mussel, sheepnose mussel and spectaclecase mussel within the project area

With the exception of the fat pocketbook mussel, there currently is no known habitat for these species within the boundaries of the Forest. The only mid-sized river habitats on the Forest are sections of the Big Muddy River in southwestern Jackson County. None of these species have been identified to date from that river.

The entire Forest is within the watershed of direct tributaries to both the Mississippi and Ohio Rivers and the Forest includes over 25,000 acres in the floodplains of both rivers in OB, EH, MO, and NA management areas. Land management on the Forest including soil disturbing activities and actions affecting water quality in tributary streams could indirectly affect habitat for these four mussel species in adjacent Mississippi and Ohio Rivers. Some activities that have the potential to affect water quality in tributary streams on the Forest include wetland restoration and improvement, riparian habitat protection, timber harvest and management, prescribed burning, road and trail construction and closure, aquatic habitat management, minerals management and non-native invasive species management. Prescribed burning, some TSI-like tree and shrub removal and invasive species management are planned on the Forest in this project. Burning and invasive species management including the use of herbicides included in this proposed project could have indirect effects on potential habitats for these species.

FISH

The pallid sturgeon is a native fish of main stems of the Missouri and Mississippi Rivers ranging from Montana in the northwest to Louisiana in the southeast. It is similar in appearance to the more common shovelnose sturgeon (*Scaphirhynchus platorynchus*) that coexists within the same river systems. The pallid sturgeon has a snout that is flattened and shovel-shaped but more pointed and longer than the shovelnose. It is variable in color but is generally lighter than the shovelnose with back and sides usually grayish-white rather than buff (Pfliger 1997). It is larger than the shovelnose sturgeon attaining weights up to 65 pounds but with the majority of individuals around 10 pounds.

It is a federally and State of Illinois-listed endangered species. There is no critical habitat for the species on the Forest, nor is the species known from the Forest. It has been identified from the Mississippi River in Alexander, Jackson and Union counties adjacent and bordering the Forest on its western boundary.

Habitat requirements for the species are open channels of large turbid rivers in areas with current and firm bottom substrates. Degradation of its habitat has occurred from impoundments. These have decreased turbidity, inundated much of its former habitat and interfered with movements (Nature Serve 2009). Its diet consists of aquatic invertebrates (principally insects) and fish (mostly minnows).

The species reaches sexual maturity at ages 5-7 years. Females spawn for the first time at ages 15-20 and then at intervals of several years thereafter (Pfliger 1997). Maximum ages recorded were approximately 40 years. The pallid sturgeon spawns from July to August (Nature Serve 2009). It also hybridizes with the shovelnose sturgeon with most hybrids being fertile and female. The pallid sturgeon is greatly outnumbered in areas where both it and the shovelnose sturgeon occur (Nature Serve 2009).

The species is rare/uncommon throughout its range. It is threatened by habitat modification (dam construction and channelization) that has severely reduced or eliminated successful reproduction (Pfliger and Grace 1987 in Nature Serve 2009)). Past commercial exploitation likely exceeded biological recruitment. Pollution is also thought to be a problem for the species over much of its range. Increased hybridization with the shovelnose sturgeon thought to be forced by habitat modifications is also threatening the species.

Likely effects

No direct effects on the species will occur from the Forest Plan since the species is not known to occur in the project locations on the Forest where practices would be implemented. There could be some indirect effects on the species through effects on water quality of direct Mississippi River tributaries and any subsequent sedimentation effects downstream in the Mississippi Rivers.

Status of pallid sturgeon within the Forest planning area

There is no historical or potential habitat for the species on the Forest. The species is a species of turbulent sections of large rivers. There are a few locations where the Forest borders the Mississippi and Ohio Rivers within their floodplains, in Union, Gallatin, Hardin and Pope Counties. The Forest also has ownership on in much of the protected and unprotected floodplain of the lower Big Muddy River. The species has not been identified from the Big Muddy River or from any of the specific Forest locations on the Mississippi or Ohio Rivers. The Forest includes approximately 19,000 acres of floodplain for the Mississippi River including those along the Big Muddy levee. However, protective levee systems in place since the 1950's prevent the Mississippi River from contacting and interacting with most of this floodplain. Thus use of the vast majority of the floodplain on the Forest by Mississippi River fishes such as the pallid sturgeon has not occurred since the levees were constructed. There are about 500 acres of Forest-owned, Mississippi River floodplain on the unprotected side of the levee in Union County; however, none of the planned actions would occur in these areas.

Factors affecting pallid sturgeon habitats adjacent to the Forest planning area

Currently there is no habitat for the species within the boundaries of the Forest. The only mid-river habitats on the Forest are sections of the Big Muddy River, a small to medium-sized river in southwestern Jackson County, and the species has not been identified to date from that river.

The entire Forest is within the watershed of direct tributaries to both the Mississippi and Ohio Rivers and the Forest includes over 25,000 acres in the floodplains of both rivers in OB, EH, MO, CR, NA management areas. Land management on the Forest including soil disturbing activities and actions affecting water quality in tributary streams could indirectly affect habitat for the pallid sturgeon in the adjacent Mississippi River. Some activities that have the potential to affect water quality in tributary streams on the Forest include: wetland and riparian habitat protection; timber harvest and management; prescribed burning; road and trail construction, management and closure; aquatic habitat management; minerals management; and non-native invasive species management. Prescribed burning and invasive species management are planned as part of this project. None of the planned actions would affect the Forest on the unprotected areas of the Mississippi River floodplain.

SITE-SPECIFIC EFFECTS ON AQUATIC SPECIES CONSIDERED IN DETAIL

It was determined that there may be potentially suitable habitat for all seven species in the Big Muddy River and/or some perennial streams on the Forest that are direct tributaries to the Mississippi and/or Ohio rivers. All species are known adjacent to the Forest in either the Mississippi and/or the Ohio rivers and known habitats and populations could be indirectly affected by actions, upstream in the watersheds of these rivers that are part of the Invasive Species Management Project. The following is the analysis of these effects for the proposed actions.

Table 6. Suitable Habitats for Aquatic T&E and Candidate Species adjacent to Project Areas.

Aquatic Species	Illinois County of Documented Occurrence	Potentially Suitable River/Stream Habitat	Location	Documented Occurrences on SNF?
Fat pocketbook	Gallatin, Hardin, Massac, Pope	Ohio River and lower reaches of the large tributaries.	Slow flowing water in mud or sand	NO
Pink Mucket	Massac	Ohio River and lower reaches of of Alcorn Creek.	In gravel or sand.	NO
Orange-throated pearlymussel	Massac	Ohio River and lower reaches of of Alcorn Creek.	In gravel or mixed sand and gravel	NO
Spectaclecase	Massac	Ohio River and lower reaches of Alcorn Creek	Swift flowing water among boulders in patches of sand, cobble, or gravel where current is reduced	NO
Sheepnose	Gallatin, Massac	Ohio River and lower reaches of Alcorn Creek	In gravel or mixed sand and gravel	NO
Pallid sturgeon	Alexander, Jackson, and Union	Portions of the Big Muddy River and unprotected Mississippi River floodplain in Union County	Open channels of large turbid rivers in areas with current and firm bottom substrates	NO
Least tern	Alexander, Jackson, Massac, Pope, and Union	Ohio and Mississippi Rivers and their floodplains	Sand islands or fallow agricultural fields in the River or its floodplain	NO

POTENTIALLY SUITABLE HABITAT IN THE PROJECT AREA

Table 6 displays federal and candidate species requiring permanent water, the county in which those species have been documented, and the rivers or perennial streams flowing through those respective districts that provide potential habitat and could be affected by this project.

EFFECTS ON AQUATIC T&E and CANDIDATE SPECIES

ALTERNATIVE 1 – NO ACTION

Direct and Indirect Effects

No action should result in no direct effects on aquatic T&E and Candidate birds, mussels, or fish as none are known to occur on the Forest and/or no actions are planned near perennial streams that could directly affect the species. No indirect effects on potential or known habitats are predicted as no measurable sedimentation or herbicide residue would occur in potential or known habitats for these species as a result of this alternative. There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable effect in the watersheds were they occur and subsequently on T&E birds, mussels or fish because of the small areas treated, the short duration of the treatments and the application of design criteria will quickly stabilize soil to prevent off-site movement. Spot-torching near streams would not have any effects on sedimentation of adjacent streams as few plants would killed in any one area and slowly, decomposing roots of fire-killed plants would hold the soil in place until live roots from new, native plants colonized the area following invasive plant death and decomposition.

ALTERNATIVE 2 – PROPOSED ACTION

Direct and Indirect Effects

1. Prescribed burning- Prescribed burning would be used on a broader scale to treat barren and oak forest areas and in other areas as needed to control the spread of IP. The size of the individual burning units would range from 40-3400 acres with about 12,000 acres in total that would be treated within and adjacent to Natural Areas. Burns would take advantage of existing man-made and natural firelines, such as rivers and streams, rock bluffs, and roads to reduce the need to construct new fireline and reduce soil impacts. Standards and guidelines in the Forest Plan and specific ones developed for planned actions (identified in Design Criteria for All Action Alternatives (Table 4 above) would protect aquatic environments during prescribed burning operations.

No heavy equipment will be used in the aquatic environment. However, small areas adjacent to potential stream habitats could be treated using bulldozers to create small fire lines in accordance with bare soil limitation standards in the Forest Plan (USDA Forest Service 2006b, page 41). Overall, dozer lines would not be extensively used adjacent to rivers and streams in accordance with Forest Plan standards and guidelines for bare soil exposure limits (Forest Plan 2006, page 41). Constructed fire lines will utilize water bars and soil stabilization practices in accordance with Design Criteria. All of the above will limit the amounts of exposed soil that would be potentially available for movement into aquatic environments in project areas and thus minimize the siltation in the water that may interfere with mussel filtration or fish feeding or spawning. Soil movement is also expected to be minimal related to fire line construction due to the small and scattered areas affected, the limited time of treatment, and the application of design criteria which will reduce potential effects to aquatic species.

The proposed alternatives and actions could have some, possible, indirect effects on potential habitats for aquatic species with the most indirect effects in the Barren Creek, Running Lake Ditch, and Bay Creek watersheds where prescribed burning could affect areas greater than 1000 acres at any one time. However even in these watersheds, burning treatments of ecological communities and IP locations within and adjacent to NA's including some areas adjacent to aquatic environments are not likely to have measurable, indirect effects on aquatic species with the implementation of standards and guidelines in the Forest Plan and specific design criteria developed for this project (Table 4 Above). In addition, because the riparian corridor adjacent to aquatic environments remains moist throughout the majority of the year, it is unlikely available fuel (in the form of vegetation) will carry extensively in these corridors to the water's edge and as such there should be a barrier for sediment movement to the rivers in place during and after burns. Prescribed burns are also carefully planned to ensure that a layer of organic matter remains after the burn is

completed and that there are some unburned areas within burned units. In burned areas there is a duff layer of 1-2 inch thickness remaining over all or most of prescribed burn units across the Forest. All of the above would provide layers of filtering, minimizing the chances of soil movement into aquatic environments.

In summary, burning as planned in Alternative 2 would have minor negative effects if any on water quality and sedimentation and thus overall within known and potentially suitable habitats of aquatic T&E, the indirect effects on T&E and candidate aquatic species would be minimal and immeasurable.

2. Tree and shrub cutting and treatment

This will involve the use of chainsaws to cut and girdle trees and shrubs in Natural Areas with little if any associated soil disturbance as no heavy equipment would be involved in these actions. Some stumps would be sprayed on cut stumps or trees and shrubs would be treated with a basal bark treatment both of which would involve hand application of herbicides. Glyphosate and triclopyr would be used to treat some stumps and/or girdled trees and shrubs. Since treatments would involve hand applications versus spraying, there would be no or very little chance of off-site movement of herbicides into known or potential suitable aquatic habitats for aquatic T&E and candidate species. Also only chemical formulas of both herbicides that are approved for aquatic use would be used in any project locations within 100 feet of aquatic areas. There would also be no soil disturbance associated with this planned action. Therefore there would be no indirect effects on populations of aquatic T&E species within or adjacent to the project areas.

3. Herbicide Treatment

Appendix A at the end of this document shows all chemicals proposed for use and compares their characteristics. Five herbicides may be used. Potential effects to aquatic wildlife species include direct exposure as herbicides are applied to terrestrial areas adjacent to aquatic settings and move on top of or through the soil into adjacent, occupied aquatic habitats. In addition, indirect effects could occur if the food chain (primarily aquatic invertebrates) is affected. Chemical control will not affect soil erosion because it would kill but would not physically remove plants or their root systems. The dead plants will continue to stabilize the soil until new plants re-establish naturally.

The proposed herbicides pose different levels of toxicity concerns to aquatic invertebrates. Prior to registration by the EPA, environmental risks must be evaluated on a variety of plant and animal species. Fish and/or *Daphnia* are used to assess effects to aquatic organisms.

The ecological risk assessment described in Appendix B suggests that proper use of herbicides, especially at average rather than maximum rates, would pose little risk to aquatic receptors in nearby waterways, although the assessments focused primarily on fish and zooplankton rather than mussels. Only those formulations of glyphosate and other herbicides labeled for use in aquatic settings would be used adjacent to aquatic habitats. Should herbicides enter surface water, their concentration would quickly decline because of mixing and dilution, volatilization, and degradation by sunlight and microorganisms (Van Es 1990). Most of the herbicides proposed for use under Alternative 2 are of low toxicity to birds, fish and aquatic invertebrate species and have been demonstrated to pose little toxicological risk to fish and wildlife when used at lower application rates typical for the Forest Service (Appendices C and E). However, some formulations of triclopyr (ester form), some surfactants used with glyphosate (terrestrial form), and picloram are toxic or mildly toxic to fish and aquatic invertebrates. Implementation of design criteria will prevent the ester formulation of triclopyr, surfactants used with the terrestrial form of glyphosate, and all formulations of picloram from being applied in or near aquatic settings. Mixing of labeled chemicals will occur at least 100 feet from aquatic habitats.

The data summarized in Appendix C and the ecological risk assessments summarized in Appendix B generally suggest that these herbicides are not highly toxic to fish. In addition, chemicals proposed for application near aquatic systems are of low toxicity to aquatic invertebrates, so it is unlikely that there would be decreases in invertebrates. Due to the limited extent of proposed treatment areas, the relatively small amounts of herbicide used in any one location, and the ability for these aquatic-labeled herbicides to dilute in fast moving aquatic systems and degrade by sunlight and microorganisms; it is likely that the amount of

herbicide that could affect any aquatic environments in the project areas would be far below any of the levels of concern shown for fish and aquatic invertebrates.

Care would also be taken during applications adjacent to waterways to ensure that these herbicides and surfactants do not enter aquatic resources. Label direction would be followed to prevent or minimize any groundwater and surface water contamination from mobile chemicals. Herbicide treatment in riparian areas would follow label direction, specified design criteria, and Forest Plan direction to protect aquatic resources. When herbicides are used according to label specifications, no substantial long-term impacts to water quality, aquatic habitat, or aquatic species are expected.

Overall, while any adverse effects from Alternative 2 would be relatively small and temporary, beneficial effects from eliminating IP from terrestrial habitats would be more wide spread and long term in plant and animal communities on the Forest.

ALTERNATIVE 3 – NO CHEMICALS

1. Cultural methods – There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable, direct or indirect effect on T&E or candidate mussel species or the pallid sturgeon because none are known from the project area; the small areas treated; and the short duration of treatment. Application of design criteria will also quickly stabilize soil to prevent off-site movement.

2. Tree and shrub cutting and mechanical treatments –Effects of tree and shrub cutting would be similar to those described in Alternative 2 above except that no herbicides would be used on cut stumps or girdled trees and shrubs. Effects on aquatic T&E and candidate species would be comparable to those described in Alternative 2 above except for possible runoff from soil disturbance due to heavy equipment use. A bulldozer may be used in this alternative for removal of populations of large invasive shrubs and vines from several sites. Bush-hogging may be used more extensively where possible in this alternative as a treatment and preventative action to control some invasive plants. The majority of these planned actions would have no direct or indirect effect on these T&E and Candidate species.

3. Natural Weed Killers- Hot, soapy, sugar water would be used to spot treat some IP locations near easily accessible roads and trails. No effects on aquatic T&E or Candidate species are anticipated from this technique as the small amounts of runoff solution would be quickly absorbed by the surrounding soils. Vinegar and clove oil may be used on other sites. The effectiveness of these natural weed killers is questionable and repeated applications would likely be necessary possibly changing the pH of the treated soils. However, no measurable effect to aquatic T&E or Candidate species is anticipated.

4. Prescribed Fire- Prescribed burning effects to aquatic T&E and Candidate Species would be similar to what is described above in Alternative 2 for these species since overall burning would be similar.

Although the activities proposed in Alternative 3 may result in the reduction or eradication of some IP, it is not likely to treat those areas as effectively as Alternative 2 because some IP cannot be eradicated or controlled without the use of chemicals.

Cumulative Effects – Aquatic Species - Endangered Species Act (ESA)

This discussion of ESA cumulative effects is specific to aquatic T&E and candidate species.

The geographic cumulative effects boundary for aquatic species is their immediate habitat (perennial rivers and streams) along with the lands which comprise those watersheds (HUC 5 level). The geographic boundary for the six aquatic T&E and Candidate species are as follows: Ohio River and the lower reaches of the Alcorn Creek for orange-footed pearly mussel, pink mucket, sheepnose, and spectaclecase; Ohio River and the lower reaches of Alcorn, Dog, Barren, Bay, Lusk, and Grand Pierre Creek for the fat pocketbook; and the Mississippi and Big Muddy River for the pallid sturgeon and the associated watersheds (HUC 5 level) for each. This boundary was determined because these purely aquatic species are limited to these habitats, dispersal of the species being analyzed is limited, and impacts to intermittent waterways could affect

perennial habitat. The temporal boundary is 10 years, which is the life of the 2006 Forest Plan and the timeframe that allows for initial and subsequent treatments of IP infestations. This was determined because known locations should all be able to be treated within that timeframe, and any measurable impacts would be apparent.

Table 7. Past (last ten years), present and reasonably foreseeable future actions, with potential for cumulative effects, within the Forest watersheds (includes Forest Service and private lands).

Action	Scope of Action
Agriculture (cultivated - row-cropping)	About 526,500 acres (past, present and future).
Agriculture (pastureland)	About 59,200 acres (past, present and future).
Prescribed burning *	About 3,000 acres per year (past). About 10,000 acres (present and future).
Wildfires	About 85 acres per year (past). About 1,000 acres per year (future).
Timber harvest/firewood cutting	About 1,000 acres per year (past, present and future).
Timber stand improvement	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 forest products (mushrooms, berries, and others). About 600 for bicycling.
ATV use	Variable use in watersheds (past, present and future).
Road (including right of way) maintenance	About 300 miles per year (past, present and future). About 1000 acres per year (past, present and future).
Tree planting	About 500 acres per year (past, present and future).
Utility right of way maintenance	About 250 miles per year maintained with herbicide (past, present and future).
Trail construction, reconstruction and maintenance	About 75 miles maintained per year (past, present and future). About 10 miles per year constructed or reconstructed.
Non-system trails	Estimate less than 100 miles of trail (past, present and future).
Special-use permits (telephone, electric, water and driveways).	Estimate less than 20 acres per year (past, present and future).
Invasive species control (private land)	About 200 acres treatment per year (past and present). About 400 acres herbicide treatment (future).
Openlands management	Disking and planting about 200 acres (past). Disking and planting about 100 acres (future).
Residential development	About 2,000 houses per decade (past and future).

* The Forest is planning on burning about 8,000-12,000 acres per year in the future. The prescribe burns in the proposed project (about 12,000 acres) would be included in these acres.
** Based on the 2008 National Visitor Use Monitoring Survey.

ESA cumulative effects are defined as "those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation" [50 CFR, section 402.02]. Future federal actions are not included since they are subject to Section 7 consultation. Past and current federal actions are included as part of the baseline for analysis of potential ESA impacts. There is some state and large areas of privately-owned land within the action area. Reasonably foreseeable future activities on private and state land that could occur in the future within the action area and result in impacts similar to those described for NNIS treatment on the Forest include harvesting timber (soil disturbance) within the watersheds of rivers and streams that provide potentially suitable habitat for aquatic species, construction of dams, channelization, creation of new housing subdivisions and other structures (soil disturbance, erosion, water quality impacts, and habitat loss), application of a variety of pesticides that may or may not be used as labeled associated with agricultural activities and human developments, human disturbance, prescribed burning, and road construction. Table 7 summarizes the actions that have and will continue to occur in the future on other ownerships throughout the Forest proclamation boundary.

Although long-term impacts of uncontrolled IP infestations on aquatic federal/candidate species are not clearly understood, ESA cumulative effects are not anticipated as a result of Alternatives 1. Although negative effects have been documented in various situations with regard to rare species and IP infestations in other areas of the United States, it is highly unlikely negative cumulative effects would occur to aquatic federal/candidate species as a result of Alternative 1 for several reasons. The presence or abundance of IP in suitable habitats has not been identified as a factor responsible for the decline of any of the federal/ candidate species in question. In addition, IP infestations near documented rare aquatic species are small and no obvious negative impacts have been seen that are affecting localized populations of any of the aquatic federal/candidate species in question.

Past, present, and future actions including agriculture, prescribed fire, ATV use, road and trail maintenance, utility right-of-way maintenance, and invasive species control results in lower water quality, erosion and sedimentation. The proposed actions of alternatives 2 and 3 may cumulatively contribute to these environmental impacts. However, these effects would be minor and would not add measurably to the existing effects on aquatic habitats and associated species. Although short-term direct or indirect effects may occur to these species in the form of sedimentation or human disturbance (see aquatic species' analyses), there would be minor to no incremental effect when combined with impacts of other past, present, and reasonably foreseeable future activities. This is because areas proposed for treatment and prescribed fire on National Forest System lands are relatively small and the application of design criteria will protect potentially suitable habitat for aquatic species by reducing the potential for impacts to occur. This is particularly true where herbicide application will occur within or near a riparian area or watercourse protection zone.

Cumulative Effects – NEPA

This discussion of NEPA cumulative effects is specific to TE and candidate aquatic species.

Cumulative effects as described by the National Environmental Policy Act (NEPA) are "the impact on the environment which results from the incremental impact of the actions when added to other past, present, and reasonably foreseeable future action regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" [40 CFR 1508]. Table 7 and the discussion above regarding the condition of private lands and current/past activities also applies to NEPA cumulative effects. The difference between this and ESA cumulative effects is that future federal actions are included as part of the NEPA cumulative effects analysis.

A number of future projects are planned across the Forest, which may have impacts to aquatic habitat and/or species. Some of the present and reasonably foreseeable future activities on National Forest System land include timber harvest operations, reforestation, firewood gathering, site preparation, prescribed

burning, pond construction and maintenance, transportation management, road closures, old growth designation, and herbicide application conducted by qualified pesticide applicators. Forest Plan standards and guidelines would be applied to these activities, reducing the potential for adverse impacts on aquatic habitats.

Cumulative effects from the implementation of Alternative 1 are difficult to assess because IP infestations are dynamic, exotic species are spread by humans and wildlife and continue to be documented, and all outbreaks have not been discovered in their entirety. Limited research exists regarding impacts of IP on wildlife. While some research shows species benefits from IP, other research shows negative impacts (USGS website, 2007). Because native wildlife species evolved with native plants, it makes sense to keep native habitats intact. It is unknown how quickly or how far existing or new invasive plants will take hold and spread in the ten year cumulative effects timeframe if left untreated, but it is unlikely cumulative impacts will occur to the aquatic species.

Past, present, and future actions including agriculture, prescribed fire, ATV use, road and trail maintenance, utility right-of-way maintenance, and invasive species control results in lower water quality, erosion and sedimentation. The proposed actions of alternatives 2 and 3 may cumulatively contribute to these environmental impacts. However, these effects would be minor and would not add measurably to the existing effects on aquatic habitats and associated species. Although short-term direct or indirect effects may occur to these species in the form of sedimentation or human disturbance (see aquatic species' analyses), there would be minor to no incremental effect when combined with impacts of other past, present, and reasonably foreseeable future activities identified in Alternatives 2 and 3 for the following reasons:

- Standards and guidelines in the Forest Plan were created to protect aquatic habitats and will be applied with all treatments.
- Implementation of design criteria will further protect aquatic habitats by minimizing the potential for impacts to occur as a result of specific actions proposed in this project.
- Only aquatic labeled herbicide will be used in aquatic systems, and all chemicals will be mixed at least 100 feet from aquatic habitats.
- Chemicals applied to aquatic systems would degrade quickly in soil or water by natural processes.

Consequently, actions proposed in Alternatives 1-3 are not expected to contribute substantially to any measurable increase in cumulative degradation of water quality, aquatic habitat, host species, or aquatic prey.

DETERMINATION OF EFFECT

The implementation of the no action, existing condition would have no effect on least tern, fat pocketbook, pink mucket, orange-footed pearlymussel, sheepnose, spectaclecase, and pallid sturgeon since none of the species are known from existing treatment areas and treatments would have little direct or indirect effects on aquatic habitats for these species. The implementation of Alternatives 2-3 may affect but is not likely to adversely affect least tern, fat pocketbook, pink mucket, orange-footed pearlymussel, sheepnose, spectaclecase, and pallid sturgeon. This determination was made primarily because it may be possible for direct or indirect adverse effects to occur to individuals. However, for reasons given below, these effects meet the definition of insignificant and discountable.

Several design criteria related to water quality will be implemented to protect these species from potential adverse impacts of treatments proposed in Alternatives 2 and 3. In particular, only formulations approved for aquatic-use would be applied adjacent to wetlands, lakes, and streams, following label direction. Mixing of these chemicals will be done at least 100 feet away from these areas to prevent spills and concentrated chemicals from entering water occupied by rare species. Exposed soils will be promptly revegetated to avoid re-colonization by IP and to stabilize the soil. Fueling or oiling of mechanical equipment and mechanically

constructed firelines for prescribed burning would occur at least 100 feet from aquatic habitats, caves, and mine openings. In addition, effects from herbicide application within the watersheds could occur, but these effects are considered insignificant and discountable given the implementation of Forest Plan standards and guidelines and design criteria, the scattered location of treatments within a watershed, and the relatively small individual sites being treated.

Beneficial effects from the elimination or reduction of IP (as proposed in Alternatives 2 and 3) from adjacent terrestrial habitats would be long term. Protecting aquatic habitats and allowing native vegetation to thrive will also benefit various host species that the five mussels rely upon.

II. RIPARIAN/POND/CAVE HABITATS – TERRESTRIAL SPECIES

Gray Bat (*Myotis grisescens*) uses caves year-round. Different caves are used during summer and winter, while other caves are used as transient caves during migration between summer and winter caves. No caves or mines that occur on the forest are known to be used by gray bats to any significant extent as either summer or winter roost sites, even though it is recognized that gray bats frequent areas of the Forest in close proximity to larger creeks and rivers (i.e. Grand Pierre Creek and the Saline River) as travel corridors and for foraging. Only one cave has been identified as a summer cave for the species within the Forest proclamation boundary, Cave Springs Cave East.

In 2011, the Forest acquired ownership of Ellis Cave. This cave has been known to be used on occasion by single to a few gray (<15) bats in the winter, spring, and summer, but with no sustained consistency (USDA RONI 2012). It is believed that this cave serves as a transitional cave for a few gray bats. One nearby stream location, Grand Pierre Creek in Pope County, has been identified (based upon captures of adult, male gray bats) as a foraging area for the species on the forest in summer. Specific temperature and humidity are preferred for summer young rearing and winter hibernation. Males and females hibernate together but spend most of the summer in separate caves.

When not in caves, this species is either in migration or can be found foraging for aquatic insects along major riparian systems. Adult gray bats feed almost exclusively over water, and have been documented foraging up to 45 miles from their cave along river and reservoir edges, eating primarily aquatic insects (US Fish and Wildlife Service 1982). Gray bats forage within and directly adjacent to riparian corridors, but recent survey efforts on the nearby Mark Twain National Forest found this species using upland man-made ponds (Personal communication with Rod McClanahan 2008).

With few documented occurrences for the species statewide in Illinois except for Cave Springs Cave East, its population appears to be decreasing in Illinois and on the Forest but steady or increasing across its range. The major reason for the decline in southern Illinois within the Forest boundaries is the mining activities at the largest, known summer cave on private land. The gray bat is currently undergoing analysis for its reclassification (either for downlisting to threatened, or for delisting it completely). USFWS lists the species from Alexander, Jackson, Johnson, Pope, and Hardin Counties in Illinois. However, the species has only been found within or directly adjacent to the Forest in Pope and Hardin Counties to date. Threats include any disturbance to riparian areas that would increase sediment loads and negatively affect aquatic prey diversity and abundance, disturbance to occupied caves, pesticides and their effect on prey densities and their residual concentrations in prey, impoundments of waterways (flooding of occupied caves), and deforestation.

Indiana Bat (*Myotis sodalis*) requires caves for winter. Males and females usually roost separately, and generally males stay near winter hibernacula for the summer. Summer roosting and foraging habitat includes open canopy forest containing dead or dying trees with loose bark. Many roost trees have been documented on the Forest thus far primarily in bottomland hardwood forests. Most are dead, and all have been hardwoods (Carter 2003, Feldhamer et al. 2006, McClanahan and Deaton 2007 and Carter et. al. 2008). Females form maternity colonies in larger diameter trees, where up to 100 females will each give birth to one pup.

This species feeds on aquatic and terrestrial insects and has been documented foraging over open upland and bottomland forests, old fields, along borders of cropland, along wooded fencerows, and over farm ponds in pastures. Open woodland (50-70% canopy closure) with relatively open understories is preferred foraging habitat. Dense forest canopy that is "cluttered" (greater than 70%) may make it difficult for bats to capture their insect prey. Foraging occurs along riparian corridors, within bottomland and upland forest canopy, and over ponds. Threats to this species includes human disturbance of occupied caves, loss and degradation of summer habitat and roost sites due to impoundment, stream channelization, housing development, and clearcutting for agricultural use (Herkert 1992 *In* NatureServe, 2007).

There are many documented occurrences across the state of Illinois including within Illinois counties that include the project areas. USFWS has identified the species as occurring in all counties that include the Forest. On the Forest, we have documented occurrences of the species in Alexander, Jackson, Hardin, Pope, Saline, and Union counties.

Included in this category are Indiana bat and gray bat. Both bat species depend on caves throughout their life cycles. In addition, Indiana and gray bats use riparian and pond habitats for drinking, foraging, and travel corridors.

Activities that impact caves, foraging and drinking areas (ponds and riparian areas), migration habitat in the form of dead/dying trees, and roost trees will be analyzed in this section.

More can be learned about these two species on the Forest in the Biological Assessment for the Forest Plan (USDA Forest Service 2005) and the Biological Opinion for the Forest Plan (USFWS 2005). No Indiana bat caves or mines have been documented near IP sites included in this analysis, and neither have IP been documented inside caves or mines located on the Forest.

POTENTIALLY SUITABLE HABITAT IN THE PROJECT AREA

There are no documented caves on the Forest that are known to harbor gray bats during part or all of the year. There are three caves and ten silica mines on the Forest that are known hibernacula for Indiana bats. One is a Priority 1, one is Priority 2, three are Priority 3, and eight are Priority 4 hibernacula. All have had fluctuating populations.

Foraging and roosting habitat for known maternity colonies of Indiana bats is bottomland and floodplain forests in the Mississippi River floodplain (Carter 2003, Feldhamer et al. 2006, McClanahan and Deaton 2007 and Carter et. al. 2008). All major waterways, their tributaries, and their floodplains located on the Forest could provide foraging habitat for the gray and Indiana bat. These include six wild and scenic river candidates (USDA Forest Service 2006b, p. 162), and Mississippi and Ohio Rivers. Roosting and migration habitat occurs along these waterways and in upland forest, especially hardwood forest within five miles of hibernacula.

Much of the Forest is heavily forested, upland hardwood forests with basal areas exceeding 80 square feet, which would not be suitable foraging habitat for the Indiana bat. Areas likely or known to provide foraging habitat for Indiana bat include upland forests with thinner canopies, such as those areas recently affected by tornados, other windstorms, and floods with at least 30 square feet of residual basal area, as well as riparian areas, bottomland hardwood forests, wetlands, ponds and canopy gaps. To date, gray bats have not been documented using artificial ponds across the forest but have been documented using riparian forest areas along Grand Pierre Creek and using two caves within the Forest boundaries.

The tree species targeted for removal in Alternative 2 include princess tree, tree of heaven, short-leaf and loblolly pines, and autumn olive. Indiana bats have been identified using dead, pine trees in some studies across the East and Midwest. To date in Illinois and on the Forest, a variety of native hardwoods have been identified as roost trees for Indiana bats; but no pines have been identified as roost trees to date (Carter 2003, Feldhamer et al. 2006, McClanahan and Deaton 2007 and Carter et. al. 2008). No Indiana bat use of princess tree, tree of heaven or autumn olive has been documented to date. These latter tree species are not considered roost trees for Indiana bats. Both male and female Indiana bats could roost in dead pine trees.

No dead trees would be removed as part of planned actions in any of the alternatives in accordance with Forest Plan standards and guidelines (USDA Forest Service 2006b, p. 288).

EFFECTS ON INDIANA BATS AND GRAY BATS

ALTERNATIVE 1 – NO ACTION

Direct and Indirect Effects

There is very little documentation of effects of IP on bats. No direct effects are predicted on either species from this alternative.

No action, pulling and torching of about 100 to 150 acres of invasive species each year would continue. Inventory and mapping of invasive species infestations would also continue. These limited actions should result in no direct effects on T&E bats as none of these actions are planned near known habitats for these species and or actions are so limited that any impacts to unknown bat resources would have no measurable impacts on T&E bats.

No indirect effects on potential or known habitats are predicted as no measurable sedimentation or herbicide residue would occur in potential or known habitats for these species as a result of this alternative. There may be a small amount of soil disturbance adjacent to aquatic environments as weeds are pulled or dug out of the ground, but these actions are unlikely to have any measurable effect in the watersheds were they occur and subsequently on T&E bats or their prey. Spot torching near streams would not have any effects on sedimentation of adjacent streams as few plants would killed in any one area and slowly, decomposing roots of fire-killed plants would hold the soil in place until live roots from new, native plants colonized the area following invasive plant death and decomposition.

One potential indirect effect Alternative 1 may have on both the Indiana and gray bat is the potential loss of or change in distribution or abundance of prey species within areas of suitable habitat as most IP on the Forest are left untreated. Primarily, these species may be indirectly affected if numbers, distribution, and/or abundance of aquatic or terrestrial prey species changes due to IP infestations. It has been documented in California that, as plant community organization is modified by exotic species, delicate relationships between plants and animals are altered or eliminated (Lovich, 1997). If exotic species monocultures are allowed to form and persist, floral diversity will decrease, along with prey species diversity.

Because most insects evolved with a variety of native plants, it is unknown to what degree these prey insects will be affected with the growing IP infestations and changes in flora across the Forest. Because current documented IP infestations are relatively small in size, impacts are thought to be minimal. There may be localized impacts on aquatic and terrestrial insects. Until impacts are researched further, it is unknown to what degree these changes will have on the gray or Indiana bat population over the long term or if these species will simply adapt to foraging on different prey species based on changes in the floral makeup of the landscape. The diet of Indiana bats varies through time and across the geographic range of the species (Sparks et al. 2005). Murray and Kurta (2002) determined the Indiana bat has a flexible diet and is probably influenced by available foraging habitat and prey, and possibly by local, interspecific competition. Therefore, it is likely that at least for small areas, Indiana bats would be able to adjust feeding with little impact to survivability and reproduction. Since aquatic IP infestations on Forest are also small, scattered, and localized, it is unlikely that aquatic insect distribution, composition, or amounts would change so much that would affect gray bat reproduction or survival for the foreseeable future.

In addition, the Indiana bat could be indirectly affected due to changes in roost tree suitability caused by IP, including the proliferation of those invasive plants with vine-like qualities that could inhibit the use of roost trees by the bat. Access to roost sites and the amount of sunlight reaching roosts may be impacted negatively by the presence of living or dead vines on the trunk of a suitable roost tree (Kurta 2005). Invasive plants with these habits include but are not limited to kudzu, Japanese honeysuckle, Chinese yam, and wintercreeper. These plants are known to climb mature trees, although most don't reach the canopy of mature trees. Kudzu is one example of an invasive plant known to smother entire groups of mature trees. If

these invasive vine species continue to grow without any treatment, indirect effects may occur to the Indiana bat, although it will likely take several years to have a noticeable impact. Another indirect effect to both Indiana and gray bats would be if IP such as kudzu were present at a cave entrance and grew massive enough to alter air flow in and out of the cave, changing the suitability of the cave for bats. Vegetation at a cave entrance may also provide cover for predators such as snakes that could catch bats as they enter/exit a cave entrance. This scenario is highly unlikely to occur in the foreseeable future, as none of the known bat caves on Forest have any evidence of IP at their entrances as yet.

ALTERNATIVE 2 – PROPOSED ACTION

Direct and Indirect Effects

1. Prescribed burning – Prescribed burning could be used on a broader scale to treat IP within and outside of Natural Areas. The largest planned burning site in this alternative would be about 3,000 acres in LaRue-Pine Hills Ecological Area. Most of the planned burns of NA's or IP sites outside of NA's would be much smaller than this. A total of 12,000 acres are planned to be burned during the life of this project, about five years. That is about 4% of the entire Forest that would be affected in the long term (five years). Much less than that would be affected in the short term (annually) during fall, winter, and spring burning seasons. Currently the Forest is burning about 5,000 acres/year or 2% of the Forest for other than NNIS or NA management purposes and no direct, negative impacts to Indiana bats have been identified from those actions to date and overall known Indiana and gray bat populations are stable to increasing across the Forest.

Effects of prescribed burning on the gray bat would be minimal as the species roosts in caves and its prey are flying stages of aquatic invertebrates. The two known caves on private land would not be affected by prescribed burning as planned and there would be few if any sedimentation effects on perennial streams in the project area. See above for effects of prescribed burning on aquatic T&E for more information.

Effects of prescribed burning on Indiana bats can be divided into effects related to three types of actions that are part of the implementation of burns. These are fireline construction, ignition and burn, and mop-up operations.

Where possible, natural features such as, streams and drainage ways, roads and trails, will be used as fire-breaks. However, in some cases firelines will have to be constructed. In general, firelines are constructed by raking 3-foot wide swaths through the Forest. Machinery is used in some situations and usually no big trees are cleared. Small numbers of unknown and occupied roost trees may be cut during all seasons with most during the spring, summer and fall to construct firelines. Direct mortality or injury to Indiana bats could occur if a maternity tree is cut and pups are non-volant. Individual roosting Indiana bats could be killed. Roosting areas could be abandoned. At a minimum roosting activities would be disrupted and bats would have to relocate to another roost tree, requiring additional energy expenditures. If roost trees are cut during winter extra energy would be required in the spring to find new roost trees. Roost quality may decrease leading to an increased gestation period. The range of response for Indiana bats would range from displacement to mortality, leading to decreased reproduction.

The potential impacts associated with fireline construction are greatly lessened by the Forest Plan standards and guidelines developed to protect Indiana bat roosting habitat. First, only roost trees harboring a single or few bats are likely to go undetected, and only a subset of the individuals in these trees could actually be injured or killed. Therefore, it is not anticipated that there would be any negative fitness consequences from traditional roost trees being cut during the inactive season. Also, given the small amount of habitat impacted by fireline construction, we do not expect a substantial portion of the bat's home-range to be affected by fire-line construction. Second, we do not anticipate that an occupied primary or secondary roost tree would go undetected, and hence, cut during the active season. With implementation of Indiana bat standards and guidelines it is also not anticipated that undetected occupied roost trees will be cut due to fireline construction. Forest Plan (USDA Forest Service 2006b, Appendix H) standards and guidelines would require that all potentially suitable roost trees be checked for Indiana bat use prior to removal. Any trees identified as Indiana bat roosting trees would be avoided during fireline construction.

Ignition will generally occur with the use of drip torches. However, in some situations aerial ignitions will be accomplished with the release of a poly (plastic) material ping pong balls that are normally completely consumed by the chemical reaction that causes ignition. Ignition and burns could result in the loss of potential roost trees or unknown occupied roost trees in the spring or fall. Burning could result in direct mortality or injury if unknown, maternity trees are impacted and pups are non-volant. Colonies may abandon the area which would require relocating to another primary roost tree within the home range. Single roosting bats may also be impacted. At a minimum roosting activity would be disrupted requiring additional energy expenditures. Indiana bats could be displaced or actually killed by the proposed action. Prescribed fire conducted during the winter could result in the loss of unknown, primary and/or secondary maternity roost trees. Indiana bats would be required to expend extra energy finding new roost trees in the spring. Roosts may be of decreased quality which could lead to an increased gestation period. This may lead to displacement, lower pup fitness, lower over-winter survival, and ultimately decreased reproduction. However, as explained below, the standards and guidelines specific to prescribed burns will make it unlikely that maternity colonies will have direct or indirect negative fitness consequences. It is anticipated that males and non-reproductive female Indiana bats may flush from roosting trees during prescribed fire. However, these individuals are highly mobile and should suffer only short term effects as a result. Therefore, the standards and guidelines specific to prescribed burns will make it unlikely that males and non-reproductive females will have direct or indirect negative fitness consequences.

The smoke from prescribed fires may or may not cause Indiana bats to flush from the roost, depending on the location on the tree where bats are actually roosting and on whether or not that area becomes super-heated or is exposed to too much smoke. Since prescribed fires generally move through an area fairly quickly (generally less than 24 hours for an entire burn unit), this flushing is not likely to significantly alter the habits of Indiana bats, though it may expose them to a slight predation risk. Indiana bats have been documented switching roosts during the day (Murray et. al. 2002) also suggesting that this flushing may not be a significant risk. Carter et al. (2002) suggests that the ability to arouse quickly in summer, and the ability to carry young in flight, combined with the behavior of using multiple roosts, could offset negative impacts of snag roosts being destroyed by fire. Furthermore, as indicated below, the standards and guidelines make it unlikely for non-volant pups to be directly exposed to smoke.

Prescribed burns would result in temporary decreases in insect abundance. The potential adverse impacts to Indiana bats would depend upon the time of year when the burns occur and the location. Prescribed burns conducted in the spring or summer within the home range of maternity colonies could significantly depress insect production. On the other hand prescribed burns within maternity colony home ranges during the fall are not expected to be as significant as Indiana bats move out of these areas in transit to hibernacula.

However, within the area around hibernacula, burning during the spring would allow the opportunity for vegetative growth and subsequent insect production in the fall. Fall burns within the areas around hibernacula could significantly depress insect populations during the swarming period. This would impair the bats ability to accumulate fat reserves, thus impacting overwinter survival and reproductive success the following year. As explained below, however, the standards and guidelines greatly reduce the potential for burns to occur in maternity colonies during the spring and summer, and hence, their prey availability should not be affected. Also, the standards and guidelines reduce the potential for prey abundance in the spring and fall around known hibernacula to be adversely affected by burns.

Some prescribed fire is anticipated during the winter. However, most fires would be conducted during the late fall or early spring when Indiana bats are in hibernation. Prescribed fire near hibernacula could result in smoke entering and killing bats while in torpor. Prescribed fire conducted near hibernacula in the summer would also impact summer colonies. For reasons discussed below, we do not believe either of these scenarios is likely to occur, however.

The potential adverse effects associated with prescribed fire are greatly ameliorated through implementation of standards and guidelines for Indiana bats. The following is a list of forest-wide and Indiana bat standards and guidelines applicable to prescribed fire and an explanation of benefits for Indiana bats:

1. *Prohibit any significant disturbance such as prescribed burning and smoke generation and tree cutting, except for bat habitat enhancements, within approximately 100 feet of a cave entrance or open abandoned mine entrance when occupied by bats (Appendix H, p 286).*
2. *FW51.2.1.1 (S) Smoke-management planning is used to control the effects of smoke emissions and meet air-quality standards. During prescribed fires, consideration shall be given to smoke-sensitive areas including Indiana or gray bat hibernacula that may lie downwind of the burn.*
3. *FW51.2.1.2 (S) Burns within 0.25 miles of any Indiana or gray bat hibernacula shall be conducted under conditions that will reduce or eliminate smoke dispersing into the hibernacula.*

Implementation of these standards will significantly reduce the possibility of smoke entering hibernacula and impacting hibernating or roosting Indiana bats.

4. *FW51.2.1.3 (S) To reduce the chances of affecting maternity roosts and foraging habitats, no prescribed burns shall be done in upland forest from 5/1-9/1 and in bottomland forests from 4/1-9/1. No burning shall be done in forested areas of Oakwood Bottoms during the spring seasons, 3/1-4/1 annually. Only 30% (approximately 1,900 acres) of the Big Muddy bottomlands (approximately 6,200 acres of National Forest) east of the Big Muddy levee shall be burned (blackened) annually during spring burning seasons.*

Implementation of this standard will significantly reduce the potential impacts associated with prescribed burns within the home range of maternity colonies. By limiting the timing and amount of prescribed burning within the Oakwood Bottoms and Big Muddy bottomlands, insect populations should not be significantly affected in any given year to such a degree that there will be negative fitness consequences for Indiana bats. As prescribed burns will occur in the spring in uplands, roosting Indiana bats could be adversely impacted. However, these burns will occur early in the maternity season prior to the birth of pups, thus female bats should be able to relocate to other roosting habitats, thus direct mortality is not anticipated. Fall burns after 9/1 could also adversely impact roosting Indiana bats. However, by this time pups will be mobile and should be able to relocate to other roosting habitats, thus direct mortality is not anticipated.

5. *FW51.2.1.4 (S) To reduce the chances of adversely affecting Indiana bat, male roosting habitat within 4km (2.5 miles) of surrounding known hibernacula, no more than 20% of the habitat in this zone shall be burned (blackened) annually. Within 4km-8km (2.5 to 5 miles) surrounding known hibernacula, no more than 50% shall be burned (blackened) annually.*

Implementation of this standard should ensure that insect populations are not significantly depressed around hibernacula in any given year due to prescribed burns. Thus, the fitness of individuals using these areas should not be negatively affected (i.e., insect availability is not expected to be decreased such that the foraging efficiency of those individuals will be decreased). Some burns will occur during the spring and summer which may impact roosting habitat for individuals using this area in the summer. However, these bats are mobile and will be able to locate alternate roost trees readily.

Given the small amount of habitat impacted around hibernacula (see analysis in FEIS Appendix F and Appendix B of this biological opinion) and the relatively small number of individuals exposed, the bats are expected to be able to relocate and fitness consequences are not anticipated. In the fall, larger numbers of Indiana bats occupy the habitat within and surrounding hibernacula. During this time bats are accumulating fat reserves and continue to roost in trees to some extent. Habitat around hibernacula is abundant in comparison to the number of bats utilizing these hibernacula (Appendix B). Prescribed fire may also benefit Indiana bats in many ways. High-intensity fire may create additional snags and potential roost trees for Indiana bats. Opening the understory would reduce clutter around these potential roost trees improving microclimate diversity and foraging conditions. In addition, oak regeneration should occur in response to the

fire, leading to long-term potential roosting habitat on the landscape. The benefits would be increased fitness, shortened gestation periods and improved reproductive success. This could ultimately lead to population stability or increase.

Table 8. Effects of Prescribed Burning on Endangered Bats.				
SPECIES	**POTENTIAL IMPACTS**			
	Smoke/ Entering Caves	**Sedimentation** (affecting water quality, aquatic insects, and potentially suitable habitat)	**Roost-Tree Impacts**	**Changes in Vegetative Structure**
Indiana Bat	No effect since Rx burning probably done during growing season when bats are not in caves.	Slightly Possible, but impacts mitigated with implementation of Design Criteria and Forest Plan S&G	Rx burning may eliminate some, but will likely create some snags	Rx burning likely to reduce understory clutter and improve foraging suitability
Gray Bat	Slightly Possible since gray bats use caves year round. May be mitigated with wind direction, mixing height, timing, ignition sequence. Also, no burning is planned near known, summer roosting or winter hibernating caves on the Forest.	Slightly Possible, but impacts mitigated with implementation of Design Criteria and Forest Plan S&G	NA	No effect since gray bats forage primarily over water or in riparian corridor which would probably not burn well due to fuel moisture.

Finally, insect abundance in areas has been identified as increasing for some time following prescribed fire, ranging from months to years, (Jackson 2005). While this effect may depend on location and/or time of year, it could lead to higher quality and quantity of the insect base and increased feeding success for Indiana bats. This would lead to an improved energy budget, increased reproductive success and survival, ultimately resulting in population stability or increase.

Mop-up operations include measures to extinguish burning coals and/or trees to preclude fire escape. Burning trees may be felled for this purpose. No additional impacts beyond those discussed above are anticipated as a result of mop-up operations.

2. Tree and shrub removal and treatment- This will involve the use of chainsaws to cut and girdle trees and shrubs in Natural Areas with little if any associated soil disturbance as no heavy equipment would be involved in these actions. Some stumps would be sprayed on cut stumps or trees and shrubs would be treated with a basal bark treatment both of which would involve hand application of herbicides. Glyphosate and triclopyr would be used to treat some stumps and/or girdled trees and shrubs. Since treatments would involve hand applications versus spraying, there would be no or very little chance of off-site movement of herbicides into known or potential suitable aquatic habitats and thus no indirect effects on insect prey for gray or Indiana bats. Also only chemical formulas of both herbicides that are approved for aquatic use would be used in any project locations within 100 feet of aquatic areas. There would also be no soil disturbance associated with this planned action. Therefore there would be no indirect effects on populations of endangered bat species within or adjacent to the project areas.

Only small, live trees and shrubs would be cut in some, smaller areas within NA's. Large diameter trees and shrubs which could be future roost trees for Indiana bats would be girdled rather than cut down as part of implementation of this action. Thus any girdled trees would be improved as bat roost trees as tree death resulting from girdling would increase the amount of loose bark for roosting.

Forest Plan direction for the removal of dead live trees during bat maternity seasons would be followed (USDA Forest Service 2006b, Appendix H).

3. Herbicide Treatment - Herbicides will be utilized to control invasive plants such as kudzu and garlic mustard. Such herbicides can have localized impacts to insect populations, particularly if they enter waterways. Although insect populations in these areas could be impacted, persistent chemicals that bioaccumulate are not proposed to be utilized on the Forest and thus any negative effects on insect prey of bats and indirectly on the bats who prey on them would be small and short term.

Localized decreases in insect abundance could reduce Indiana bat foraging and feeding success in some areas. In some instances bats may be required to travel further to obtain food. This would disrupt the bats energy budget. Depending on the time of year and environmental conditions, significant imbalances in their energy budgets can lead to decreased reproductive success for adults and decreased health for pups.

Since the amount of chemical used in any one watershed on the Forest is very small (treatments of less than 100 acres are predicted in any one watershed annually), direct and indirect effects on endangered bats is predicted to be minimal.

Indiana and gray bat are nocturnal and typically remain in roosts during the day (trees for Indiana bats and caves for gray bats). Therefore, there is little risk they would be directly contacted by herbicide spray streams applied during the day on the ground or onto ground or mid-level vegetation. Upon leaving day roosts, bats could contact foliage recently sprayed with herbicides. Again, because they are nocturnal, it is highly unlikely the herbicide would still be wet, but it is possible that bats might get some on their fur by contact with treated plants. Mammalian toxicity data in Appendix D suggests that the potential for adverse toxicological impacts to bats from the proposed herbicides is low. Noise or human activity near roosts during application is unlikely to impact Indiana or gray bat. During roost monitoring activities using radio telemetry equipment on the Forest, Indiana bats remained in roosts when threatened by human activities on the ground. During hibernation, both species would remain in caves and would not be affected by the minor amounts and temporary nature of noise created with herbicide application. No direct effects to these species will occur.

Proper application of herbicides following the manufacturer label would ensure little potential for inadvertently killing the crowns of mature, live trees, therefore having no impact on the suitability or unsuitability of areas for foraging. In addition, Indiana bats avoid roost trees choked with vines. Any snags or dying trees with heavy IP in the form of vines (such as kudzu) would not be considered suitable roosts for the Indiana bat. Therefore, no potential roost trees will be affected as a result of chemical application to herbaceous or woody IP. The less dense understory that would result following the killing or removal of dense woody vegetation could slightly improve foraging conditions until vegetation reestablishes.

The most likelihood of impacting the gray or Indiana bat would occur if chemical application affected 1) aquatic or terrestrial prey abundance or diversity or 2) if ingestion of contaminated prey or drinking water occurs. The proposed herbicides pose different levels of toxicity concerns to terrestrial and aquatic invertebrates. Prior to registration by the EPA, environmental risks must be evaluated on a variety of plant and animal species. Honeybees are typically used to indicate possible toxicity concerns for terrestrial invertebrates, while fish and/or *Daphnia* are used to assess effects to aquatic organisms.

All herbicides proposed for use in Alternative 2 have been tested on the honeybee, and testing showed that these herbicides are of low toxicity to the bee (LD_{50} dose of 10 µg/bee to 100 µg/bee) (LD_{50} = dose required to kill 50% of the test subjects). In fact, the U.S. EPA stated that sethoxydim, the herbicide that resulted in mortality to bees at the lowest dose (LD_{50} at 10 µg/bee), was practically non-toxic to honeybees (SERA 2001). Much higher doses of the other herbicides proposed for use in Alternative 2 would be needed to affect the honeybee (i.e., 100 µg/bee or greater doses). The fact that the herbicides are of a low toxicity, combined with small treatment areas, and the low likelihood that an Indiana or gray bat would be in the treatment area foraging at the time of treatment, these potential indirect effects are considered insignificant and would not likely rise to the level of take.

The herbicides proposed for use are considered to pose little risk of toxicity to aquatic organisms, with the exception of the ester form of triclopyr and the surfactants used with the terrestrial form of glyphosate which both can be highly toxic to aquatic organisms (Appendix A). Applying these materials following their label specifications and the design criteria, outlined earlier in this BE, would reduce the risk of potential harm to aquatic life. In addition, application of these two materials in upland areas would likely occur on small portions of the project areas, and any small amounts reaching water sources would likely be diluted (in rivers or streams) and degraded by sunlight or microorganisms in ponds. Following design criteria, no triclopyr (ester formulation) or surfactants used with glyphosate (terrestrial version) will be applied within 100 feet of lakes, ponds, sinkholes, or wetlands. In addition, mixing of chemicals will occur at least 100 feet from these areas to prevent concentrated chemicals from accidentally impacting special habitats. With the implementation of these design criteria, the chemicals proposed for use are not likely to harm aquatic life. For these reasons, this potential indirect effect on the Indiana and gray bat is considered insignificant and would not rise to the level of take.

The Indiana and gray bat could be indirectly exposed to herbicides through ingestion of contaminated insects or contaminated drinking water. The likelihood that individual bats would consume a terrestrial insect that had encountered herbicides is low, especially when one considers the small area that would be treated at any one time. It is assumed that direct contact or a high level of consumption of insect prey from herbicide-treated areas could potentially result in toxicological impacts. Again, mammalian toxicity data in Appendix F suggests that the potential for adverse toxicological impacts to bats from the proposed herbicides is low. Herbicides would be applied directly to targeted plants in a manner that minimizes the potential for drift (which could affect insects) or runoff that could contaminate drinking water sources. Should herbicides enter surface water used by Indiana bats for drinking, herbicide concentrations would quickly decline because of mixing and dilution, volatilization, and degradation by sunlight and microorganisms (Van Es 1990). Research suggests there is low risk of bioaccumulation in the food chain from use of the herbicides proposed for use in Alternative 2 (Appendix A).

Overall, while any adverse effects from Alternative 2 would be relatively small and temporary, any beneficial effects from eliminating IP from aquatic and terrestrial habitats would be long term. Protecting these habitats and allowing native vegetation to thrive will also benefit various prey species the Indiana and gray bat feed upon.

ALTERNATIVE 3 – NO CHEMICALS

The same direct, indirect, and cumulative effects described for cultural activities including prescribed burning and mechanical parts of tree and shrub removal in Alternative 2 above would apply to Alternative 3. Alternative 3 would also include use of hot soapy, sugar water in some selected locations near roads and a vinegar/clove oil mix for other areas. No measurable direct or indirect effects on federal endangered bats are predicted to occur as a result of this alternative similar to those described for similar actions in Alternative 2 above. Although the activities proposed in Alternative 3 may result in the reduction or eradication of some IP, it is not likely to treat those areas as effectively as Alternative 2 because some IP cannot be eradicated or controlled without the use of chemicals.

Cumulative Effects - Endangered Species Act (ESA)

Note: Please refer to the past, present, and reasonably foreseeable future actions described in the ESA cumulative effects section for aquatic TE and candidate species and in Table 7. The same assumptions described in that section are made here, while also considering the great threat of White Nose Syndrome that is affecting bat populations in neighboring states, and potentially on the Forest in the near future (USDA RONI, 2008 & 2011).

The geographic cumulative effects boundary for gray bat is the Forest and perennial/intermittent waterways extending 45 miles outside of that boundary. This was determined because actions are limited to Forest lands and the gray bat is known to forage 45 miles along river corridors and cross upland habitats to use ponds. The Indiana bat geographic area is the Forest plus a five mile boundary around the Proclamation

Boundary. This was determined because this species has been documented foraging and roosting within five miles of roost sites and could occur across the Forest in suitable habitats. The temporal boundary for these species is the ten year planning cycle. This timeframe allows documented IP to be treated and allows time for additional sites to be identified and treated.

The abundance of IP in suitable habitats has not been identified as a factor responsible for the decline of Indiana or gray bat. Although negative effects have been documented in various situations with regard to rare species and IP in other areas of the United States, long term impacts on federal species as a result of IP infestations is not clearly understood. ESA cumulative effects are not anticipated as a result of the implementation of Alternative 1. Although negative effects have been documented in various situations with regard to rare species and IP infestations in other areas of the United States, it is highly unlikely negative cumulative effects would occur to bat species as a result of the no action alternative, due to the relatively small and scattered locations of known infestations at this time. The limiting factor thought to have the most impact on these bat species is cave and mine resources and these would be protected through Forest Plan Standards and Guidelines and/or site-specific design criteria.

The implementation of Alternatives 2 and 3 are not expected to cause an incremental effect when combined with reasonably foreseeable future activities conducted on state or private lands. Areas proposed for treatment are relatively small and scattered across the Forest, encompassing primarily roadsides, oldfield habitats, barrens, and upland and bottomland hardwood forests and design criteria will protect potentially suitable foraging and roosting habitat for gray and Indiana bat.

Cumulative Effects – NEPA

Note: Please refer to the past, present, and reasonably foreseeable future actions described in the NEPA cumulative effects section for aquatic TE and candidate species and in Table 7. The same assumptions described in that section are made here, while also considering the great threat of White Nose Syndrome that is affecting bat populations in neighboring states, and potentially on the Forest in the near future.

Past activities on National Forest lands, which may have affected the gray and Indiana bat include timber harvest and illegal ATV use in riparian habitat (creating erosion/siltation, changing prey species abundance and diversity, and impacting water quality), illegal human disturbance to caves/mines, prescribed burning, and the construction of upland ponds. Present and reasonably foreseeable future actions are the same as those described in the aquatic cumulative effects section.

Cumulative effects from the implementation of Alternative 1 are difficult to assess because IP infestations are dynamic, exotic species are spread by humans and wildlife and continue to be documented, and all outbreaks have not been discovered in their entirety. Limited research exists regarding impacts of IP on wildlife. While some research shows species benefits from IP, other research shows negative impacts. Because native wildlife species evolved with native plants, it makes sense to keep native habitats intact. The lack of IP treatment is not likely to have a measurable cumulative effect on any of these species. Although most IP are very aggressive, thus far no impacts have been identified with regard to gray or Indiana bats. The lack of IP treatment, combined with past, present, and reasonably foreseeable future actions on federal lands is not expected to contribute substantially to any measurable increase in cumulative degradation to these two species or their habitats.

The treatment of terrestrial and aquatic habitats with the implementation of Alternatives 2 or 3 is not expected to cause negative cumulative effects to the gray or Indiana bat. Cumulative impacts to water quality, caves, terrestrial and aquatic prey, and roost trees are not anticipated because the scope of the proposed actions is extremely small and caves, mines, and maternity roosts would be protected by Forest Plan standards and guidelines and/or project design criteria. Although direct or indirect short-term and localized effects may occur to gray or Indiana bat in the form of sedimentation or human disturbance, there will be little to no incremental effect when combined with impacts of other past, present, and reasonably foreseeable future activities identified in Alternatives 1-3. This was determined because the treatment areas are relatively small and scattered, and the application of standards and guidelines in the Forest Plan will

reduce or eliminate impacts to aquatic and other unique habitats. Design criteria will further protect aquatic and terrestrial habitats for specific actions proposed in this project. Chemicals would not be applied to aquatic systems as part of any planned project actions. And, only aquatic labeled herbicide will be used near aquatic systems, and all chemicals will be mixed at least 100 feet from aquatic habitats. Consequently, actions proposed in Alternatives 1-3 are not expected to contribute substantially to any measurable increase in cumulative degradation of water quality, aquatic or terrestrial habitat (roost trees or foraging areas), or terrestrial and aquatic prey diversity or abundance.

DETERMINATION OF EFFECT

Alternative 1 will have no direct, indirect, or cumulative effect on the Indiana bat or gray bat. Alternatives 2 and 3 may affect but are not likely to adversely affect the Indiana or gray bat. These effects are considered beneficial, insignificant, and discountable. This was determined primarily because smoke could enter caves and fire could burn unknown roost trees. Also, if smoke lingered within the forested areas at dusk when Indiana bats are foraging, it could temporarily displace individuals. The treatment of IP may also be beneficial for the gray and Indiana bat because it will help maintain native habitats and those native insects (prey species) that have evolved with native plants. To protect these two species, only formulations approved for aquatic-use would be applied adjacent to wetlands, lakes, and streams, following label direction. Mixing of these chemicals will be done at least 100 feet away from these areas to prevent accidental spills and concentrated chemicals from entering water used by rare species. Only a few of the project locations would be near (within 2.5-5.0 miles) of any known hibernacula or maternity colonies and Forest Plan Standards and Guidelines would provide added protection to these known bat resources from burns near them.

Fueling or oiling of mechanical equipment and mechanically constructed firelines for prescribed burning would occur at least 100 feet from aquatic habitats, caves, and mine openings. Exposed soils will be promptly re-vegetated so as to avoid re-colonization by IP and for soil stabilization. With the implementation of Standards and Guidelines in the Forest Plan, along with design criteria for Alternatives 2 and 3, the potential for "incidental take" is nil as similarly identified in the BO for the Forest Plan (USFWS 2005).

MEAD'S MILKWEED

Mead's milkweed *(Asclepias meadii)* is found on National Forest System land only on the Hidden Springs Ranger District. There are four, wild populations (remnants of a once larger population) of Mead's milkweed on the Forest located in the Eagle Mountains of Saline County, Illinois. All are located in three Research Natural Areas (RNAs), Stoneface, Cave Hill and Dennsion Hollow within a few miles of each other. Management direction for these areas is to maintain the ecological diversity of all four areas including the sandstone barrens communities where the Mead's milkweed populations currently exist.

There is also one experimental population on the Forest in a limestone barrens in Johnson County, Illinois south of Trigg Tower. Botanical surveys, vegetation inventories, and field visits have failed to find any other populations of Mead's milkweed on the Forest. According to the recovery plan for the species, management through prescribed fire should be considered the optimal management tool (USFWS 2003). In addition, woody encroachment is a threat to Mead's milkweed populations. Historically, the species is known to have occurred in Cook, Ford, Fulton, Hancock, Henderson, LaSalle, Menard, Peoria, and Saline counties in Illinois (USFWS 2003). However, according to Bowles et al. (2001) the species likely occurred throughout much of Illinois, but disappeared before being discovered. In 2001, the last remaining population of Mead's milkweed occurring in Ford County, consisting of one individual, was destroyed after a change in land ownership (Bowles et al. 2001 and Elizabeth Shimp, USFS, pers. comm. 2005).

None of the planned actions would affect any of the five known locations for the species on the Forest including the experimental population as none of the planned actions would include these areas.

POTENTIALLY SUITABLE HABITAT IN THE PROJECT AREA

The Biological Opinion and Biological Assessment for the Forest Plan identified Mead's milkweed habitat throughout its range and on the Forest as described above (USFS 2005 and USFWS 2005).

Suitable habitat for this species occurs only on the Hidden Springs Ranger District. The three RNA's that include the four wild populations total approximately 850 acres. Within those RNA's, the existing four, wild populations of the species occupy < 4 ha of barrens habitats (USFWS 2005). The NA that includes the one, experimental population is approximately 400 acres in size. According to the Forest Plan, there are about 2,700 acres of barrens on the Forest and about 1250 acres of those are existing or potential suitable habitat for the species. In 2008-2009, the Forest has identified about 3,500 acres for prescribed burning in areas that include and surround the four wild and one experimental population.

Threats to the species from Forest actions were identified as administrative actions, recreational use, pest management including treatment of IP, prescribed burning, and timber management or lack thereof, and minerals management in the 2006 Forest Plan (USFWS 2005). The primary threats are considered to be lack of prescribed fire and active vegetation management for the species (USFWS 2003 and 2005). The following Forest Plan standards and guidelines were included in the 2006 Forest Plan to protect and improve habitat conditions for the species:

- Forest Plan S&G's (USDA Forest Service 2006b, Appendix H, p. 285). Manage and expand existing habitat through the use of prescribed burning and other management tools. Prescribed burns would take place between the end of October and the end of March to stimulate flowering.
- Expand current populations into restored habitat through the use of propagated plants.
- Remove critical shading trees and shrubs as needed to perpetuate the species.
- Where impacts occur or are expected to occur as a result of recreational use adjacent to known populations, implement corrective actions as needed to avoid or stop the impact.
- Where non-native invasive species are invading occupied habitat, utilize control measures necessary to eradicate these undesirable species. In order to avoid negative impacts to Mead's milkweed, treatments should take place between the end of October and the end of March.

EFFECTS ON MEAD'S MILKWEED

ALTERNATIVES 1 – 3

Direct and Indirect Effects

Although Mead's milkweed is documented at five sites on National Forest lands, there are no IP documented at the sites that are identified for treatments as part of these planned actions. Therefore, implementation of Alternatives 1-3 would have no direct or indirect effect on the Mead's milkweed.

Cumulative Effects

Since there are no direct or indirect effects on Mead's milkweed, there would be no cumulative effects.

DETERMINATION OF EFFECT

There will be no direct, indirect, or cumulative effects to Mead's milkweed as a result of the implementation of Alternatives 1-3. No cumulative effects will occur to this species. If Mead's milkweed populations are found in or directly adjacent to areas proposed for treatment, reinitiation with the U.S. Fish and Wildlife Service will occur.

/s/Chad Deaton August 27, 2012
Chad Deaton Date
Wildlife Biologist

/s/ Elizabeth Longo Shimp August 23, 2012
Elizabeth Longo Shimp Date
Botanist

The above Biological Evaluation of Federal Threatened and Endangered Species prepared for the revised proposed Invasive Species Management Project has been reviewed by the U.S. Fish and Wildlife Service and their concurrence noted.

/s/ Matthew T. Mangan — January 29, 2013

Matthew Mangan — Date
U.S. Fish and Wildlife Service
Marion Field Office
Marion, Illinois

Prepared By: Steve Widowski (retired) and Chad Deaton, Wildlife Biologists and Elizabeth Shimp, Botanist, Shawnee National Forest

Appendix A. Comparison of Herbicide Characteristics

Triclopyr (Tu et al. 2001; SERA 2003b) http://pmep.cce.cornell.edu/profiles/extoxnet/pyrethrins-ziram/triclopyr-ext.html	
Solubility	Offsite movement through surface or sub-surface runoff is a possibility with triclopyr acid, as it is relatively persistent and has only moderate rates of adsorption to soil particles. In water, the salt formulation is soluble, and with adequate sunlight, may degrade in several hours. The ester is not water-soluble and can take significantly longer to degrade. It can bind with the organic fraction of the water column and be transported to the sediments.
Half-life	In soils, degradation occurs primarily through microbial metabolism, but photolysis and hydrolysis can be important as well. The average half-life of triclopyr acid in soils is 30 days.
Toxicity	Both the salt and ester formulations are relatively non-toxic to terrestrial vertebrates and invertebrates. The ester formulation, however, can be extremely toxic to fish and aquatic invertebrates.
Toxicity and Bioaccumulation	Both the salt and ester formulations are relatively non-toxic to terrestrial vertebrates and invertebrates. The ester formulation, however, can be extremely toxic to fish and aquatic invertebrates. The hydrophobic nature of the ester formulation allows it to be readily absorbed through fish tissues where it is converted to triclopyr acid which can be accumulated to a toxic level. Most researchers have concluded that if applied properly, triclopyr would not be found in concentrations adequate to harm aquatic organisms. Tendency for triclopyr to dissipate quickly in the environment, which would preclude any problems with bioaccumulation in the food chain.
Glyphosate (Tu et al. 2001; SERA 2003a) http://pmep.cce.cornell.edu/profiles/extoxnet/dienochlor-glyphosate/glyphosate-ext.html	
Solubility	Glyphosate is strongly adsorbed to soil particles, which prevents it from excessive leaching or from being taken-up from the soil by non-target plants. It is degraded primarily by microbial metabolism, but strong adsorption to soil can inhibit microbial metabolism and slow degradation. Photo- and chemical degradation are not significant in the dissipation of glyphosate from soils.
Half-life	The half-life of glyphosate ranges from several weeks to years, but averages two months. In water, glyphosate is rapidly dissipated through adsorption to suspended and bottom sediments, and has a half-life of 12 days to ten weeks.
Toxicity	Glyphosate by itself is of relatively low toxicity to birds, mammals, and fish, and at least one formulation sold as Rodeo® is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate, however, are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use.
Toxicity and Bioaccumulation	Glyphosate by itself is of relatively low toxicity to birds, mammals, and fish, and at least one formulation sold as Rodeo® is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate, however, are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use. Glyphosate does not bioaccumulate in fish. Residue levels not detectable in herbivores after 55 days; carnivores and omnivores at lower risk of detecting long-term residue levels.
Sethoxydim (Tu et al. 2001; SERA 2001) http://pmep.cce.cornell.edu/profiles/extoxnet/pyrethrins-ziram/sethoxydim-ext.html	
Solubility	Because sethoxydim is water-soluble and does not bind strongly with soils, it can be highly mobile. No reports, however, were found referring to water contamination or off-site movement by sethoxydim.
Half-life	The average half-life of sethoxydim in soils is four to five days, but half-lives can range from a few hours to 25 days. Sethoxydim is readily degraded through microbial metabolism and photolysis, and possibly by hydrolysis. Numerous degradation products have been identified, some of which are also toxic to plants.
Toxicity	Sethoxydim is of relatively low toxicity to birds, mammals, and aquatic animals, and has little noticeable impact on soil microbe populations.
Toxicity and Bioaccumulation	Sethoxydim is of relatively low toxicity to birds, mammals, and aquatic animals, and has little noticeable impact on soil microbe populations. The tendency to dissipate quickly precludes any bioaccumulation in the food chain.

Clopyralid (Tu et al. 2001; SERA 2004a)	
Solubility	Clopyralid is highly water-soluble and will not bind with suspended particles in the water column. The inability of clopyralid to bind with soils and its persistence implies that clopyralid has the potential to be highly mobile and a contamination threat to water resources and non-target plant species; although no extensive offsite movement has been documented.
Half-life	Clopyralid's half-life in the environment averages one to two months and ranges up to one year. It is degraded almost entirely by microbial metabolism in soils and aquatic sediments. Clopyralid is not degraded by sunlight or hydrolysis.
Toxicity	Clopyralid can cause severe eye damage if splashed into the eyes during application,but otherwise is non-toxic to fish, birds, mammals, and other animals.
Toxicity and Bioaccumulation	Clopyralid can cause severe eye damage if splashed into the eyes during application, but otherwise is non-toxic to fish, birds, mammals, and other animals. There is no evidence of bioaccumulation.
Picloram (Tu et al. 2001; SERA 2003a)	
Solubility	Picloram is water-soluble and does not bind strongly with soil particles and is not degraded rapidly in the environment. It considered highly mobile and persistent and a contamination threat to non-target plants. Extensive offsite movement has been documented for it in the groundwater in 11 states.
Half-life	Picloram's half-life in the environment can range from one month up to one year. It is degraded primarily by microbial metabolism in soils but can be degraded in sunlight when directly exposed to water.
Toxicity	Picloram is not highly toxic to birds, mammals, and aquatic species. Some formulations are highly toxic if inhaled and others can cause severe eye damage if splashed into the eyes.
Toxicity and Bioaccumulation	Because of persistence in the environment, chronic exposure to wildlife is a concern. Studies have found weight loss and liver damage in mammals following long term exposure to high concentrations. It is not recommened for use near water.

Given the small amount of habitat impacted around hibernacula (see analysis in FEIS Appendix F and Appendix B of this biological opinion) and the relatively small number of individuals exposed, the bats are expected to be able to relocate and fitness consequences are not anticipated. In the fall, larger numbers of Indiana bats occupy the habitat within and surrounding hibernacula. During this time bats are accumulating fat reserves and continue to roost in trees to some extent. Habitat around hibernacula is abundant in comparison to the number of bats utilizing these hibernacula (Appendix B). Prescribed fire may also benefit Indiana bats in many ways. High intensity fire may create additional snags and potential roost trees for Indiana bats. Opening the understory would reduce clutter around these potential roost trees improving microclimate diversity and foraging conditions. In addition, oak regeneration should occur in response to the fire, leading to long-term potential roosting habitat on the landscape. The benefits would be increased fitness, shortened gestation periods and improved reproductive success. This could ultimately lead to population stability or increase.

Appendix B. Ecological Risk Assessment Information for Herbicides Proposed for the Non-Native Invasive Plant Control on the Shawnee National Forest.

Risk Assessment Application Rate	Terrestrial Mammals	Birds	Insects	Fish & Other Aquatic Receptors
Glyphosate (Source: SERA 2003a)				
2 lb a.i./acre (average rate) 2.4 a. i./acre (recommended rate for the Shawnee NF applications) 7 lb a. i./acre (maximum rate)	Effects resulting from average application rate are minimal. Some risk for large mammals consuming foliage for an extended period of time in areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk for small birds consuming insects for an extended period of time from areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk from maximum application rate to bees exposed to direct spray.	Effects resulting from average application rate are minimal. Some risks to fish near areas treated with maximum application rate using some of the more toxic formulations not labeled for use in aquatic settings.
Sethoxydim (Source: SERA 2001)				
0.09375 lb/acre (minimum rate) 0.375 lb/acre (maximum rate and recommended rate for the Shawnee NF applications)	No substantial risk at maximum rates.	No substantial risk at maximum rates.	Studies on beetle larvae suggest that rates exceeding maximum rates are relatively non-toxic.	No substantial risk at maximum rates. However, limited toxicological data available. Potential risk to aquatic plants from maximum rates is borderline.
Triclopyr (Source: SERA 2003b)				
1 lb a. i./acre (average rate) 3.75—8.0 lbs a.i./acre- (recommended rate for Shawnee NF applications) 10 lb a.i./acre (maximum rate)	No substantial risk at average rate. Some risk for mammals exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	No substantial risk at average rate. Some risk for large bird exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	No information.	No substantial risk when triethylamine (TEA) salt formulations are applied at average rate. Some risk to aquatic species when butoxyethyl ester (BEE) formulations are applied at average rate. Substantial risk when BEE formulations applied at maximum rate.
Clopyralid (Source: SERA 2004a)				
0.1 lb a. i./acre (typical rate) 0.5 lb a. i /acre- (recommended rate for Shawnee NF applications) 1.0 lb a. i./acre (maximum rate)	Reported to be relatively non-toxic, with little potential for adverse effects.	Reported to be relatively non-toxic, with little potential for adverse effects. However, based on limited available toxicological data.	Reported to be relatively non-toxic to bees, with little potential for adverse effects. However, based on limited available toxicological data.	Reported to be relatively non-toxic, with little potential for adverse effects. However, aquatic plants are somewhat more sensitive.
Picloram (Source: SERA 2003c)				
0.35 lb a. i./acre (typical rate) 1.0 lb a. i./acre (maximum rate and recommended rate for Shawnee NF applications)	Reported to be relatively non-toxic. Increases in liver weight have been observed in some mammals subjected to high rates.	Reported to be relatively non-toxic, with little potential for adverse effects even at higher rates.	Reported to be relatively non-toxic to bees, with little potential for adverse effects similar to effects on mammals and birds. However, this is based on limited available toxicological data.	Reported to be mildly toxic to freshwater fish. However, aquatic plants are somewhat more sensitive. The use of picloram in Forest Service programs is not likely to lead to adverse effects in aquatic species. However, this is based on limited available data.

Note: All rates noted, including "maximum rate", are labeled rates. See other Appendix tables for comparable information.

Appendix C. Herbicide Risk Characterization for Wildlife Species

Clopyralid (SERA 2004a)	
Mammals, Birds, and Terrestrial Invertebrates	No adverse effects are anticipated in terrestrial animals from the use of clopyralid in Forest Service programs at the typical application rate of 0.35 lb a.e./acre. The same holds for the maximum application rate of 0.5 lb a.e./acre, except for large birds or mammals feeding exclusively on contaminated vegetation over a long period of time (i.e., 90 days). The scenarios assume that the vegetation is treated and that the animal stays in the treated area consuming nothing but the contaminated vegetation. Given that most forms of vegetation would likely die or at least be substantially damaged, this exposure scenario is implausible. It is, however, routinely used in Forest Service risk assessments as a very conservative upper estimate of potential exposures and risks. The longer term consumption of vegetation contaminated by drift or the longer term consumption of contaminated water or fish – yield hazard quotients that are far below a level of concern.
Aquatic Organisms	Clopyralid appears to have a very low potential to cause any adverse effects in any aquatic species.
Soil Microorganisms	Maximum concentration of clopyralid in soil will be in the range of 0.2 to 0.25 mg clopyralid/kg soil at an application rate of 1 lb a.e./acre. At the maximum application rate of 0.5 lb a.e./acre, the estimated maximum soil concentrations would be in the range of 0.1 to 0.125 mg clopyralid/kg soil. These projected maximum concentrations in soil are far below potentially toxic levels.
Glyphosate (SERA 2003a)	
Mammals, Birds, and Terrestrial Invertebrates	Effects to birds, mammals, fish and invertebrates are minimal. Based on the typical application rate of 2 lbs a.e./acre, none of the hazard quotients for acute or chronic scenarios reach a level of concern even at the upper ranges of exposure. For the application rate of 7 lbs a.e./acre, there is some level of concern with direct spray of honey bees, for large mammals consuming contaminated vegetation, and small birds consuming contaminated insects. These concerns are based on conservative dosing studies and environmental conditions that are not likely to occur in the field.
Aquatic Organisms	Some formulations of glyphosate are much more acutely toxic to fish and aquatic invertebrates than technical grade glyphosate or other formulations of glyphosate. This difference in acute toxicity among formulations appears to be due largely to the use of surfactants that are toxic to fish and invertebrates.
Soil Microorganisms	Transient decreases in the populations of soil fungi and bacteria may occur in the field after the application of glyphosate at application rates that are substantially less than those used in Forest Service programs. Several field studies have noted an increase rather than decrease in soil microorganisms or microbial activity, including populations of fungal plant pathogens, in soil after glyphosate exposures. While the mechanism of this apparent enhancement is unclear, it is plausible that glyphosate treatment resulted in an increase in the population of microorganisms in soil because glyphosate was used as a carbon source and/or treatment with glyphosate resulted in increased nutrients for microorganisms in the soil secondary to damage to plants.
Sethoxydim (SERA 2001)	
Mammals, Birds, and Terrestrial Invertebrates	No adverse effects can be anticipated in terrestrial animals from the use of this compound in Forest Service programs.
Aquatic Organisms	There is no indication that fish, aquatic invertebrates, or aquatic plants are likely to be exposed to concentrations of sethoxydim that will result in toxic effects.
Soil Microorganisms	At sethoxydim concentrations <50 ppm, negligible response was noted in microbial populations. At higher concentrations (1000 ppm), soil actinomycetes and bacteria populations were stimulated, but fungal populations changed little.
Triclopyr (SERA 2003b)	
Mammals, Birds, and Terrestrial Invertebrates	Contaminated vegetation is the primary concern in the used of triclopyr and that high application rates will exceed the level of concern for both birds and mammals in longer term exposure scenarios. For terrestrial mammals, the central estimates of hazard quotients do not exceed the level of concern for any exposure scenarios. Tryiclopyr is slightly to practically non-toxic to birds and practically non-toxic to bees (http://npic.orst.edu/factsheets/triclogen.pdf).
Aquatic Organisms	At an application rate of 1 lb/acre, acute and chronic risks to aquatic animals, fish or invertebrates, as well as risk to aquatic plants are low with use of the salt form of triclopyr. At the highest application considered in this risk assessment, 10 lbs a.e./acre, the risks to aquatic animals remain substantially below a level of concern. The ester form of triclopyr is projected to be somewhat more hazardous when used near bodies of water where runoff to open water may occur.
Soil Microorganisms	The potential for substantial effects on soil microorganisms appears to be low. An application rate of 1 lb/acre is estimate to result in longer term soil concentrations that are well below 0.1 ppm – i.e., in the range of about 0.02 to 0.05 ppm – and peak concentrations in the range of about 0.2 ppm. Thus, if the

	laboratory studies are used to characterize risk, transient inhibition in the growth of some bacteria or fungi might be expected. This could result in a shift in the population structure of microbial soil communities but substantial impacts on soil – i.e., gross changes in capacity of soil to support vegetation – do not seem plausible. This is consistent with the field experience in the use of triclopyr to manage vegetation.
Picloram (SERA 2003c)	
Mammals, Birds, and Terrestrial Invertebrates	Even at a high dosage levels in Forest Service projects, effects on these species are minimal. There is concern for the effects of hexachlorobenzene one of the contaminant chemicals in commercial formulations. Hexachlorobenzene is considered as a mild carcinogen bu US EPA and there is concern for handlers and applicators.
Aquatic Organisms	Fish are moderately sensitive to this chemical at moderate and high use rates. Other aquatic species are minimally affected.
Soil Microorganisms	Soil microorganisms appear to be reduced at moderate levels of chemical application. However this is no evidence that these reductions would have any adverse effedts on soil productivity.

Appendix D. Mammalian Toxicity Data

Herbicide Formulation	Acute Toxicity						Chronic Toxicity		
	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	4 hour inhalation LC_{50} (rat)	Skin Irritation (rabbit)	Skin Sensitization (guinea pig)	Eye Irritation (rabbit)	24-Month Dietary NOEL (mouse)	24-Month Dietary NOEL (rat)	12-Month Dietary NOEL (dog)
	mg/kg BW		mg/L				mg/kg BW/day		
Glyphosate									
Glyphosate acid	5600	>5000	NA	None	No	Slight	4500	400	500
Blyphosate iso-propylamine salt	>5000	>5000	NA	None	No	Slight	Chronic toxicity data available only for technical glyphosate acid		
Glyphosate trimethylsulfonium salt	748	>200	>5.18 (usnpec.)	Mild	Mild	Mild			
ROUNDUP	>5000	>5000	3.2	None	No	Moderate			
RODEO	>5000	>5000	1.3	None	No	None			
LANDMASTER Glyphosate + 2,4-D	3860	6366	NA	Moderate	NA	Severe			
Sethoxydim									
Sethoxydim	2676	>5000 (rat)	6.1	None	No	None	18	NA	8.86
POAST	4.1	>5000 (rat)	>4.6	Moderate	No	Moderate	Chronic toxicity data available only for technical sethoxidim		
POAST PLUS	>2200	>2000 (rat)	>7.6	Slight	No	Slight			
Triclopyr									
Triclopyr acid	713	>2000	NA	None	Positive	Mild	5.3 (22 mo)	3	NA
GARLON 3A	2574	>5000	>2.6 (unspec.)	NA	NA	Severe	Chronic toxicity data available only for technical triclopyr acid		
GARLON 4	1581	>2000	>5.2 (unspec.)	Moderate	Positive	Slight			
Clopyralid									
Clopyralid acid	>5000	>2000	>1.3 (unspec.)	Very Slight	No	Severe	500 (18 mo)	50 (rat)	100
STINGER	>5000	NA	NA	NA	NA	NA	Chronic toxicity data available only for technical clopyralid acid		
Picloram									
Picloram acid	>3436	>2000	>1.63 (unspec.)	Very Slight	YES	Moderate	500 (24 mo)	20 (rat)	35 (dog)
TORDON	>8200	>4000	NA	NA	NA	NA	Chronic toxicity data available only for technical picloram acid		

Source: SERA 2001, 2003a, 2003b, 2003c, 2004)
NA = Not Available

Appendix E. Toxicity Data for Other Types of Wildlife, Herbicides Potentially Used as Part of Proposed Action

Herbicide Formulation	**Avian Receptors**				**Terrestrial Invertebrates**		**Aquatic Receptors**		
(Technical product unless specific formulation noted)	Bobwhite Quail		Mallard Duck		Earth-worm	Honeybee	Daphnia	Bluegill	Rainbow Trout
	Oral LD_{50}	8-day dietary LC_{50}	Oral LD_{50}	8-day dietary LC_{50}	LC_{50}	Topical LD_{50}	48-hour LC_{50} or EC_{50}	96-hour LC_{50}	96-hour LC_{50}
	mg/kg BW	ppm (in food)	mg/kg BW	ppm (in food)	ppm (in soil)	ug/bee	mg/L (in water)		
Glyphosate									
Glyphosate acid	>4640	>4640		4640		>100	780	120	86
Glyphosate trimethylsulfo-nium salt		>5000	950	>5000		>62.1	71	3500	1800
ROUNDUP					>5000	>100	5.3	5.8	8.2
RODEO							930	>1000	>1000
Sethoxydim									
Sethoxydim		>5620	>2510	>5620				100	32
Triclopyr									
Triclopyr acid		2934	1698	>5620		>100	133	148	117
Triclopyr butoxyethyl ester		5401		>5401		>100	1.7	0.36	0.65
Triclopyr triethylamine salt		>10000	3176	>10000		>100	775	891	613
Clopyralid									
Clopyralid acid		>4640	1465	>4640	1000	>0.1	232	125	104
Fosamine ammonium salt	>5000	>5620	>5000	>5620		Non-toxic	1524	590	330
Picloram									
Picloram salt	>2000	>10000	>2510	>10000		>0.1	68.3	14.5-19.4	5.5
TORDON	>2000	>5000	>2000	>5000			>100	10-100	10-100

Appendix F. Determination of Effect for Federally Listed and Candidate Species

CLASS	SPECIES	COMMON NAME	STATUS	Alt. 1	Alt. 2	Alt. 3
Mollusk	*Lampsilis abruptus*	pink mucket pearly mussel	E	NE	NLAA	NLAA
Mollusk	*Plethobasus cooperianus*	orange-footed pearlymussel	E	NE	NLAA	NLAA
Mollusk	*Potamilus capax*	fat pocketbook pearlymussel	E	NE	NLAA	NLAA
Mollusk	*Cumberlandia monodota*	spectaclecase	C	NE	NLAA	NLAA
Mollusk	*Plethobasus cyphus*	sheepnose	C	NE	NLAA	NLAA
Bird	*Sterna antillarum*	least tern	E	NE	NLAA	NLAA
Mammal	*Myotis sodalis*	Indiana bat	E	NE	NLAA	NLAA
Mammal	*Myotis grisescens*	gray bat	E	NE	NLAA	NLAA
Fish	*Scaphirhynchus albus*	pallid sturgeon	E	NE	NLAA	NLAA
Plant	*Asclepias meadii*	Mead's milkweed	T	NE	NE	NE

NLAA = Not Likely to Adversely Affect
NE = No Effect

NLAA was determined for pallid sturgeon and pink mucket, spectaclecase, and scaleshell mussels because effects are considered insignificant and/or discountable. NLAA was determined for Indiana bat, gray bat because effects are considered beneficial, insignificant, and/or discountable. No effect (NE) determinations were made due to lack of documented occurrences on National Forest lands, the project is outside the known or expected range of the species, and/or design criteria were incorporated into the project proposal and will be implemented to protect the species.

Literature Cited

Anderson, F. A. 2005. Conservation Assessment for the Carinate Pillsnail, *Euchemotrema hubrichti*. Shawnee National Forest, Harrisburg, Ill. 11 pp.

Berg, D. J., W. R. Haag, D. W. Garton, and J. L. Farris. 1993. Responses of native unionids to encrustation by zebra mussels. Page 178 *in* K. S. Cummings, A. C. Buchanon, and L. M. Koch, editors. Conservation and Management of Freshwater Mussels. Proceedings of a UMRCC symposium, 12-14 October 1992, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Bowles, M.L., J.L. McBride, and T. Bell. 2001. Restoration of the Federally Threatened Mead's Milkweed (*Asclepias meadii*). Ecological Restoration. 19(4): 235-241.

Buchanan, A.C. 1980. Mussels (naiades) of the Merrimac River Basin. Missouri Department of Conservation, Aquatic Series, 17: 1-68.

Carter, T.C., W. M. Ford, M.A. Menzel. 2000. Fire and Bats in the Southeast and Mid-Atlantic: More Questions Than Answers? In: The Role of Fire in Nongame Wildlife Management and Community Restoration: Traditional Uses and New Directions, Proceedings of a Special Workshop. Gen. Tech. Rep. GTR-NE-288. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. p. 139-143.

Carter, T. C., S. K. Carrol, J. E. Hofmann, J. E. Gardner, and G. A. Feldhamer. 2002. Landscape Analysis of Roosting Habitat in Illinois. In "The Indiana Bat, biology and management of an endangered species", A. Kurta and J. Kennedy editors, Bat Conservation International, Austin, Texas, pp.160-164.

Carter, T. C. 2003. Summer Habitat Use of Roost Trees by the Endangered Indiana Bat (*Myotis Sodalis*) n the Shawnee National Forest Of Southern Illinois. PhD. Dissertation. Department of Zoology in the Graduate School, Southern Illinois University, Carbondale, Ill. 96pp.

Carter, T. C., M. L. Miller, and T. J. Sichmeller. 2008. Annual Report Project: USDA-FS-08-PA-11090800-023, Monitoring Indiana Bat Maternity Colonies in Southern Illinois submitted to: Shawnee National Forest, Harrisburg, Ill., 16pp.

Cummings, K. S. and C. A. Meyers. 1992. Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey, Champaign, Ill., Manual 5. 194 pp.

Gardner J. E., J. E. Garner, and J. E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Illinois Natural History Survey/Illinois Department of Conservation, Champaign, Ill., 56pp.

Feldhamer, G. A., Carter, T. C., and B. J. Steffen. 2006. ANNUAL REPORT-PROJECT: USDA-FS-06-PA-11090800-018, Monitoring Indiana Bat Maternity Colonies in Southern Illinois. Submitted to: Shawnee National Forest, Harrisburg, Ill., 6pp.

Gumbert, M.W., J.M. O'Keefe, and J.R. MacGregor. 2002. Roost Fidelity in Kentucky, *In* The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Hanson, R. USDA-APHIS-PPQ, Forestry Sciences Lab, Montana State University, Bozeman, Mont. http://www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/a.flava.html; http://www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/a.lacertosa.html; and http://www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/a.nigriscutis.html.

Hardy, J. W. 1957. The Least Tern in the Mississippi Valley. Publ. Mus. Mich. St. Univ. Biol. Ser. Vo. 1 60pp.

Illinois Fish and Wildlife Information System. 2004. Illinois Birds-Least Tern. Illinois Natural History Survey Information Database, 8pp.

Jackson, J. L. 2005. Effects of wildlife stand improvements and prescribed burning on bat and insect communities: Buffalo Ranger District, Ozark-St. Francis National Forest, Arkansas. M.S. Thesis, Arkansas State University, Jonesboro, Ark., 162pp.

Kurta, A. 2005. Roosting Ecology and Behavior of Indiana Bats (Myotis sodalis) in Summer. *In* The Proceedings of the Indiana bat and coal mining: a technical interactive forum (K.C. Vories and A. Harrington, eds.). Office of Surface Mining, U.S. Department of the Interior, Alton, Illinois, pp 29-42.

Lauritsen, D. and G. T. Watters. 1986. Element stewardship abstract for general unionid mussel. The Nature Conservancy, Minneapolis. 9 pp.

Law, Jay R., R. Melick,C. Studyvin, and J.R. Steinman. Oak Decline in Missouri: History Revisited. 2004. Gen. Tech. Rep. SRS-73. Asheville, N.C.: U.S. Department of Agriculture, Forest Service, Southern Research Station. 311p.

Lewis, William M. and Stephen Flickinger. 1967. "Home Range Tendency of the Largemouth Bass *(Micropterussa/moides).*"EcoloID'1967:Vol.48 No.6.1020-1023.

Lovich, J. E. 1997. Wildlife as weeds. In, pp. 46-51. J. Lovich, J. Randall, and M. Kelly (eds.). Proceedings California Exotic Pest Plant Council Symposium '96.

Lyon, L.J., R.G> Hooper, E.S. Telfer, and D.S. Schreiner, 2000. Fire effects on wildlife foods. Chapter 7. *In* Smith, J.K. ed. Wildland Fire in Ecosystems: Effects of Fire on Fauna. Gen. Tech. Rep. RMRS-GTR-42-vol. l. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 51-58.

McClanahan, R. and Deaton, C. 2007. Indiana Bat Maternity Colony Monitoring Oakwood Bottoms GTR. Shawnee National Forest. 4pp.

Menzel, Michael A., Jennifer M. Menzel, Timothy C. Carter, W. Mark Ford, John W. Edwards. 2001. Review of the Forest Habitat Relationships of the Indiana Bat *(Myotissoda/is).* U.S. Forest Service, Northeastern Research Station, General Technical Report NE-284,pp.21.

Murray, S.W. and A. Kurta. 2002. Spatial and temporal variation in diet. Pp. 182-192 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, Texas.

NatureServe. 2009. Comprehensive Report for the Pallid Sturgeon (*Scaphirhynchus albus*). 16pp.

Oesch, R.D. 1995. Missouri Naiades. A Guide to the Mussels of Missouri. Second edition. Missouri Department of Conservation: Jefferson City, Missouri. viii + 271 pp.

Parmalee, Paul W. 1967. The freshwater mussels of Illinois. Popular Science Series, Vol VIII. Springfield,Ill. 107pp.

Pfliger W. L. 1997. Fishes of Missouri. Missouri Department of Conservation, Jefferson City, Mo. 372pp.

Personal communication between Rod McClanahan and Steve Widowski, Shawnee National Forest. 2008.

Romme, R.C., K. Tyrell, and V. Brack. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, *Myotis sodali*s. Federal Aid Project E-1-7, Study No. 8. 3/D Environmental. 38 pp. + appendices.

SERA. 2001. Sethoxydim – Human Health and Ecological Risk Assessment – Final Report. Prepared for USDA Forest Service, Forest Health Protection, October 31, 2001. Available online at: www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2003a. Glyphosate – Human Health and Ecological Risk Assessment – Final Report. Prepared for USDA Forest Service, Forest Health Protection, March 1, 2003. Available online at: www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2003b. Triclopyr – Human Health and Ecological Risk Assessment – Final Report. Prepared for USDA Forest Service, Forest Health Protection, March 15, 2003. Available online at: www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2003c. Picloram – Revised Human Health and Ecological Risk Assessment – Final Report. Prepared for USDA Forest Service, Forest Health Protection, June 30, 2003. Online: www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2004a. Clopyralid – Human Health and Ecological Risk Assessment – Final Report. Prepared for USDA Forest Service, Forest Health Protection, December 5, 2004. Available online: www.fs.fed.us/foresthealth/pesticide/risk.shtml

Shimp, E. 2005. Personal communication. Botanist. U.S. Forest Service, Shawnee Ranger District. Harrisburg, Illinois.

Smith, J.K. ed. Wildland Fire in Ecosystems: Effects of Fire on Fauna. Gen. Tech. Rep. RMRSGTR-42-vol. l. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 51-58.

Sparks, D.W., J.O. Whitaker, Jr., and C.M. Ritzi. 2005. Foraging ecology of the endangered Indiana bat. Pp. 15-27 *in* K.C. Vories and A. Harrington (eds.), The Proceedings of the Indiana bat and coal mining: a technical interactive forum Office of Surface Mining, U.S. Department of the Interior, Alton, Ill.

Stansbery, D.H. 1967. Observations on the habitat distribution of the naiad *Cumberlandia monodonta* (Say, 1829). American Malacogical Union Annual Report 1965(32): 16-17.

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Nature Conservancy. p. 3.3.

Tuttle, Merlin D. "Population Ecology of the Gray Bat *(Myotis Grisescens):* Factors Influencing Growth and Survival of Newly Volant Young." Ecology1976:587-595.

Tuttle, Merlin D. and Jim Kennedy. "New Hope for the Indiana Myotis." BATS 23 (2005): 1-7.

USDA Forest Service, Shawnee National Forest, 1986. Wildlife Habitat Evaluation Handbook, Forest Service Handbook 2609.21.

USDA Forest Service, 2001. Guide to Noxious Weed Prevention Practices. Washington Office. Online: www.fs.fed.us/rangelands/ecology/invasives.shtml.

USDA Forest Service, 2005. Biological Assessment for Federal Threatened and Endangered Species on the Shawnee National Forest. Shawnee National Forest, Harrisburg, Ill., 163pp.

USDA Forest Service, 2006a. Shawnee National Forest Plan, Final Environmental Impact Statement. 362pp.

USDA Forest Service, 2006b. Shawnee National Forest Land and Resource Management Plan. Shawnee National Forest, Harrisburg, Ill., 298pp.

USDA Forest Service, July 2008. Shawnee National Forest, Review of New Information Related to White-Nose Fungus.

USDA Forest Service, September 2011. Shawnee National Forest, Update of Review of New Information Related to White-Nosed Syndrome and Occurrence Information for Federally Listed Bats

USDA Forest Service, 2007. USDA Forest Service Strategic Plan FY2007-2012. Washington Office, Washington D.C. 32pp.

U.S. Fish and Wildlife Service, 1982. Gray Bat Recovery Plan. U.S. Fish and Wildlife Service, July 8, 1982.

U.S. Fish and Wildlife Service. 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, Minnesota. 53 pp.

USDI Fish and Wildlife Service. 2003. Mead's milkweed (*Asclepias meadii*) Recovery Plan. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 120pp.

U.S. Fish and Wildlife Service, 2005. Programmatic Biological Opinion for the Shawnee National Forest 2005 Forest Plan, Carterville, Ill.

USGS, 2007. http://nas.er.usgs.gov/taxgroup/plants/default.asp> Accessed 12-13-07.

Van Es, H. M. 1990. Pesticide Management For Water Quality: Principles and Practices. Pesticide Management Education Program, Cornell University: http://pmep.cce.cornell.edu/.

Westbrooks, R. G. 1998. Invasive Plants: Changing the Landscape of America. Federal Interagency Committee for the Management of Noxious and Exotic Weeds. Washington, D. C.: https://www.denix.osd.mil/denix/Public/ES-Programs/Conservation/Invasive/intro.html.

Yates, M.D. and R.M. Muzika. 2006. Effect of forest structure and fragmentation on site occupancy of bat species in Missouri Ozark forests. *Journal of Wildlife Management* 70:1238-1248.

Databases and Websites

Google Earth, 2004 version. http://earth.google.com/tour/thanks-win4.html

U.S. Fish and Wildlife Service at: http://www.fws.gov/htm

U.S. Forest Service Human Health and Ecological Risk Assessments website at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

USGS, 2007 at: http://nas.er.usgs.gov/taxgroup/plants/ and http://www.werc.usgs.gov/hq/invasive/

Waipuna System: at: http://www.ou.edu/cas/botany-micro/ben/ben316.html; http://www.waipuna.com; and http://www.waipuna.eom/releases/JAN2001.PDF

www.fs.fed.us/rangelands/ftp/invasives/documents/**Guide**toNox**Weed**Prev**Practices**_07052**001**.pdf